WIRELESS *for the* WARRIOR

Pamphlet Series

No. 7 Charging Set Lightweight 80 Watt

WftW Pamphlet No. 7.
Cover and layout: Louis Meulstee.
Cover illustration: Charging Set Lightweight 80 Watt as seen from left hand side.

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April 2023

WftW Pamphlet No. 7 Charging Set Lightweight 80 Watt.

About this publication.

WftW Pamphlet No. 7 was inspired when during preliminary research for (printed) material for a prospective new book entitled 'Power Sources' in the WftW Volume series, a boxed 'new old supply' Charging Set Lightweight 80 Watt was offered on loan to inspect and to take photographs. Both Charging Set Lightweight 80 Watt and Charging Set Pedal Driven 60 Watt (see WftW Pamphlet No.8) formed the backbone of battery charging for wireless equipment used by parachute troops.

Charging Set Lightweight 80 Watt was designed for charging 12 Volt batteries, used for powering wireless equipment such as Wireless Set No. 22, 62, Adm 5G (Modified)/R109 and 76/R109. It found primarily use by parachute and airborne troops in most any type of warfare.

Described in this pamphlet are technical details, starting, illustrated spare parts and tools list, some details of the history, projected replacement of a new type of generator (which never materialised), and a scan of the Working Instructions.

For more information about parachute and airborne forces communication, see the free to download WftW Volume 1 Amendment No. 2, entitled '*From Type 65 to Wireless Sender No. 76. A survey*'. This is a publication listed in the download section of www.wftw.nl

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Acknowledgements

Most of the information and illustrations in this pamphlet were retrieved from the Royal Signals Museum Archives with kind permission and assistance of current and past Directors and Staff of the Royal Signals Museum, Blandford Forum, U.K. I am indebted to Mike Willenbroek, Holland, for the loan of a new old supply Charging Set 80 Watt which allowed me to take photographs and study its construction.

Charging Set, Lightweight, 80 Watt

DATA SUMMARY

Manufacturer and type number: E. Pass and Co (EP Ltd), Enfield Cycle Co (EEC), Stuart-Turner (ST Ltd) and later also Aero Engines Ltd. Noted is Douglas Kingswood (DK Ltd), and Edgar Westbury Ltd though not in any official document.

Year of introduction: 1944.

Purpose: Charging 12V batteries. Primarily used by parachute forces and airborne troops.

-Engine-

Ignition: Magneto, fully screened. There was no cut-out.
Spark plug: 10mm, screened with pigtail earth to cylinder head. Type AC103M (10mm). Gap 0.012in.
Number of cylinders: Single cylinder, 4 stroke. Vertical mounted, side valve.
Carburettor: Suction type, fitted with adjustable jet.
Air cleaner: Burgess Fabric.
Rating: ⅜ BHP at full load @ 2800rpm.
Standard bore of cylinders: 1⅜in; Stroke 1½in.
Cubic cap.: 35cc
Exhaust: Flexible exhaust pipe ⅜in bore; 3ft length.
Silencer: Detachable flat box
Type of starting: Hand. Pulley and starting cord.
Rotating speed (RPM)**:** Normal 2800/3200; max no load 4500.
Method of cooling: Air-cooled.
Type of fuel: Clear unleaded petrol.
Fuel tank capacity: 4 pints.
Consumption: 0.45 pint per hour at full load.
Lubrication: Splash.
Grade oil: HD 30. Sump capacity ⅔ pint.

-Generator-

Manufacturer and type number: Lucas.
Type of generator: Alternator, Single phase 300Hz AC.
Output ratings: Continuous rating 80W**;** 18V DC at 4.5A.

Size (in) and Weight (lbs):	height	length	width	weight
Complete unit (dry)	14½	13¾	7¾	45

Accessories: See Working Instructions on page 22.
VAOS Catalogue number: Z2/ZB 10632.
EMERs: Power F100/F110/E220 depending on year of issue.

Introduction

Charging Set Lightweight 80 Watt was developed around 1943 for charging 12V accumulators for wireless equipment used by parachute and airborne forces. It was principally used with Sender Adm 5G (Modified) /R109, Sender WS76/R109, Wireless Sets Nos. 22 and No. 62 in special roles. According a 1967 CES catalogue the charging sets were in stores at least till that year. The 80 Watt charging set comprised a petrol engine, directly coupled to an alternator, both supported by anti-vibration spring mountings on the top of the petrol tank.
A guard frame and canvas cover with carrying handle were provided although the early production model the charging set was enclosed in a sheet metal cover with carrying handle. The silencer and flexible exhaust pipe were detachable and stowed underneath the cover when not in use (believed not in all versions). A cord and handle for starting the engine were in pockets at the end shield.

Engine

The petrol engine was four-stroke, air cooled supplied to the engine from a fan which was integral with the flywheel. It was lubricated by splash from the sump; a dipstick was attached to the oil filler plug. The filling cap of the petrol tank had a screw down vent which should be screwed up to open the air vent when operating the generator set. Filters were provided in the filler opening at the tank end of the petrol suction pipe, and beneath the petrol cock flange. The most important and easiest accessible was the filter in the filling orifice. The flexible exhaust pipe and silencer (a flat unit with the size of a small cigar box with rounded sides) were disconnected from the engine when in transit; one end of the flexible pipe screwed for attachment to the exhaust outlet on the cylinder, the other end connected to the silencer by means of a clip and wing nut.

Generator

The single phase 300Hz AC power from the fully enclosed, permanent magnet inductor alternator was rectified by a full wave metal type rectifier which was mounted upon the alternator frame. This rectifier was directly connected between the alternator and the DC output terminals. Wireless interference from the ignition of the engine was fully suppressed.

Starting procedure (Taken from the Working Instructions)

- Turn on the petrol which is done by pressing the tap handle down to a horizontal position at right angles to the petrol pipe, and open the air vent screw on the filler cap.

Cold start:

- Turn the air sleeve to the position marked '0 Choke'
- Take the starter cord from the pocket in the end panel and put the knot on the end of the cord into the slot on the pulley. Wind the cord round the pulley in a clock-wise direction for about 8 or 9 turns.
- Rotate the engine by a steady pull on the cord, wind the cord on the pulley and rotate the engine once more.
- Turn the air sleeve on the end of the carburettor to the position marked '1 Cold start'. Again rotate the engine by winding the cord round the pulley and giving a steady pull.
- Turn the air sleeve to the position marked '2 Hot start'. Wind the cord on the pulley and rotate the engine as before when it should start. As soon as the engine fires turn the air sleeve to the position marked '3 Run'. It is desirable to allow the engine to run for about 30-60 seconds before putting on load.
- If the engine does not start repeat the procedure at '1 Cold start' when the engine should start without difficulty.

Warm start:

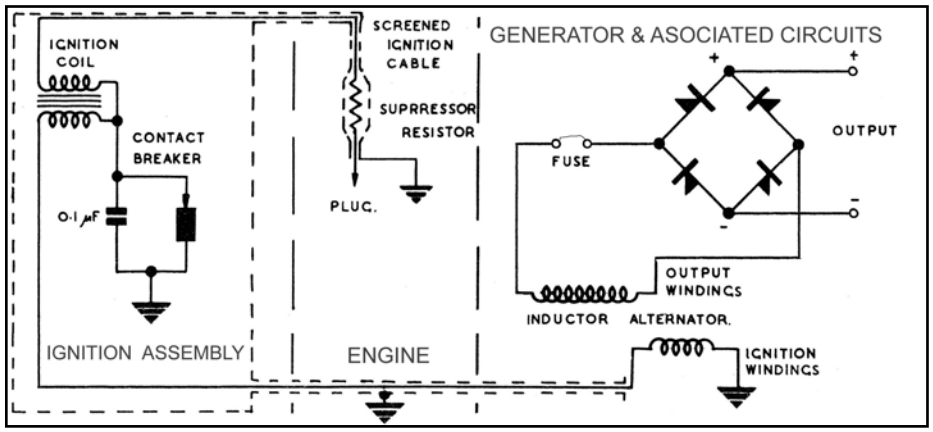
- If the engine has been stopped for a period not exceeding 30 minutes set the air sleeve to the position marked '2 Hot start' and continue the procedure as detailed above in '2 Hot start'

Stopping the engine

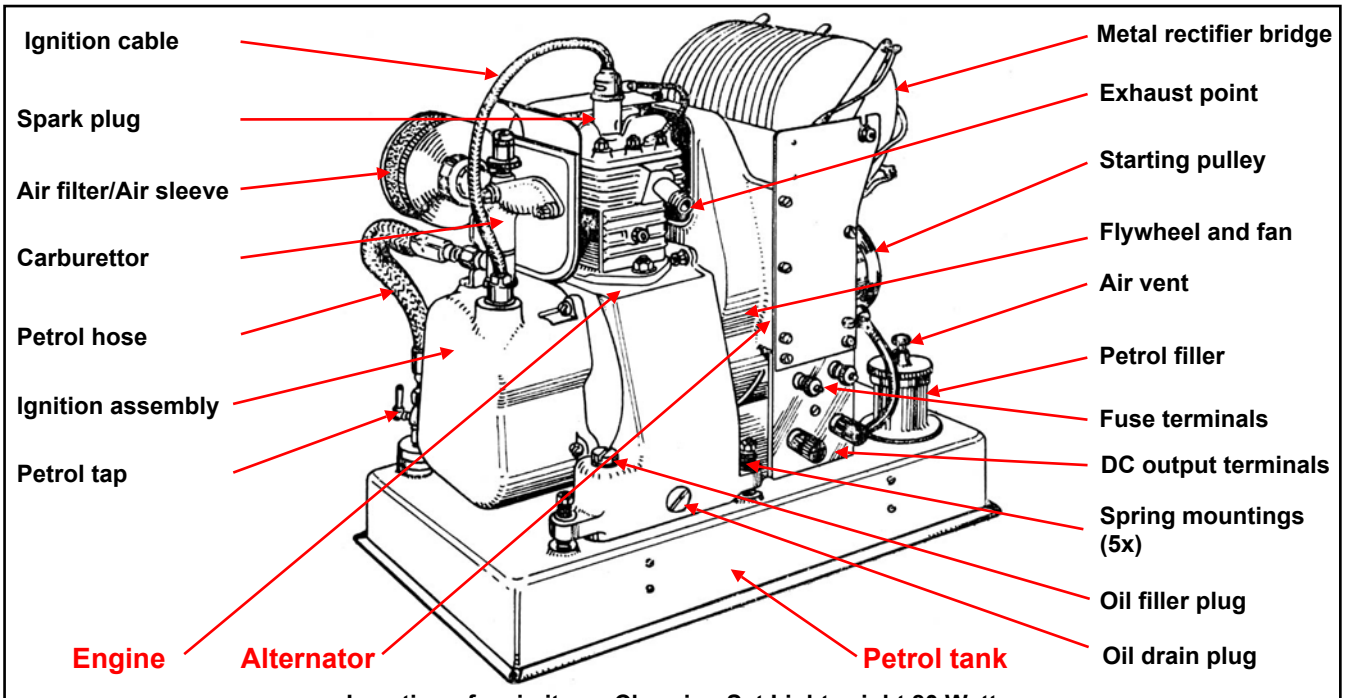
- To stop the engine turn off the petrol tap. It should be noted that the end panel cannot be replaced on the set unless the petrol cock is shut. If the set is to be moved or not to be used the air vent screw should be shut by screwing it down.

Routine maintenance

- Clean the air filter frequently, especially when working in a dirty atmosphere. To do this remove the end cover and take out the fabric element. Shake it until it is clean, then replace. If the filter element is very dirty or has become contaminated with oil it should be replaced. As a temporary measure only when no replacement is available, it may be washed in petrol and replaced when dry.
- Check the gap between the electrodes on the sparking plug. As this is a small plug it is liable to increase rather rapidly and it is essential that the gap should be checked at least once in every 24 hours of running. The correct gap , 0.012in. can be measured by means of the feeler on the magneto spanner.

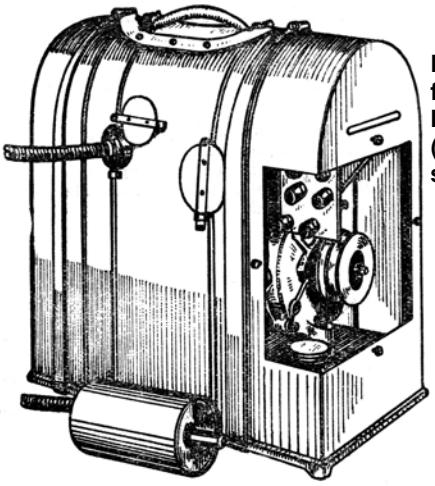


Electrical circuit of the Charging Set Lightweight 80 Watt.

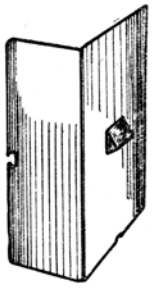


Location of main items Charging Set Lightweight 80 Watt.

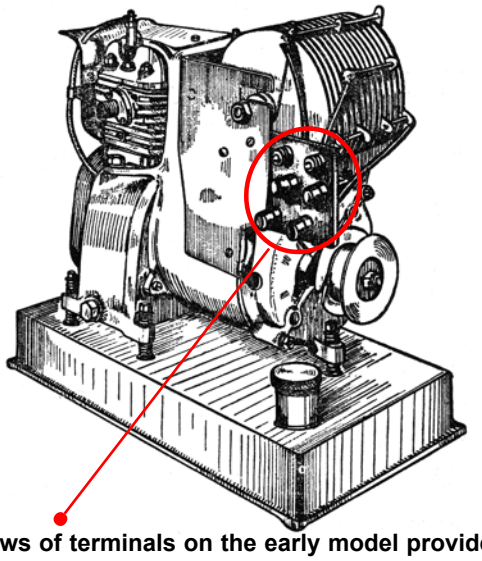
Early model and output terminals.



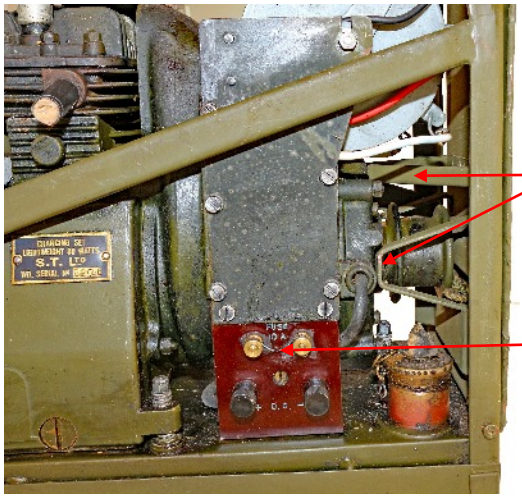
Left hand side view showing flexible exhaust pipe and cylindrically shaped silencer (left). See below for the later standard flatbox silencer.



The first version of the 80W Charging set was enclosed in a sheet metal cover incorporating a carrying handle. The later issued models had a guard frame with canvas cover.



Three rows of terminals on the early model provided DC output (bottom), two insulated terminals for AC output (middle), and on top a pair of brass terminals as a main fuse, connected with 10A fuse wire (in the Working Instructions 5A is noted). This fuse was in the AC circuit.



The front cover plate had three plates serving as buffers during the impact shock when the container landed on the ground. It was therefore mandatory that the pulley end of the generator was placed towards the percussion head side of the container Type F. See item 5 on page 12.

Left hand bottom side view of later standard issue 80 Watt charging set showing two brass terminals marked Fuse 10A and below insulated DC output terminals, mounted on a Paxolin plate.

‘Flatbox’ silencer and flexible exhaust pipe.

New old supply 80W charging set preserved and boxed.

Printed on cardboard labels attached to the engine were warnings that the engine had been preserved and certain precautions were required before starting it.

The photographs on this and the next page were taken from an un-issued 80 Watt charging set, still in state of conservation, complete with accessories and spares in its original wooden box with bag of silica gel desiccant.

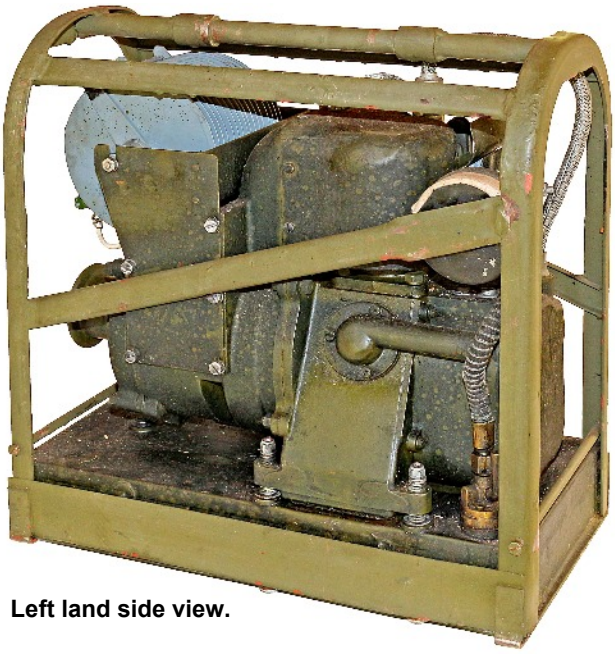
Contents of Tools and Spares box.

The folded working instructions fitted snugly into the tools and spares box.

Miniature spark plugs.

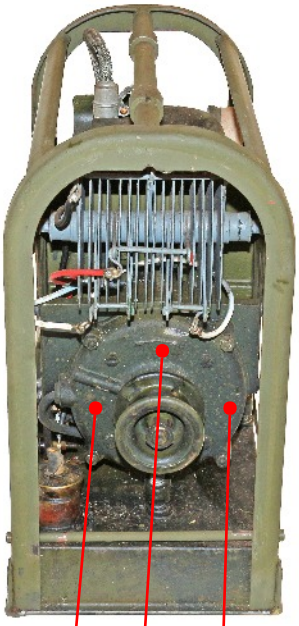
Contents of tools and spares box for Charging Set Lightweight 80 Watt. Most items were encased in grease but after many years of storage this is now a hardened messy substance, particularly the gaskets and feelers clumped together. A full list of all items is printed in the Working Instructions on page 22 of this pamphlet.

Right land side view.



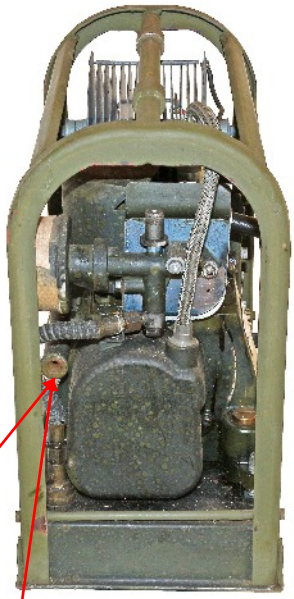
Left land side view.

Detailed views of a Charging Set Lightweight 80 Watt, as seen from different angles.



Rear view

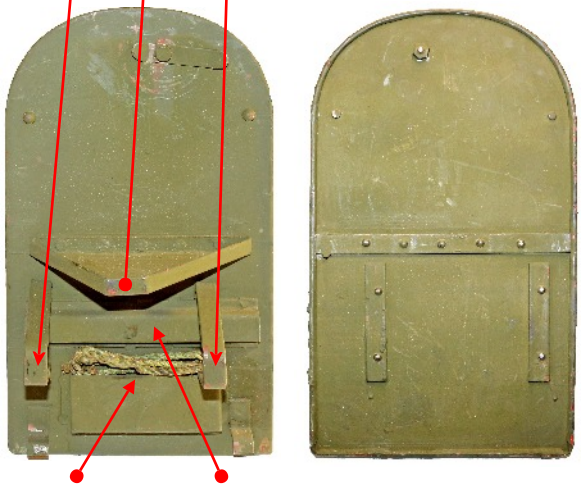
Canvas cover of 80 W Charging Set.



Front view

Three projections on the end shield served as buffers during the impact shock when the Type F container landed on the ground.

During transport the breather device of the oil sump was closed by a spring loaded valve fitted on the front shield.



Starting cord Starting handle

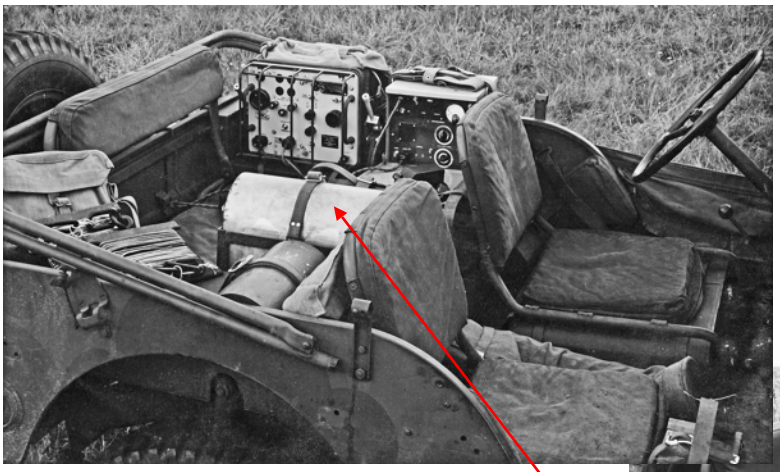
End shield: Inside left; outside right.

Front shield: Inside left; outside right.

List of currently known applications of Charging Set Lightweight 80 Watt in wireless stations.			
	Wireless Station	**Transport**	**Carrier type for 80 Watt Charging Set**
1	Adm 5 G/R109	Airborne Car 5-cwt. 4x4 (Jeep)	Frames Securing No. 3 (Not yet confirmed)
2	WS No. 22	Airborne Car 5-cwt. 4x4 (Jeep)	Frames Securing No. 3 (Not yet confirmed)
3	WS No. 76/R109	Airborne Trailer ¼-Ton	Carrier Charging Sets 80 Watt, No. 1
4	Adm 5G/R109	Animal Pack	Carrier Generating Sets No. 10
5	WS No. 22	Animal Pack	Carrier Generating Sets No. 10
6	WS No. 76/R109	Animal Pack	Carrier Generating Sets No. 10
7	WS No. 62	Animal Pack	Carrier Charging Sets 80 Watt, No. 1
8	WS No. 62	Jeep/Animal/Manpack	Carrier Charging Sets 80 Watt, No. 1
9	WS No. 62	Trailer/Animal/Manpack	Carrier Charging Sets 80 Watt, No. 1

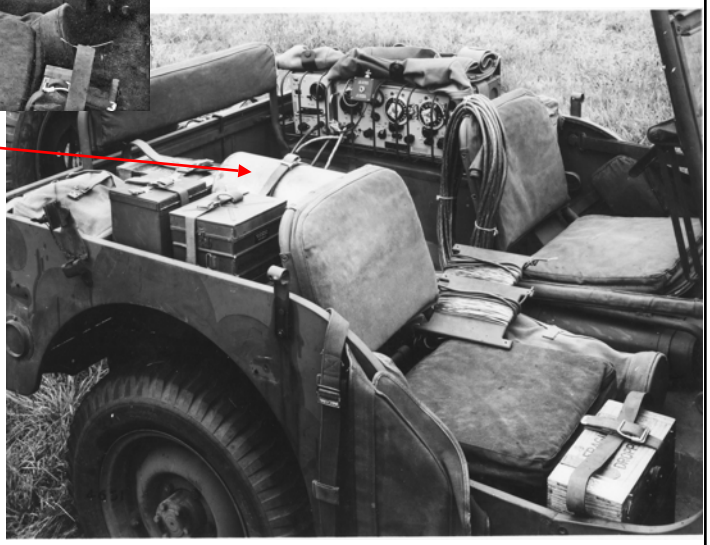
Charging Set Lightweight was developed for charging batteries used with parachute and airborne forces wireless sets such as WS76/R109 and Adm 5G/R109 rear link stations, in addition to WS Nos. 22 and 62. These stations, their method of transport and type of carrier are tabulated above. Noted in some cases a Charging Set 300 Watt Mk.I was issued in lieu of the 80 Watt set. Information for compiling this list was drawn from working instructions, fitting instructions, and station lists.

Charging Set Lightweight 80 Watt in Car 5-cwt. 4x4.



Wireless Sender Adm 5G and R109 with Charging Set lightweight 80 Watt fitted in an airborne jeep transported on a glider (left). The 80 Watt set was carried in an angle metal frame (believed Frames Security No. 3) attached to the floor of the vehicle. The station could only be used at a halt for erecting a 110-ft wire aerial.

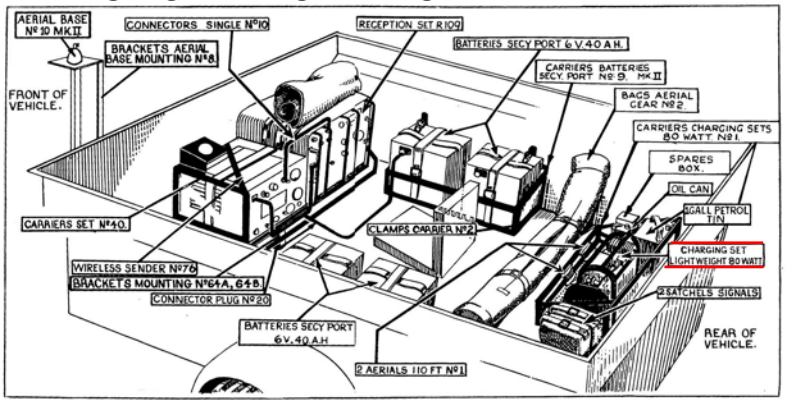
Position of fitting Charging Set Lightweight 80 Watt in Airborne Car 5-cwt. 4x4.



Wireless Set No. 22 station with Charging Set Lightweight 80 Watt in an airborne jeep carried in a glider (right).

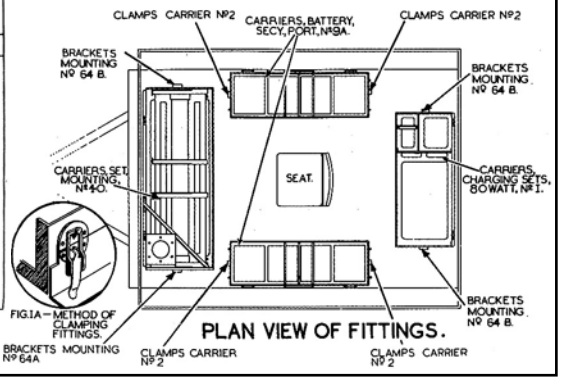
This station was functionally similar to the animal pack version shown on next page which used the early models of standard carriers.

Charging set Lightweight 80 Watt in Trailer 10-cwt WS 76/R109 station.

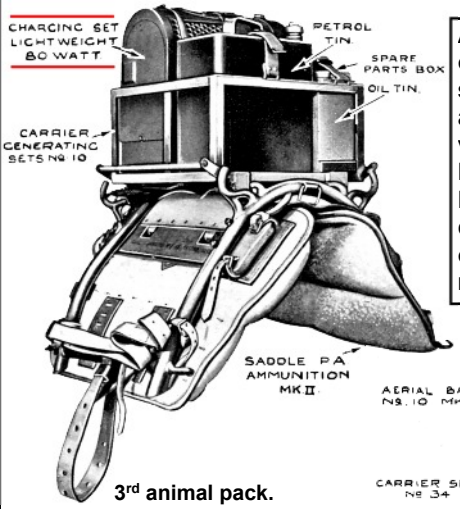


Wireless Sender No. 76 and Reception Set R109 with Charging Set Lightweight 80 Watt in and airborne glider trailer.

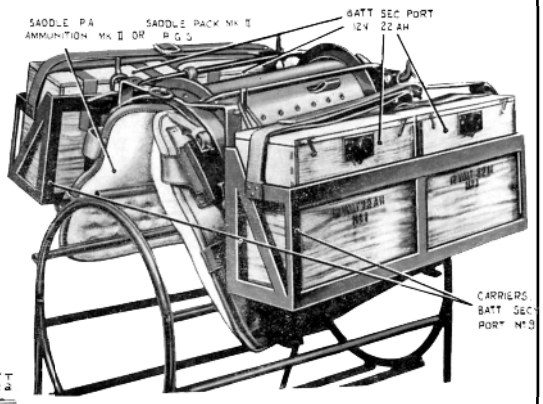
Charging Set Lightweight 80 Watt was mounted on Carrier Charging Sets 80 Watt, No. 1 (below).



Charging Set Lightweight 80 Watt in animal pack station WS No. 22, Adm 5G/R109 and WS 76/109 .

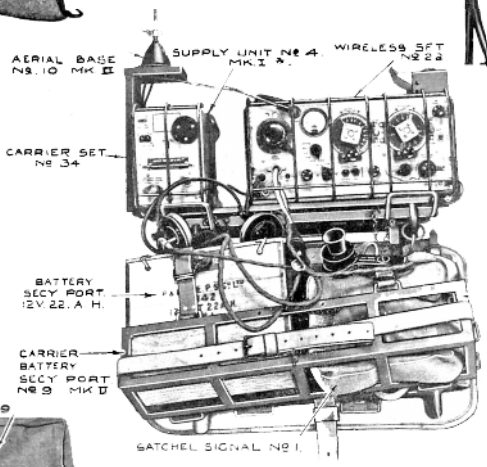


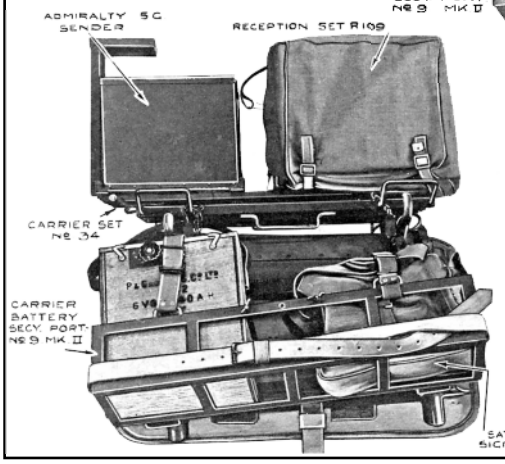
A WS No. 22, Adm 5G/R109 or WS 76/R109 animal pack station was carried by three animals on pack saddles divided over side and top loads.
Each load, packed in a special carrier which was slung or attached on the pack animal saddle.



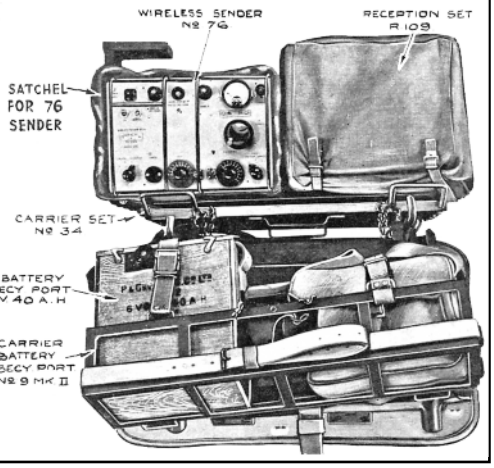
2nd animal pack.
The second animal pack comprised two side loads of each two batteries, 12V 22Ah for WS 22 or 6V 40Ah for the other stations (above).
Variations of this load and of the first animal pack (WS 22) were noted

3rd animal pack.
Carrier Generating Sets No. 10 with Charging Set Lightweight 80 Watt with petrol and oil tins, was clamped on top of the saddle pack (above).

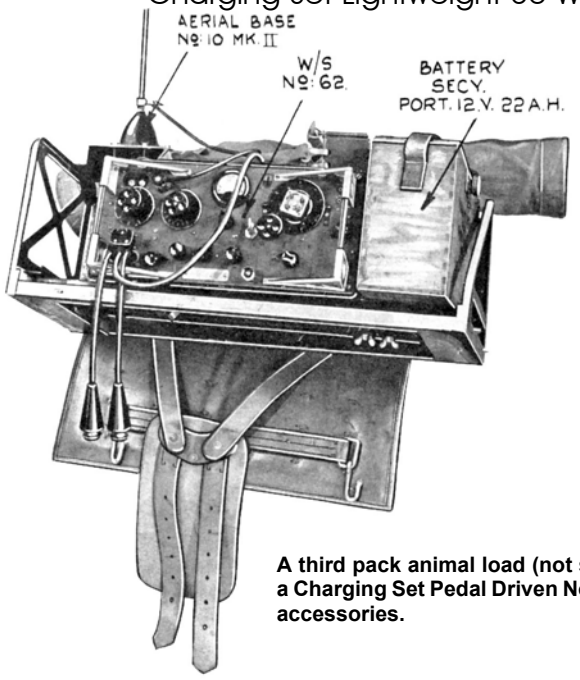




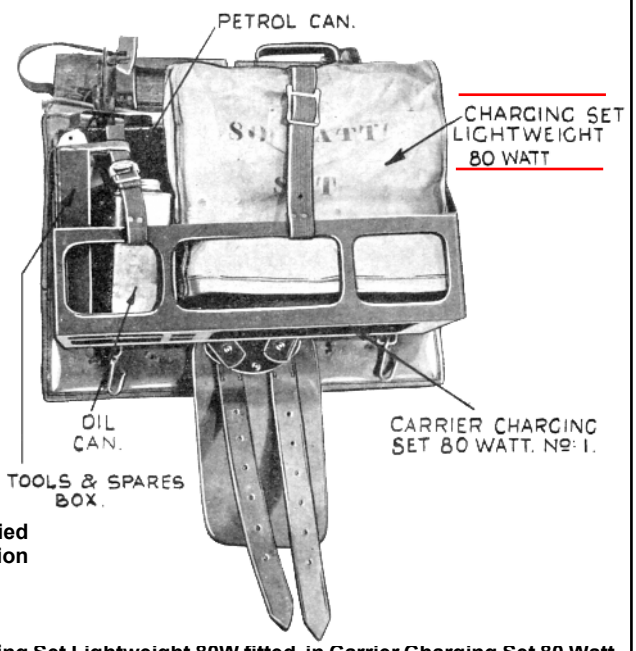
1st animal pack.
Shown in the illustrations above, left and right and as seen from the nearside was the distribution of the first animal pack station Adm 5G/R109 (left), WS 22 (above) and WS 76/R109.
Note that the Aerial Base No. 10 was only fitted on Carrier Set No. 34 of the WS 22 as the other two stations could not be operated on the move.



Charging Set Lightweight 80 Watt in WS No. 62 animal pack/man pack station.



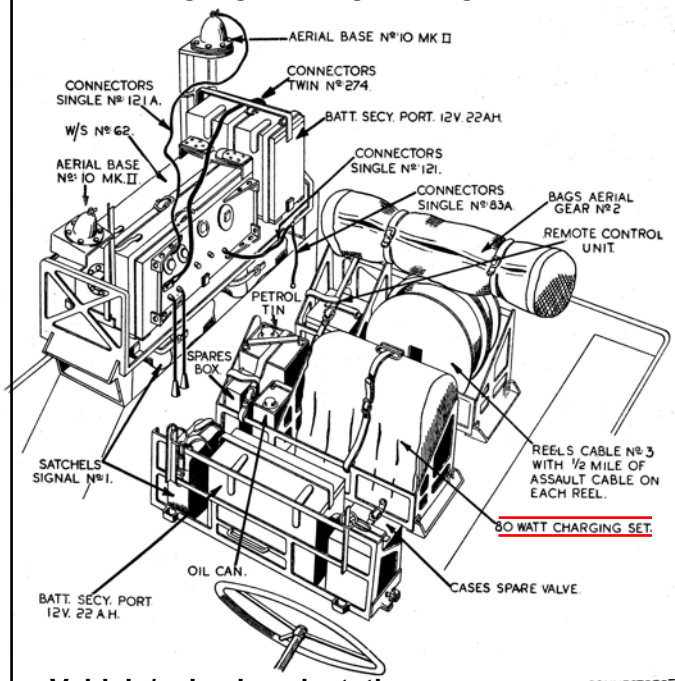
A third pack animal load (not shown) carried a Charging Set Pedal Driven No. 1 and station accessories.



Wireless Set No. 62 fitted in Carrier Set No. 40 along with a 22Ah accumulator carried the nearside of the first animal (above).

Charging Set Lightweight 80W fitted in Carrier Charging Set 80 Watt No. 1, carried on the near side of the second animal of a No. 62 animal pack station (left). Note text on canvas cover '80 watt set'.

Charging Set Lightweight 80 Watt in WS No. 62 Car 5-cwt. 4x4 stations.

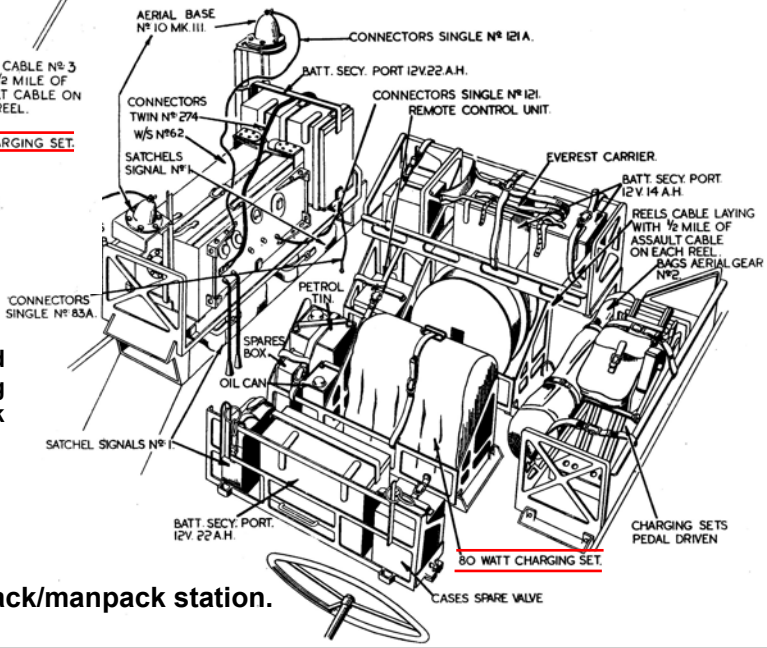


Vehicle/animal pack station

The carriers fitted in the vehicle are so arranged that they may be taken from their supporting brackets and slung from the harness of a pack animal.

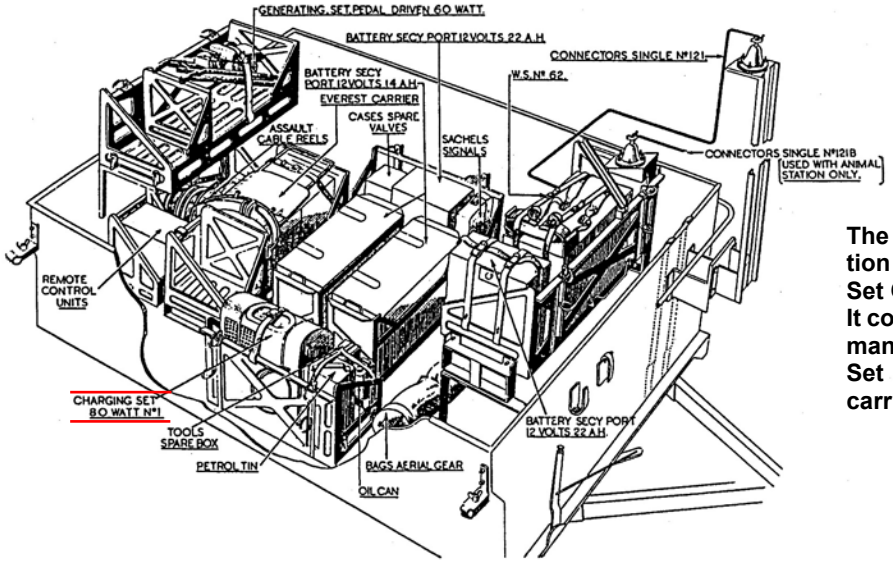
Charging Set Lightweight 80 Watt as part of a Wireless Set No. 62 station fitted in a standard jeep with carriers for an animal pack station (left). An alternative version of this station was suitable for conversion to an animal and manpack station (see also page 10).

This station was principally similar to the No. 62 Set 10-cwt trailer station.



Vehicle/animal pack/manpack station.

Charging Set Lightweight 80 Watt in WS No. 62 Trailer 10-cwt. Station.

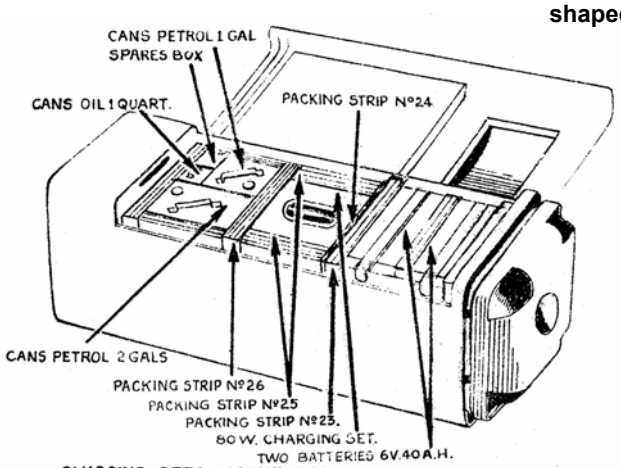


The equipment arrangement of this station was principally similar to the No. 62 Set Car 5-cwt 4x4 station above.
It could be converted to an animal pack or man pack station. For this a Generating Set Pedal Driven No. 1 and an Everest carrier was added.

Charging Set Lightweight 80 Watt in Handcart Wireless No. 1 with Adm 5G/R109 station.

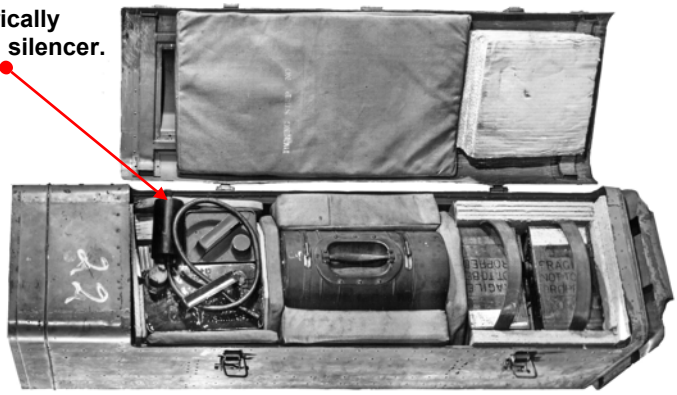
Handcart No. 1 was provided primarily for transport of wireless equipment during beach landings. The equipment was packed in waterproof bags No. 8 and No. 6 which rendered it immersion proof during the landing. The station was carried in two handcarts, the first with an actual wireless station and the second with spare batteries and a charging set which could either be a Charging Set Lightweight 80 Watt, or a Charging Set 300-Watt No. 1.

Charging Set Lightweight 80 Watt in Type F container.



CHARGING SETS LIGHTWEIGHT 80W. IN CONTAINER.

Cylindrically shaped silencer.



Type 'F' container loaded with an early version of Charging Set Lightweight 80 Watt, spared box, petrol, oil and two 6V 40Ah batteries. Note that the early version had a different cylindrically shaped silencer (See also page 6 top left).

17. Charging Sets Lightweight 80 W in Type F Container

Packings Transit Sets No. 6 are used for this packing. This comprises:-

ZA.21011	Packing Strip	No. 23	1	ZA.17802	Packing Strip	No. 15	8
21012	" "	No. 24	2	17803	" "	No. 16	3
21013	" "	No. 25	2	17808	" "	No. 21	1
21014	" "	No. 26	1	20950	Packing Transit Battery		No. 8
21015	" "	No. 27	2	21016	" "	"	No. 9
20964	" "	No. 22	1				
17801	" "	No. 14	1				

Proceed as follows:-

(1) Open container and remove metal baffle nearer parachute end.

(2) Place Packing Strip No. 21 in bottom of smaller compartment at buffer end. Place Packing Strip No. 14 vertically at buffer end and four Packing Strips No. 15 each side of this compartment.

(3) Fit one Battery 6 V 40 Ah at the buffer end of this compartment with adaptor towards inside. Place two Packing Strips No. 16 alongside the battery and fit in a second battery with its adaptor towards first battery.

NOTE: *The batteries must be tightly packed.* For any variation in packing space use remaining Packing Strips No. 15 cut as required.

(4) Place Packing Strip No. 24 in the bottom of the larger compartment, Packing Strip No. 23 vertically against the metal baffle at the end nearest the batteries and one Packing Strip No. 25 on either side with the Packing Strip No. 22 in front of this.

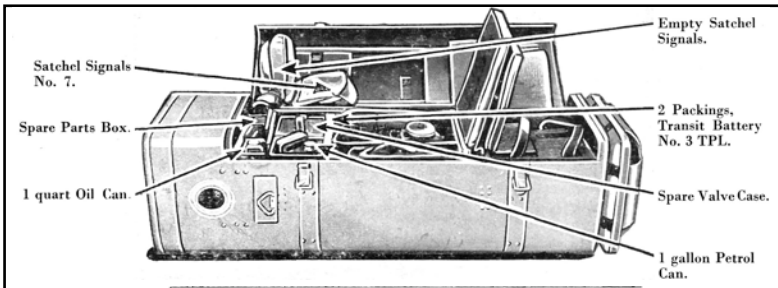
(5) Place the 80 W Generator into the space so formed with the pulley end of the generator towards the percussion head end.

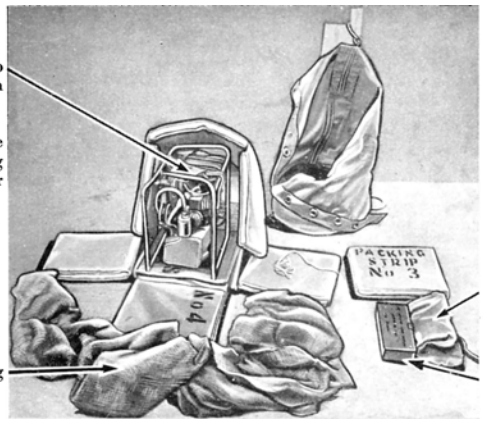
(6) Place a Packing Strip No. 26 against the open end of the generator space, and pack each side of the remaining space with a Packing Strip No. 27.

(7) Insert a two gallon petrol can, right way up, flat against the side away from container lid and insert a one gallon petrol can in remaining space at end nearer generator, followed by the oil can and tool box. At the parachute end slide in a Packing Strip No. 15 and a smaller Packing Transit Battery No. 9 to wedge in the two gallon petrol can.

(8) Place the exhaust pipe and silencer for the generator engine on top of the cans.

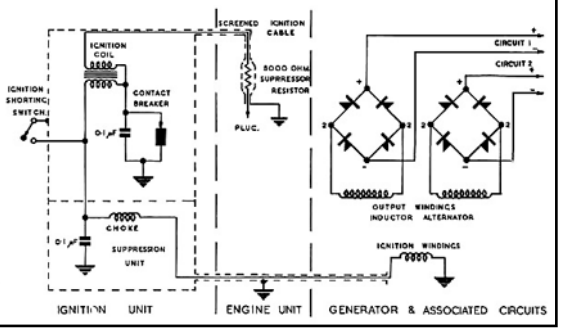
(9) Cover the batteries with a Packings Transit Battery No. 8 and the remainder of the equipment with a Packing Strip No. 24.





Charging Set Lightweight 40-60 Watt.

Charging Set Lightweight 40/60 Watt was projected as successor of the 80 Watt lightweight charging set of which development had started in 1944. Either 6V or 12V accumulators could be charged. It was suitable to be packed in a Parachutist Kitbag or a Type 'F' container. A small number were made for trials, but it never went into production due to changes in policy. (See also page 14).



After WW2

In 1944 the design for a replacement 80 Watt charging set had begun at SRDE. As lightweight charging sets were only used for specific applications, such as special missions, development was probably considered as a low priority which showed in the years to follow.

- *SRDE Progress report No. 8 Oct 1945/May 1946*:
Work was continuing to consolidate the designs of all approved generating and charging sets, to produce circuits, drawings and working instructions, and six models of the final designs which will be suitable for further production methods. These were Charging Set 6kW DC 110 Volts; Generating Set 6kVA 50Hz 230 volts; Charging Set 1kW (30-100 volts 10 amps); Charging Set Pedal Driven 60 Watt No. 2, and Charging Set 40/60 Watt. The latter was designed as a manpack load to withstand both parachute dropping and tropical conditions (believed to be a replacement of Charging Set 80 Watt). The design was approved in 1946 and manufacturing date complete, tests had been satisfactory and the manufacture of six models was proceeding. This was called the new series.
However, in the same progress report a new 'Future Policy of Power Unit Design' was given which envisage to standardise on four main requirements, 500 Watt DC, 2 kW DC, 2½ kW AC, 10kW DC, 10kW AC, with the 2/2½kW and 10kW utilising the same engine. In addition a 100 Watt man-pack set with DC output for battery charging, suitable for parachute dropping as a replacement of the 80 Watt charging set.
- *SRDE Advanced data April 1947:*
April 1947 early stages of development 100W and other mentioned above
- *SRDE Quarterly Progress Report Sept. 1949:*
It was not until late 1949 that some progress was made with development of the Charging Set 100W and two generators were delivered by Newton Bros for belt drive version, '….hitherto there has been little hope of obtaining a really satisfactory miniature petrol driven generator for forward area sets such as WS No. 62; the only engines available have been of the model aero engine type, with a too erratic a performance for army use. However, in the light of recent developments at Ricardo in small sleeve engines it is now thought possible to produce a 40 Watt output petrol generating set with an overall weight of about 10 pounds. A contract was placed at Messrs Ricardo of a miniature petrol engine of about 7 ½ cc for these requirements…' Messrs Ricardo and Vincents were working on experimental models of the 100 Watt charging set, to be expected in 1950.
- *SRDE Quarterly Progress Report Sep. 1950:* Delivery of 100 Watt Ricardo belt drive and Newton direct drive still testing. Miniature Generating set by Ricardo still in development
- *SRDE Quarterly Progress Report Dec. 1950:* Miniature Generating Set mock up model 200 hrs running. 100 Watt manpack model first manpack model. Stuart Turner approached of manufacturing B models.
- *SRDE Quarterly Progress Report June 1952:* Work slow at Miniature Generating Sets with various models are under development. Development on the 100 Watt Generating Set was abandoned after a new requirement of a 150 Watt set was raised in July 1951. Tests with the 150 Watt Charging set were carried out in the late 1950s.

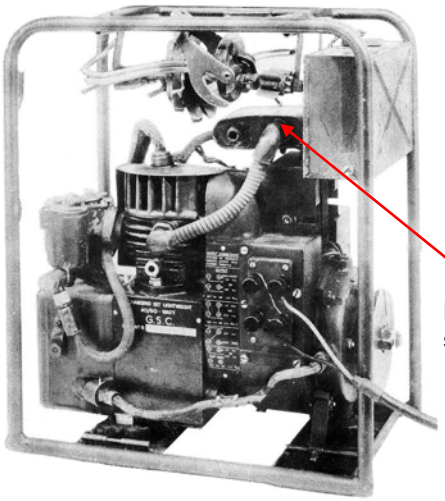
The first notation of the employment of Charging Set Lightweight 80 Watt was in the station list of Wireless Station Admiralty 5G (Modified) in Handcart Wireless No. 1, issued in June 1943, and in Wireless Station, Admiralty 5G (Modified) with R109B in Trucks, 5-cwt. F.W.D. Jungle Station. The 80 Watt charging set was issued in place of Charging Set 300 Watt Mk.I, fitted in 'Carrier, Generating Sets No. 8', ZB11131.

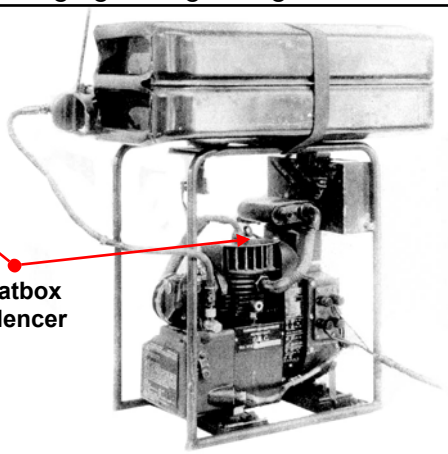
Neither of the 40/60W, 100W and 150W (lightweight) charging sets which were projected after 1945 as a replacement of the Charging Set Lightweight 80 Watt came into production as far as can be traced.

In the 1967 Catalogue of Army Publications, Part V, 'Index of complete equipment schedules', the only lightweight charging set was *'Code No. 38006, Charging Set, E.D., 80W 18V, complete with tools and spares, Catalogue No. X2/ZB 10632, Depot Donnington'.*
Stores of the Charging Set Lightweight 80 Watt were probably (not confirmed yet) held till the late 1960s.

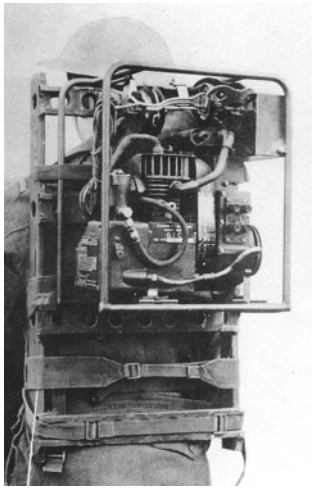
— Prototypes and trial models of projected lightweight charging sets.—

Charging Set Lightweight 40/60 Watt.



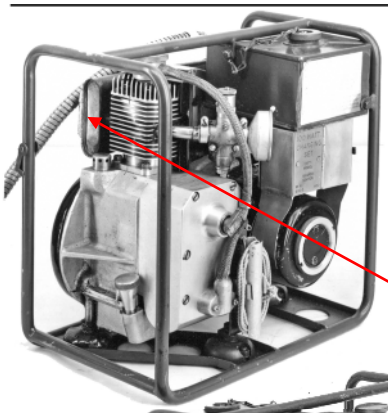


Flatbox silencer



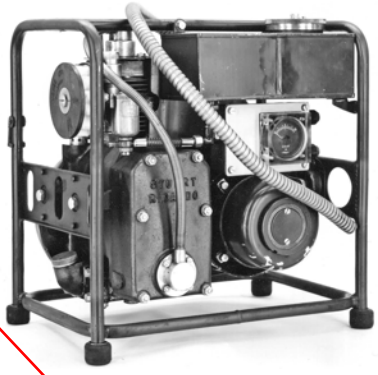
Use of a Jerrycan as fuel tank.

Charging Set 100 Watt.

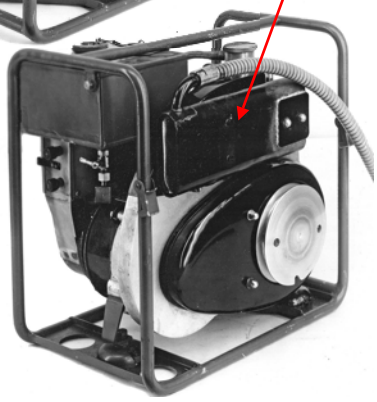


Charging Set 100 Watt Ricardo (Left).

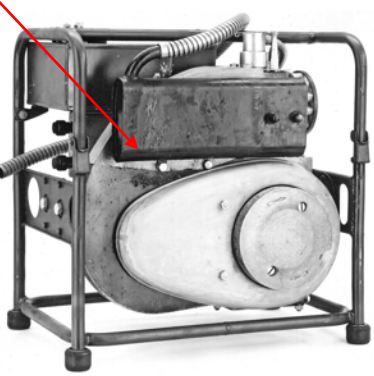
Both experimental models of the Charging Set 100 Watt had a belt reduction drive.



Flatbox silencer

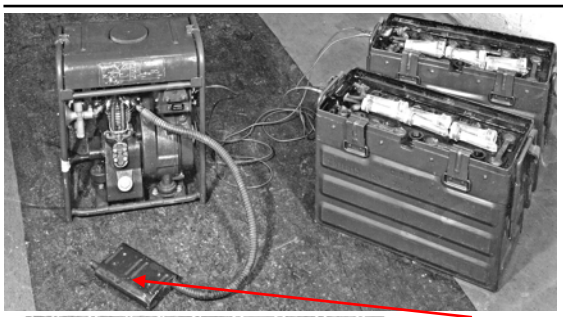


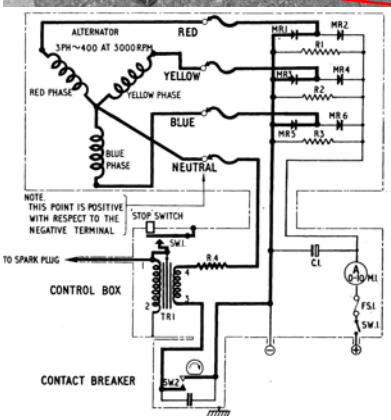
It is interesting to note that all the later developed lightweight charging sets had a flatbox silencer, quite similar to the one issued with Charging Set Lightweight 80 Watt.

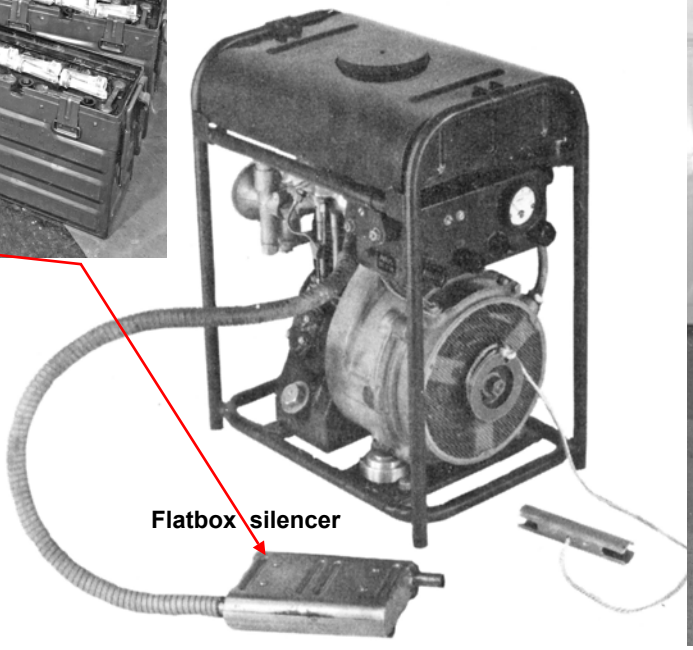


Charging Set 100 Watt Stuart/Ricardo (right).

Charging Set 150 Watt.







Flatbox silencer

CHARGING SET, LIGHTWEIGHT, 80W (ZB10632)

DATA SUMMARY

PURPOSE

Charging of 12V wireless batteries. For use with paratroops, airborne troops, jungle, arctic and mountain warfare.

DESCRIPTION

Single-cylinder air-cooled engine, direct-coupled to single-phase alternator and rectifier mounted on anti-vibration mountings on sheet metal base incorporating petrol tank. Enclosed in detachable sheet metal cover incorporating carrying handle (later models have tubular guard frame with canvas cover). Detachable silencer and flexible exhaust pipe.

PHYSICAL DATA

Weight : 45 lb. (dry) Width : 7¾ in.
Height : 1 ft. 2½ in. Length : 1 ft. 1¾ in.

ENGINE

Make, etc. : E. Pass and Co., Enfield or Stuart-Turner, 35 c.c., single-cylinder, vertical, 4-stroke, side-valve, air-cooled.
Rating : ½ H.P. (approx.) at 2,500 R.P.M. Normal speed, 2,600/2,800 R.P.M. Max. speed, 3,800 R.P.M.
Fuel : Petrol. Consumption, 0.45 pt./hour (full load). Tank capacity, 4 pints.
Lubrication : Splash. Oil. H.D. 30. Sump capacity, 2/3 pt.
Ignition : Magneto, fully screened.
Starting : Hand. Pulley and starting cord.

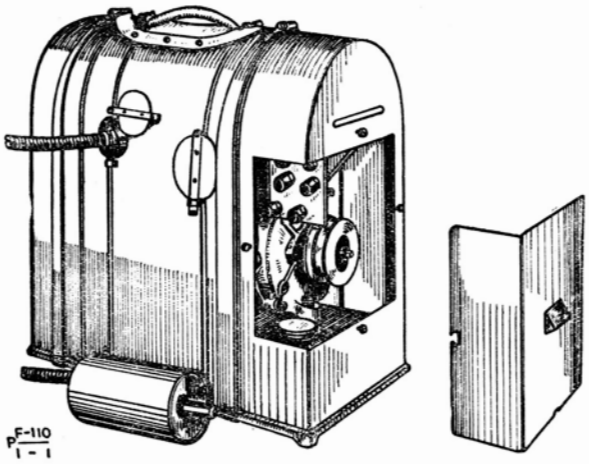


Fig. 1—Charging set with sheet metal cover

Distribution—Codes Nos. 4 and 5

**Scan of the initial Electrical and Mechanical Engineering Regulations, Power F 110.
Data Summary for the initial version Charging Set Lightweight 80 Watt, issued in January 1945.
Note the cylindrically shaped muffler.**

GENERATOR, ETC.

Make, etc. : Lucas, single-phase, 300 ~ totally enclosed, permanent magnet inductor alternator type with rotor on extension of crankshaft and magnet frame bolted direct to crank case. Used in conjunction with full-wave metal rectifier to give D.C. output.
Rating : 80w, 18v, 4.5a, D.C., two-wire.

SWITCHBOARD

There is no separate switchboard. Two insulated terminals are provided for D.C. output connections (bottom) and two insulated terminals for A.C. output connections if required (middle); a pair of brass terminals (top) are provided for a main fuse which should be connected with 10A fuse wire. Fuse is on the A.C. circuit.

END

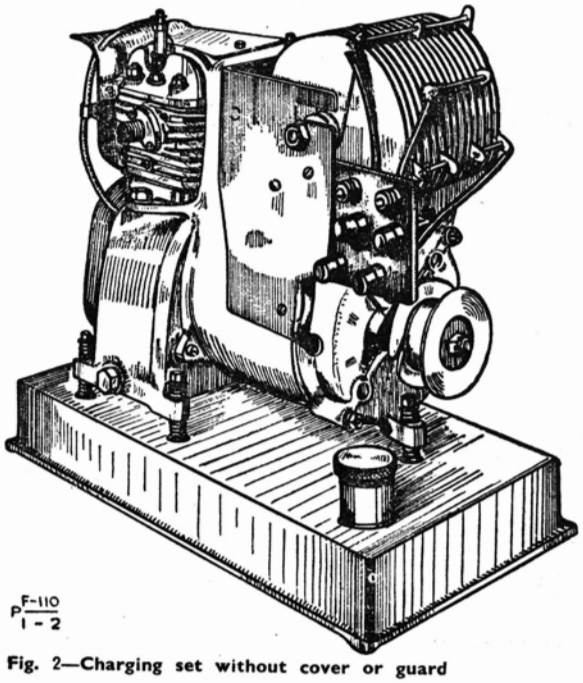


Fig. 2—Charging set without cover or guard

ELECTRICAL AND MECHANICAL ENGINEERING REGULATIONS

POWER
F 100

CHARGING SET, LIGHTWEIGHT, 80W (ZB 10632)

DATA SUMMARY

Note : This issue supersedes Power F 110, Issue 1, which has been amended throughout.

27 Jan. 1945

PURPOSE

Charging of 12V wireless batteries. For use with paratroops, airborne troops, jungle, arctic and mountain warfare.

DESCRIPTION

Single-cylinder air-cooled engine, single-phase alternator carried on an extension of the crankshaft, and rectifier mounted on anti-vibration mountings on sheet metal base which forms the petrol tank. Tubular guard frame over which is clipped a canvas cover. Detachable silencer and flexible exhaust pipe.

PHYSICAL DATA

Weight : 45 lb. (dry) Width : 7¾ in.
Height : 1 ft. 2½ in. Length : 1 ft. 1¾ in.

ENGINE

Make, etc. : E. Pass and Co., Enfield Cycle Co., Stuart-Turner, or Aero Engines Ltd., 35 c.c., single-cylinder, vertical, 4-stroke, side-valve, air-cooled.
Rating : ¾ H.P. (approx.) at 2,800 R.P.M.
Approx. normal speed at full load, 2,800/3,200 R.P.M., Max., no-load speed, 4,500 R.P.M.
Fuel : Petrol. Consumption, 0.45 pt. /hour (full load).
Tank capacity, 4 pints.

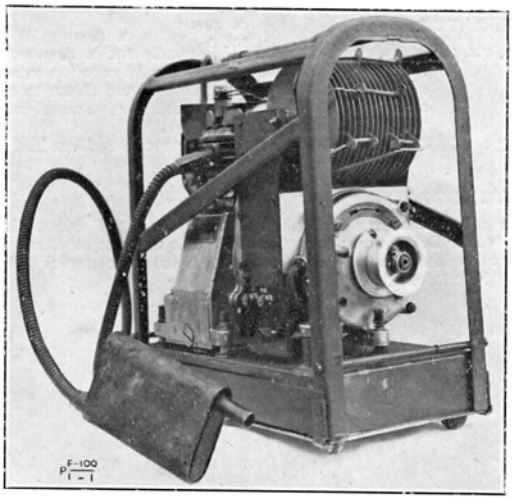


Fig. 1—Charging set with canvas cover removed

Issue 1, 14 Dec. 1945

Page 1

Distribution—Class 870. Code No. 4

Scan of the second Electrical and Mechanical Engineering Regulations, Power F 100. Data Summary for the Charging Set Lightweight 80 Watt issued in December 1945.

POWER
F 100

ELECTRICAL AND MECHANICAL ENGINEERING REGULATIONS

Lubrication : Splash. Oil ; H.D. 30.
Sump capacity, 2/3 pt.
Ignition : Magneto, fully screened, driven by an overhanging crank from the crankshaft.
Starting : Hand, pulley and starting cord.

GENERATOR, ETC.

Make, etc. : Lucas, single-phase, 300 c/s, totally enclosed, permanent magnet inductor alternator type with rotor on extension of crankshaft and magnet frame bolted direct to crank-case. Used in conjunction with full-wave metal rectifier to give D.C. output.
Rating : 80W, D.C., 2-wire, capable of producing 5A at 20V D.C.

SWITCHBOARD

There is no separate switchboard. Two insulated terminals are provided for D.C. output connections ; a pair of brass terminals (top) are provided for a main fuse which should be connected with 10A fuse wire. Fuse is on the A.C. circuit.

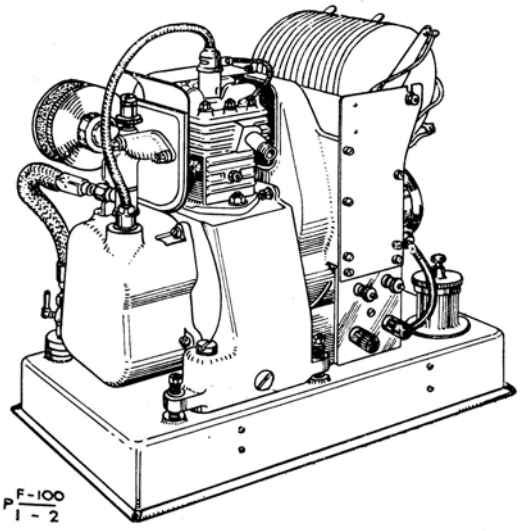


Fig. 2—Charging set with cover and cage removed

END

Page 2

Issue 1, 14 Dec. 1945

ELECTRICAL AND MECHANICAL ENGINEERING REGULATIONS

POWER
E 220/10

CHARGING SET, LIGHTWEIGHT, 80W, SINGLE-PHASE, 23V, RECTIFIED (ZB. 10632)

DATA SUMMARY

Note: This regulation supersedes Power F 100, Issue 1, dated 14 Dec. 1945, which has been revised and redesignated.

MAIN PURPOSE

Charging of 12V wireless batteries. For use with paratroops, airborne troops, jungle, arctic and mountain warfare.

DESCRIPTION

Single-cylinder air-cooled engine. Single-phase alternator carried on an extension of the crankshaft, and rectifier mounted on anti-vibration mountings on sheet-metal base which forms the petrol tank. Tubular guard frame over which is clipped a canvas cover. Detachable silencer and flexible exhaust pipe.

PHYSICAL DATA

Weight: 45 lb. (dry)
Height: 1 ft. 2½ in.
Width: 7¾ in.
Length: 1 ft. 1¾ in.

Airportable. In Pannier, airborne

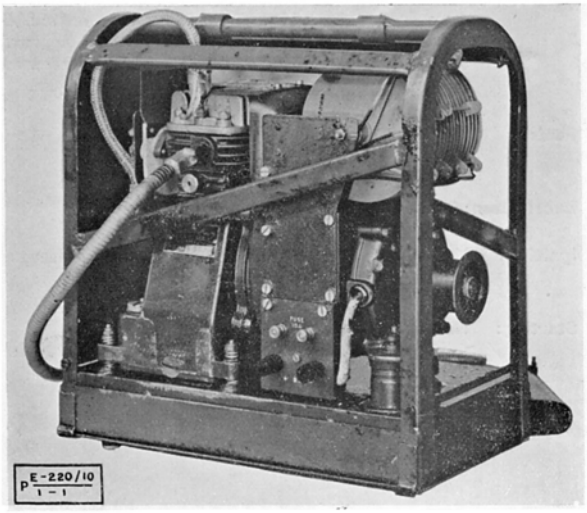


Fig. 1—General view

Issue 1, 30 Aug. 1948

Page 1

Distribution—{ Class 800. Code No. 4 / Class 1000. Code No. 5 (plus)

Scan of the final Electrical and Mechanical Engineering Regulations, Power E 220/10. Data Summary for the Charging Set Lightweight 80 Watt issued in August 1948.

POWER
E 220/10

ELECTRICAL AND MECHANICAL ENGINEERING REGULATIONS

ENGINE

Make, etc.: E. Pass and Co., Enfield Cycle Co., Stuart-Turner, or Aero Engines Ltd.; 35 c.c., single-cylinder, vertical, 4-stroke, side-valve, air-cooled. Rating, ⅜ h.p. (approx.) at 2,800 r.p.m. Approx. normal speed at full load, 2,800/3,200 r.p.m. Max. no-load speed, 4,500 r.p.m.

Fuel: Petrol. Consumption, 0.45 pt./hr. (full load). Tank capacity, 4 pt.

Lubrication: Splash. Oil, 30 H.D. Sump capacity ⅜ pt.

Ignition: Magneto, fully screened, driven by an overhanging crank from the crankshaft.

Starting: Hand, pulley and starting cord.

ALTERNATOR

Make, etc.: Lucas, single-phase, 300 c/s., totally enclosed, permanent magnet inductor alternator type with rotor on extension of crankshaft and magnet frame bolted direct to crank-case. Used in conjunction with full-wave metal rectifier to give D.C. output

Rating: 80W, D.C., 2-wire, capable of producing 5A at 20V, D.C.

SWITCHBOARD

There is no separate switchboard Two insulated terminals are provided for D.C. output connections; a pair of brass terminals (top) are provided for a main fuse which should be connected with 10A fuse wire. Fuse is on the A.C. circuit.

WIRELESS INTERFERENCE

The magneto and ignition system are screened to prevent wireless interference.

END

Page 2

Issue 1, 30 Aug. 1948

CHARGING SET LIGHTWEIGHT

80 WATT.

WORKING INSTRUCTIONS

Cat. No. ZB 11761

The War Office,
Whitehall.
October, 1944.

SECTION I.

GENERAL DESCRIPTION.

1. PURPOSE.

This set is primarily intended for Charging 12-volt Wireless Batteries, but on some sets an A.C. output at about 300 cycles per second is obtainable.

2. BRIEF DESCRIPTION.

The set consists of a Petrol Engine, direct coupled to an Alternator both supported by anti-vibration spring mountings on a sheet metal base which forms the top of the Petrol Tank. A metal type full-wave Rectifier, mounted upon the alternator frame, is connected between the alternator and the D.C. output terminals.

A guard frame and canvas cover are provided which incorporate a quickly detachable carrying handle. Packed underneath the cover there are the silencer and flexible exhaust pipe. The starting cord is in a pocket in the end shield. There are two insulated terminals for the D.C. output and a pair of brass fuse terminals. (On some early sets there are 2 extra terminals—the upper ones—for the A.C. connections).

A box is provided containing tools and spares.

3. OVERALL DIMENSIONS AND WEIGHTS.

With cover on—

Height	14½in.
Width	7¾in.
Length	14½in.
Weight (dry)	46lbs.

4. ENGINE DATA.

The engine in a single cylinder air-cooled, vertical, four stroke.

Bore	1⅜in. 34.9mm.
Stroke	1½in. 38.1mm.
Total swept volume	35 c.c.
R.P.M.	About 3,000–3,600 on load.
Magneto	Lucas—there is no Cut-out.
Sparking Plug	10mm., screened, with pigtail earthed to cylinder head.
Carburettor	Suction type, fitted with adjustable jet. The setting of this jet should NOT be altered except in extreme conditions of temperature when a slight adjustment may be necessary.
Air Cleaner	Burgess Fabric.
Lubricating Oil	H.D.30 (For low temperatures special instructions will be issued).
Fuel Tank Capacity	4 pints.
Lubricating Oil Sump Capacity	½ pint.
Tappet Clearances (cold)	Inlet .004in./.007in. Exhaust .006in./.009in.

5. TECHNICAL DESCRIPTION OF ENGINE.

This is a small, air cooled, four stroke Petrol Engine, the cooling air being supplied to the Engine from a fan which is integral with the flywheel. Lubrication is by splash from the sump and a dipstick is attached to the oil filler plug. No governor is fitted on the Engine which when running light will not exceed roughly 3,800–4,000 r.p.m. against its normal working speed of about 3,000–3,600 r.p.m. on load.

The filling cap of the petrol tank has a screw down air vent which should be screwed down when it is desired to seal the tanks. Filters are provided in the filling opening, at the tank end of the petrol suction pipe, and beneath the petrol cock flange. Of these the most important and the only one which is readily accessible is the filter at the filling orifice.

The exhaust pipe and silencer are disconnected from the engine when it is in transit. The flexible exhaust pipe, which is ⅜in. bore x 3ft. long, has one end screwed for attachment to the exhaust outlet on the cylinder and to the other end the silencer is connected by means of a clip and wing nut.

6. TECHNICAL DESCRIPTION OF ALTERNATOR.

The Generator is a totally enclosed, permanent magnet inductor alternator. The rotor MUST NOT BE REMOVED FROM THE STATOR UNDER ANY CIRCUMSTANCES. The continuous rating is 80 watts D.C. (18 volts, 4.5 amp.) while the A.C. output has a frequency of 300 cycles/second at 3,000 r.p.m.

SECTION II.

RUNNING INSTRUCTIONS.

N.B.—Clear, Unleaded Petrol ONLY should be used in this set.

7. BEFORE STARTING.

(*a*) Place the set on a smooth, level site.

(*b*) Remove the canvas cover and the end panels.

(*c*) Screw on to the cylinder the flexible exhaust pipe to be found inside the cover. To the other end of the exhaust pipe attach the silencer by means of the clip and wing nut. Ensure that the silencer discharges into the open air.

(*d*) Make sure that the two brass terminals on the set are connected together by two strands of 5-amp. fuse wire (No. 34 s.w.g. tinned copper).

(*e*) Verify that there is petrol in the tank. A tank full of 4 pints will give about nine hours' continuous running. On no account remove the filter from the petrol tank filling orifice when adding petrol.

(*f*) Check the lubricating oil level in the sump. To measure the depth of the oil unscrew the filler cap, wipe the dipstick with a clean rag, insert the dipstick until the base of the filler cap rests on the top of the filler hole, and read the level of the oil. Fill up, if necessary, with the correct grade of oil.

(*g*) Turn on the petrol. This is done by pressing the tap handle down to a horizontal position at right angles to the petrol pipe, and **open the air vent screw on the filler cap.**

8. STARTING (Cold).

(*a*) Turn the air sleeve to the position marked "O Choke."

(*b*) Take the starting cord from the pocket in the end panel and put the knot on the end of the cord into the slot on the pulley. Wind the cord round the pulley in a clockwise direction for about 8 or 9 turns.

(c) Rotate the engine by a steady pull on the cord, wind the cord on the pulley again and rotate the engine once more.

(d) Turn the air sleeve on the end of the carburettor to the position marked "1 Cold Start."

(e) Again rotate the engine by winding the cord round the pulley 8 or 9 times and giving a steady pull.

(f) Turn the air sleeve to the position marked "2 Hot Start." Wind the cord on the pulley and rotate the engine as before when it should start.
As soon as the engine fires turn the air sleeve to the position marked "3 Run." It is desirable to allow the engine to run for about 30–60 seconds before putting it on load.

(g) If the engine does not start repeat the procedure detailed above from (d) when the engine should start without difficulty.

9. STARTING (Warm).

If the engine has been stopped for a period not exceeding half-an-hour omit the priming operations (a) to (e) described above and set the air sleeve to the position marked "2 Hot Start." Then continue the remainder of the starting cycle as detailed in (f) above.

10. CHARGING BATTERIES.

It has been found that the set will start more easily if no load is connected to it and if, as previously described, the set is allowed to run for 30–60 seconds after it first fires. Thereafter connect the positive terminal of the battery which is to be charged to the + terminal on the set (marked in red) and the negative terminal of the battery to the — terminal on the set. Before doing this, however, make sure that the two brass terminals on the set are connected by 5 amp. fuse wire as specified in 7 (d) above.

11. STOPPING.

To stop the engine turn off the petrol tap. It should be noted that the end panel cannot be replaced on the set unless the petrol cock is shut. In addition, if the set is to be moved or is not to be used for a little, the air vent screw (on top of the filler cap) should be shut by screwing it down.

SECTION III.

ROUTINE MAINTENANCE.

12. GENERAL.

The Charging Set must be kept clean. Care must be taken that the exhaust pipe and the silencer outlet do not become choked with dirt and in particular a check should be made to see that no earth or dirt has entered the end of the outlet pipe of the silencer. It is most important, when filling the petrol tank, that no dirt or water be allowed to enter.

13. ENGINE.

(a) With the engine level check frequently the amount of oil in the engine sump and add more oil as necessary to bring it to the upper mark on the dipstick. At the same time the colour of the oil on the dipstick should be watched so that if the oil is becoming black or dirty the sump can be drained at the first opportunity. This should be done while the engine is warm. To empty the sump remove the drain plug from the crankcase and pour out the oil by tilting the set. Re-fill with the correct grade of oil until, with the set standing level, the oil reaches the upper mark on the dipstick.

(b) Clean the air filter frequently, especially when working in a dirty atmosphere. To do this remove the end cover and take out the fabric element. Shake it until it is clean, then replace. If, however, the filter element is very dirty or has become contaminated with oil it should be replaced. Should a spare filter element not be available then, as a temporary measure only, the dirty one may be washed in petrol and replaced when dry.

(c) Check the gap between the electrodes on the sparking plug. As this is a small plug the gap is liable to increase rather rapidly and it is essential that the gap should be checked once at least in every 24 hours of running. The correct gap, .012in., can be measured by means of the feeler on the magneto spanner. If the gap is too big it must be corrected by bending the "earth" electrode which is attached to the metal body of the plug. On no account should any attempt be made to bend the central electrode which is attached to the insulator.

(d) Remove the filter in the filling opening of the petrol tank. Clean it, if necessary, and verify that it is not damaged in any way. If this filter has become damaged a replacement should be obtained at the earliest opportunity.

(*e*) Check the compression by turning the engine clockwise by hand and if the compression is weak refer to Section IV in this Book where further details are given.

(*f*) Verify that the exhaust pipe and silencer are free from all obstructions. If there is any doubt on this point check, with the engine running, by first disconnecting the silencer and secondly the exhaust pipe from the engine in order to see the effect of removing them.

(*g*) Check carefully that all nuts on the Set are tight. As this is a small engine the nuts and screws also are small so that they can easily be broken if any excessive force is used.

SECTION IV.

FAULTS AND DEFECTS.

14. FAILURE TO START.

This may be due to three causes:—

(1) A defect in the petrol supply.
(2) An ignition defect.
(3) Lack of Compression.

(1) PETROL SUPPLY.

Verify that there is petrol in the tank, that the air vent screw on the top of the filler cap is open, that the air vent itself is unobstructed and finally that the petrol tap is turned on (*i.e.*, that the handle is horizontal). It is not possible for anyone other than a mechanic to check the petrol system in greater detail, except to verify that all connections on the petrol pipe and carburettor are tight. This is most important since petrol is drawn from the base tank to the carburettor by the vacuum in the inlet pipe so that any air leaks will affect the supply of petrol and the running of the engine.

(2) IGNITION.

The sparking plug is screened so that it is a little more difficult to check that the spark is occurring correctly. To remove the sparking plug it is necessary first of all to press down slightly the metal cover over the plug and rotate the cover about 30 degrees when it then can be lifted off the plug. Unscrew the plug from the cylinder head and re-insert the

plug into its metal cover. With the earth connection made to the engine spin the engine by hand and if there is no spark change to the spare sparking plug contained in the Spares Box. If no spark is obtained with the new sparking plug replace the screened high tension lead by the spare contained in the Spares Box and repeat the test for sparking. If there is still no spark, when the new screened lead is used, then it must be assumed that there is a defect in the magneto which should only be investigated by R.E.M.E.

(3) **LACK OF COMPRESSION.** This may be due to:—

(*a*) Leaking joints or gaskets.

(*b*) Sticking or leaking valves.

(*c*) Worn or leaking piston rings.

(*a*) LEAKING JOINTS OR GASKETS.

Check by testing the nuts on the cylinder head and the sparking plug to make sure that they are tight. If there is any doubt a further check can be made by putting a little oil round the edge of that joint. If the engine is then turned round any leakage at that joint will be shown by air bubbling through the oil. If there is a leak and if tightening the nuts does not stop it new joints will be required—which can normally only be fitted by a mechanic.

(*b*) STICKING VALVES.

Remove the small cover over the tappet chamber in the side of the cylinder and turn the engine until one valve is resting on its seat. With a screwdriver lift the valve and allow it to drop back into position. It should drop back with a sharp "snap." Turn the engine into correct position for the other valve and repeat. If either valve does not come back sharply put one or two drops of petrol or paraffin through its spring on to the valve stem and lever the valve up and down several times so as to free the stem. At the same time make sure that neither of the valve springs is broken. If after the above either valve appears to work incorrectly, or if a valve spring is broken, the set will require attention by R.E.M.E.

(*c*) WORN OR LEAKING PISTON RINGS.

If after carrying out the tests described above the compression is still poor nothing further can be done until the set can be overhauled by R.E.M.E.

TOOLS AND SPARES.

No. Off.	*Item.*	*Remarks.*
	TOOLS.	
1	Screwdriver	
1	Pliers	
1	Magneto Spanner with feeler	
1	Box Spanner .563 A/F.	Sparking Plug
1	Box Spanner 2 B.A. .324 A/F	Cylinder Head
1	4 B.A. Spanner .248 A/F \ Double 2 B.A. Spanner .324 A/F / Ended	
1	¼in. B.S.F. Spanner .445 A/F \ Double 5/16in. B.S.F. Sp'ner .525 A/F / Ended	Carburettor Unions
1	.004 Feeler	Valve Tappets
1	.006 Feeler (added on later sets)	" "
	SPARES.	
2	Valves. Complete with springs, cotters and spring retainers	
2	Pressure Piston Rings	
1	Scraper Piston Ring	
1	Carburettor Jet. Complete with needle and spring	
2	10 mm. Plugs with copper washers	
1	Screened Ignition Cable	
1	Starting Cord	
1	Length 5-amp. Fuse Wire	
2 sets	Fibre Washers	Carburettor Banjo
2	Cylinder Head Gaskets	
2	Induction Port Gaskets	
2	Tappet Chamber Cover Gaskets	
2	Cylinder Base Gaskets	
12	Tappet Shims	
1	¼in. Petrol Pipe with unions	
4	Fibre Bushes	Carburettor Fixing
40	Nuts, Washers & Screws (assorted)	

References and additional publications.

- Charging Set Lightweight, 80W, Working Instructions, ZB 11761, WO Code 953, The War Office, Oct. 1944. (Reprints 3/45 and 7/46)
- EMERs Power, F 110, Charging Set, Lightweight, 80W, Data summary, Issue 1, Jan 1945.
- EMERs Power, F 100, Charging Set, Lightweight, 80W, Data summary, Issue 1, Dec 1945.
- EMERs Power, E 220, Charging Set, Lightweight, 80W, Single-Phase, 23V, Rectified (ZB 10632), Data summary, Issue 1, Aug 1948.
- Signal Equipment - Packing Instructions (Airborne), SRDE Provisional Pamphlet No. 480A, May 1944.
- Rear link glider station - Jungle station. (Wireless Sender Adm 5G (Mod.) and Reception Set R109 in truck 5 cwt, f.w.d. Airborne), SRDE Pamphlet 368A, n.d.
- Rear link parachute station, Wireless Sender Adm 5G (Mod.) & Reception Set R109C and Generator Pedal 70watt, Packing Instructions Container Type F, SRDE Pamphlet 427A, n.d.
- Wireless Station Adm 5G (Mod.) in Handcart Wireless No. 1 (KH.7850), Fitting Istructions, SRDE Pamphlet No. 414A, June 1943.
- Animal Pack Wireless Station No. 76/R109 and Adm 5G (Mod.)/R109, July 1944, ZA 25010.
- Trailer 10-cwt. For use with car 5-cwt. 4x4, 76/R109, Fitting instructions, SRDE Provisional Pamphlet No. 565A, Sept. 1945.
- Wireless Stations No. 76/R109 and conversion to Wireless Stations No. 76/R209, Fitting Instructions, ZA 30052, Feb. 1946.
- Provisional packing instructions for Airborne Signal Equipment, SRDE Provisional Pamphlet No. 588A, Sep. 1945.
- Wireless Sets No. 22 Airborne, Working Instructions, ZA 18992, April 1944.
- Wireless Sets No. 22 Animal Pack, Loading and Fitting, n.d., ZA 23505.
- Wireless Stations No. 62, Cars 5-cwt., 4x4/Animal pack to man pack, Fitting Instructions, SRDE Pamphlet No. 541A, Dec. 1944.
- Wireless Stations No, 62 fitted in trailers light cargo ¼-ton amphibian, Fitting Instructions, SRDE Provisional pamphlet No. 593A, Aug 1945.
- Wireless Stations No. 62 in Cars 5 cwt. 4x4 and Animal Pack/Man Pack, Fitting and loading instructions, ZA 27865, April 1945.
- Charging Set Lightweight 40/60 Watt, SRDE Provisional Pamphlet No. 611B, May 1950.
- User handbook (Trials Edition) for Charging Set 150 Watt, SRDE Handbook No. 1058A, Sept. 1960.
- Charging Set 150 Watt, User trials report No. 212, 30 Signal Regiment, March 1961.
- Wireless for the Warrior, Vol. 1, Chapter WS 76, L. Meulstee, 1995, isbn 1898805 08 3.
- Wireless for the Warrior, Vol. 2, Chapters WS 22 and 62, L. Meulstee, 1998, isbn 1898805 10 5.
- Wireless for the Warrior, Compendium 2, L. Meulstee, August 2012, isbn 97890819271 0 7.
- Pigeon to Packhorse, Alan Harfield, Picton Publications, 1989, isbn 0948251 42 5.
- Engines for Electric Generating Sets for Army Use, D. Hepburn, SRDE Quarterly Progress Report June 1949.
- Catalogue of Army Publications, Part V, Index of Complete Equipment Schedules, 1967, Army Code No. 60011.

Abbreviations

C.E.S. = Complete Equipment Schedule.
EMERs = Electrical and Mechanical Engineering Regulations.
SRDE = Signals Research and Development Establishment.

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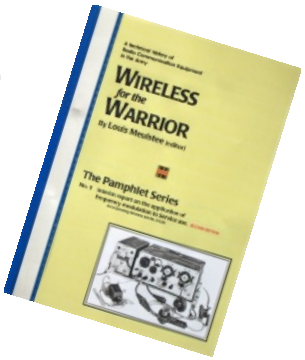

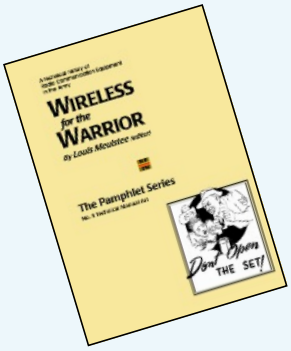

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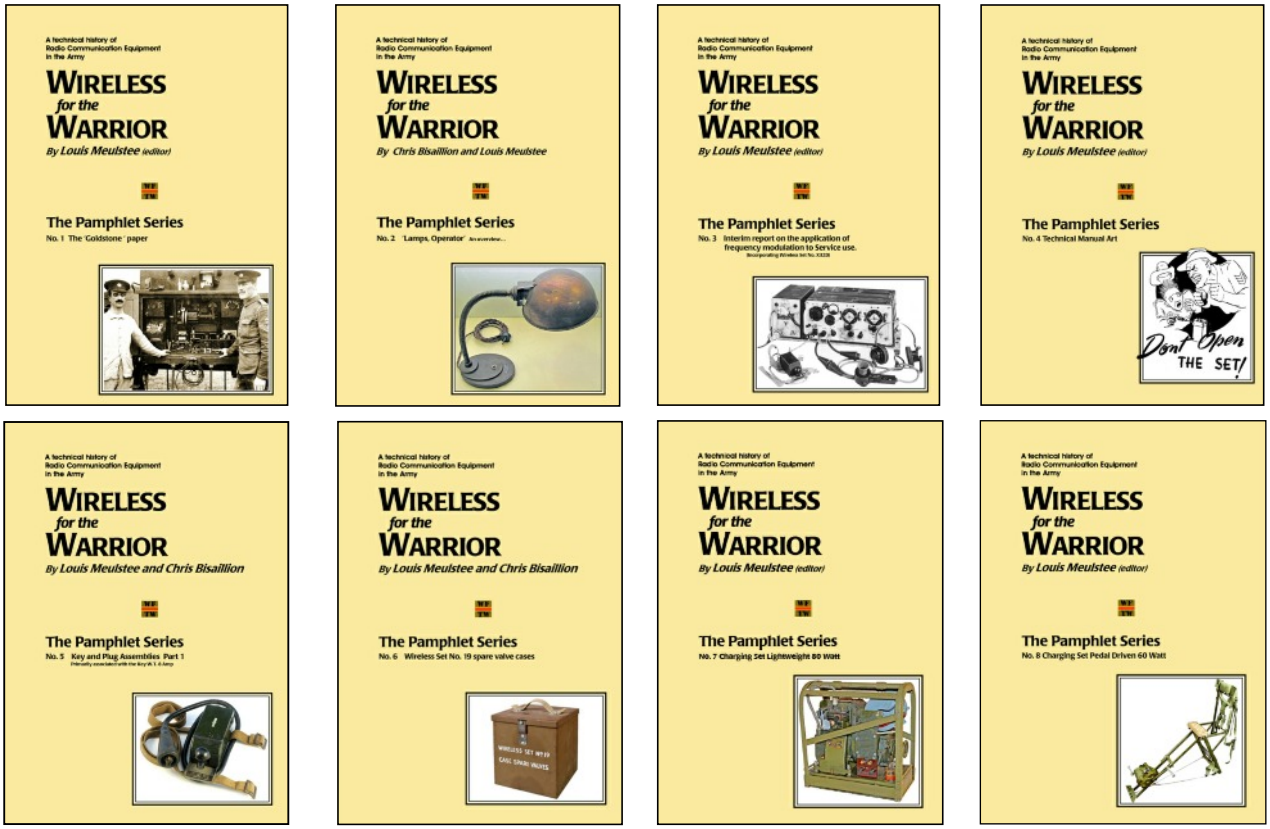

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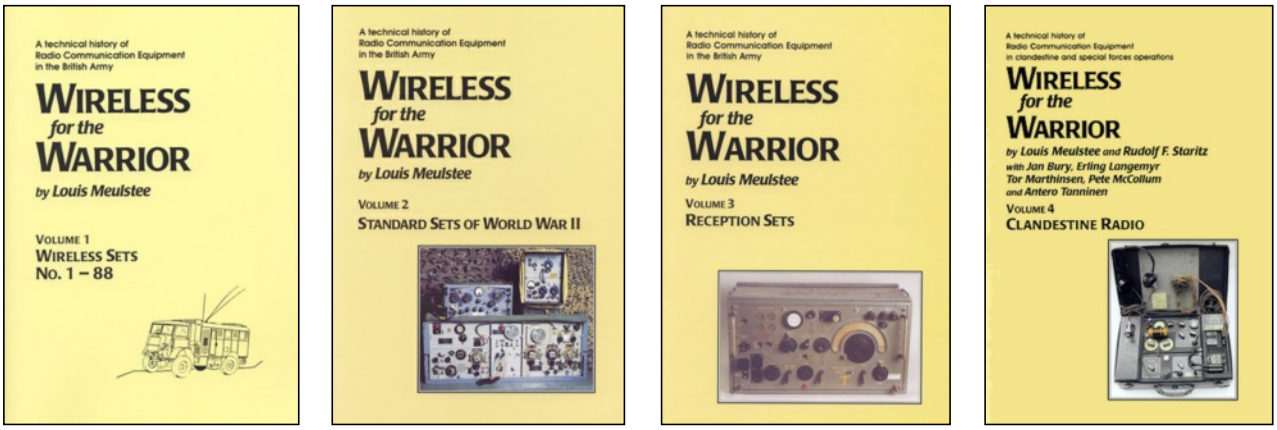

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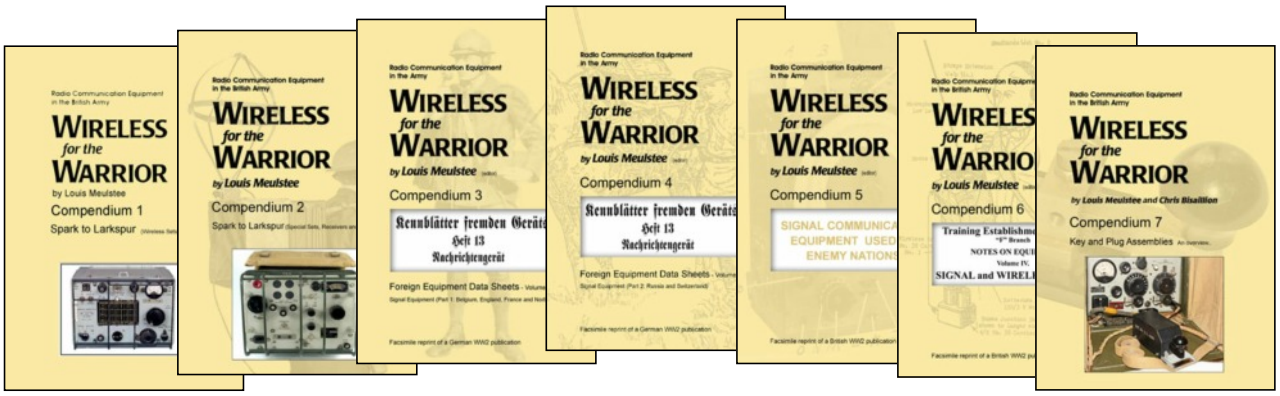

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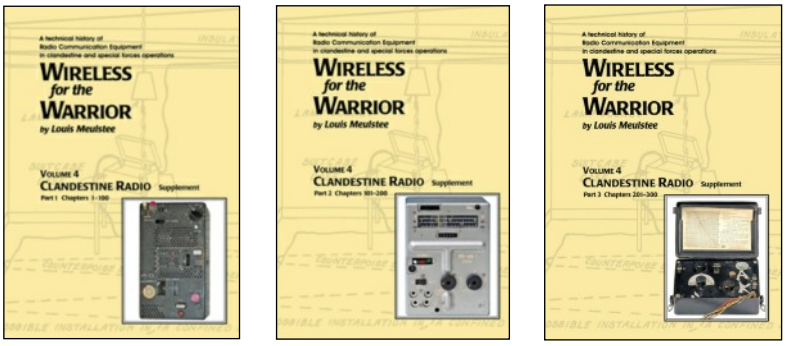

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