

SECTION 7, CHAPTER 5

NON-TOXIC GROUND HEATING TROLLEY, Mk. 3

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Introduction

1. The non-toxic ground heating trolley Mk.3 (Fig. 1) is used to supply hot air for various purposes, e.g. the pre-heating of aircraft engines; with the heating unit shut off, the unheated air can be used to improve air circulation inside an aircraft during servicing. For the purpose of description the trolley may be divided, broadly, into four main parts:—

(a) The chassis and cowling.

(b) The fuel system.

(c) The heat exchanger and its accessories.

(d) The engine.

DESCRIPTION

Chassis and Cowling

2. The chassis (Fig. 2) comprises a light-alloy framework. The two side wheels, one of which incorporates a parking brake, can be locked in either the "up" or "down" position

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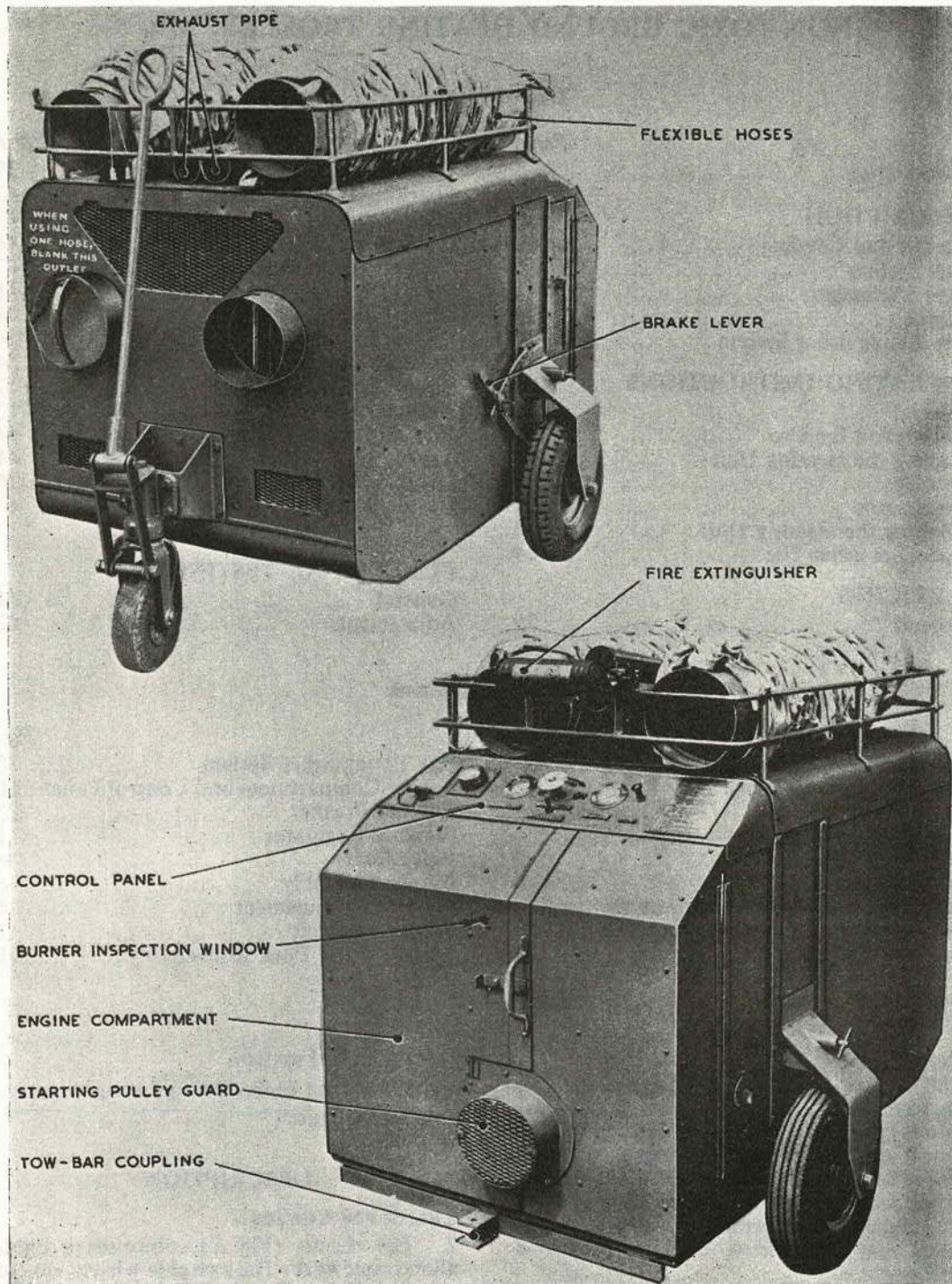


Fig. 1. NON-TOXIC GROUND HEATING TROLLEY, Mk. 3

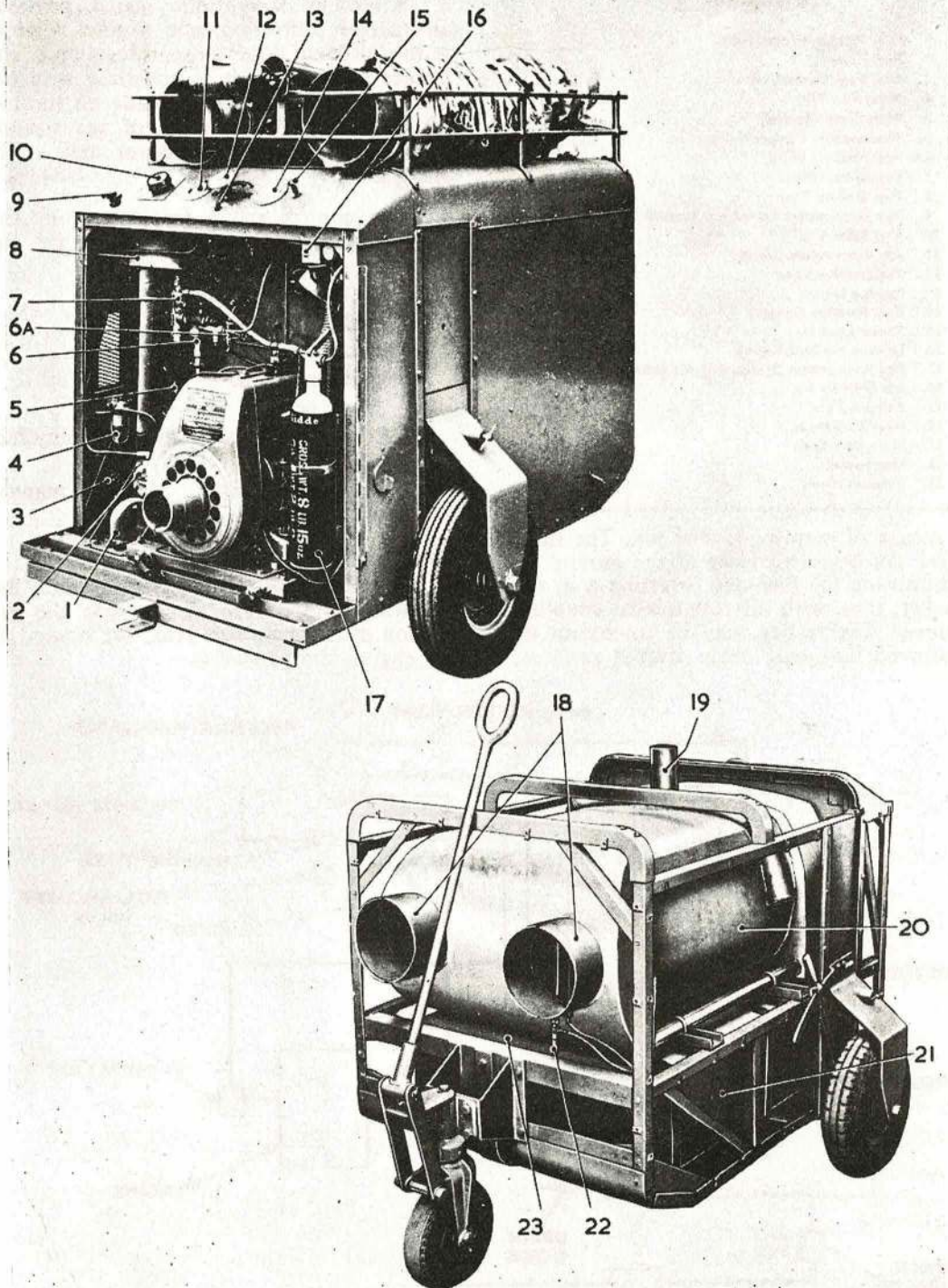


Fig. 2. TROLLEY WITH COWLING PARTIALLY REMOVED
(Key to Fig. 2 overleaf)

(A.L. 18, May 64)

Key to Fig. 2

1. Fish Tail for Heater Tube
2. Fuel Pump
3. Fuel Tank Drain Cock
4. Main Fuel Filter
5. Main Tank Dipstick
6. Thermostatic Control Valve
- 6A. Fuel Shut-off Valve
7. Engine Fuel Filter
8. Fuel Gravity Tank
9. Fire Extinguisher Emergency Control
10. Fuel Filler Cap
11. Air Temperature Gauge
12. Pressure Regulator
13. Ignition Switch
14. Fuel Pressure Gauge
15. Choke Control
16. Ignition Earthing Switch
17. Fire Extinguisher System CO₂ Cylinder
18. Air Delivery Ducts
19. Exhaust Pipe
20. Heat Exchanger
21. Main Fuel Tank
22. Thermostat
23. Asbestos Panel

by means of a spring-loaded pin. The third wheel can be raised clear of the ground by withdrawing the fork and inverting it in the bracket; thus, with the rear towbar coupling removed, the trolley may be towed on its reinforced base over snow-covered surfaces.

3. A cowling of light alloy panels provides all-weather protection, and a glass window in the left-hand door allows inspection of the burner flame when it is operating with the doors closed. Provision is made on the top of the casing for stowage of the flexible hoses, exhaust pipe extensions and a fire extinguisher.

4. The control panel forms part of the cowling and provides a mounting for the following components:—

- (a) Fuel pressure gauge.
- (b) Fuel pressure regulator.
- (c) Air delivery temperature gauge.
- (d) Ignition switch.
- (e) Choke control.
- (f) Filler cap for the main and gravity fuel tanks.
- (g) Fire extinguisher system manual control.

Fuel System

5. The fuel system (Fig. 3) incorporates the following components which, with the exception of the main fuel tank, are housed in the engine compartment:—

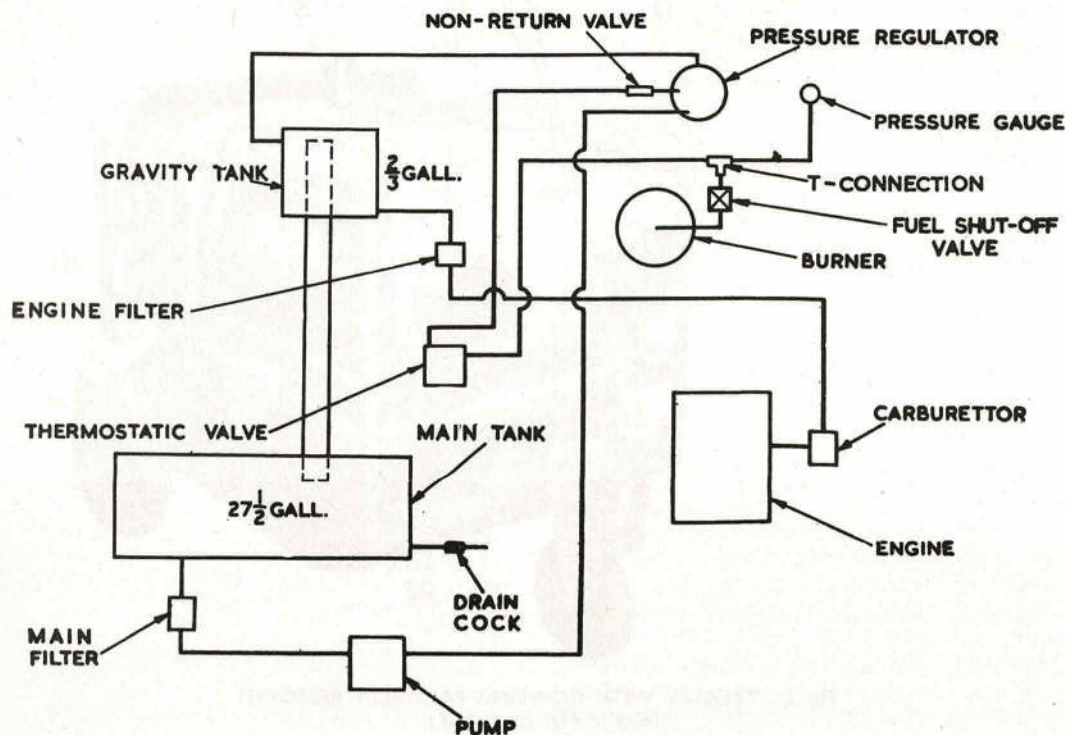


Fig. 3. FUEL SYSTEM

- (a) Main fuel tank.
- (b) Gravity fuel tank.
- (c) Fuel pump.
- (d) Fuel pressure regulator.
- (e) Thermostatic control.
- (f) Fuel pressure gauge.
- (g) Main filter.
- (h) Engine filter.

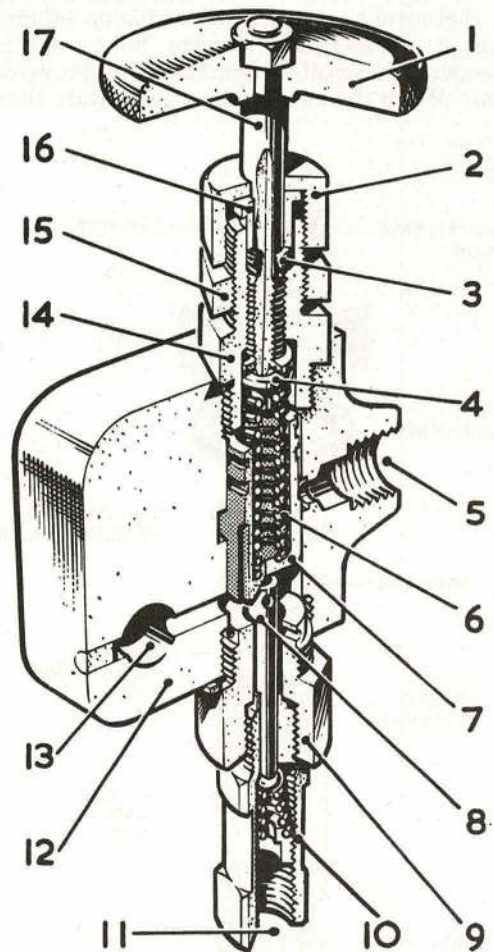
6. The fuel shut-off valve is fitted to enable the fuel supply to the burner to be shut off when the trolley is used for the delivery of cool air; it should be locked in the fully open or fully closed position, as required. When the trolley is operated with this valve closed, the fuel pressure regulator should be in the OFF position to allow the fuel to by-pass back to the tank. **On no account should the H.T. lead to the burner be disconnected or earthed, as this may burn out the engine ignition coil which is designed for dual ignition.**

7. **Fuel Tanks.** The capacities of the gravity and main fuel tanks are $\frac{3}{4}$ and 27 $\frac{1}{2}$ gallons respectively. They are filled through the orifice in the gravity tank, the main tank receiving fuel via the stack pipe. A dipstick enables the content of the main tank to be checked.

8. **Fuel Pump.** This component is belt-driven from the engine. Since, during normal operation, the pump pressure exceeds the maximum burner requirement, a full head of fuel in the gravity tank is maintained by a continuous flow of fuel that is by-passed through the pressure-regulator.

9. **Fuel Pressure Regulator.** Manual operation of this component (Fig. 4) controls the supply of fuel to the burner assembly and thus regulates the air delivery temperature up to the maximum of 275 deg. F. The maximum pressure to which the regulator may be set is 40 lb per sq. in., but it should not be necessary to use pressures above 30 lb per sq. in. unless the ambient temperature is below freezing point. When the regulator is closed, fuel from the pump enters the body, passes along four slots in the piston and thence to the gravity tank. When the regulator is opened by turning the hand wheel clockwise the spring loading of the piston is increased and this, in turn, forces the extension tube

downwards to open the non-return valve. Fuel then passes through the tube and past the valve to the burner, the flow to the gravity tank being reduced proportionately.



- 1. Hand Wheel
- 2. Gland Nut
- 3. Gland Packing
- 4. Spring Carrier
- 5. Outlet to Gravity Tank
- 6. Spring
- 7. Piston
- 8. Extension Tube
- 9. Valve Adapter
- 10. Non-return Valve
- 11. Outlet to Thermostatic Valve
- 12. Body
- 13. Inlet from Fuel Pump
- 14. Spindle Nut
- 15. Lock-nut
- 16. Gland
- 17. Spindle

Fig. 4. FUEL PRESSURE REGULATOR

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10. Thermostatic Control. Provided the pressure regulator is correctly set relative to the ambient temperature, the thermostatic control prevents the air delivery temperature exceeding 275 deg. F. The control comprises a thermostat, a length of capillary tubing, and a valve-closing element filled with a temperature-sensitive mineral oil, and a valve unit. When the air delivery temperature rises

to 275 deg. F. the thermostat, through the medium of the oil-filled capillary, moves the piston in the valve-closing element; this, in turn, closes the fuel valve to the burner. The supply to the burner is thus restricted to the fuel metered through the jet. This causes a fall in the air delivery temperature until, at approximately 265 deg. F., the reverse action takes place in the thermostat; the fuel valve then opens and the predetermined supply to the burner is restored.

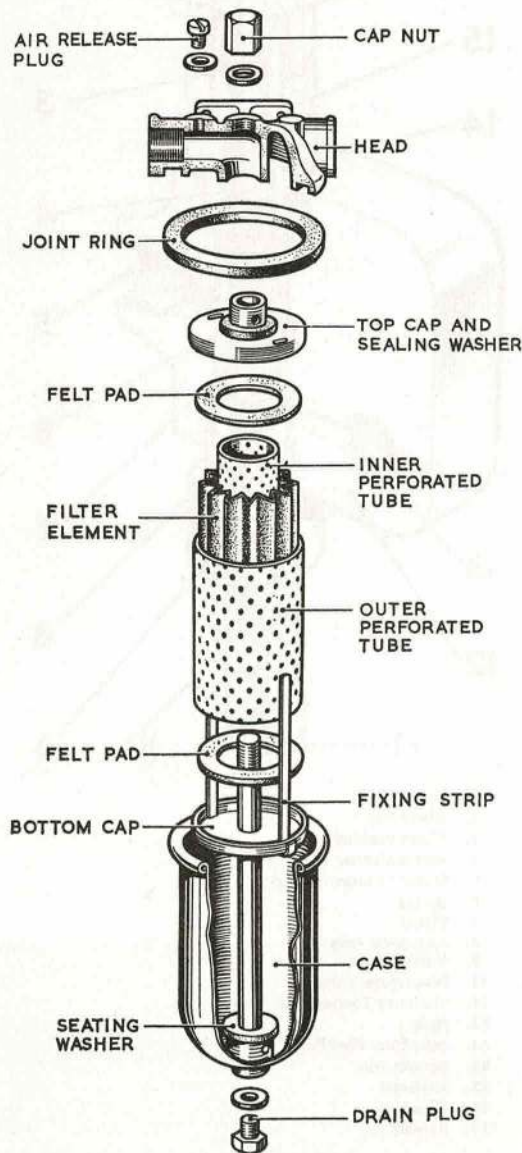


Fig. 5. MAIN FUEL FILTER

11. Fuel Filters. The main fuel filter (Fig. 5) is fitted into the fuel pipeline between the main tank and the pump, and the engine filter in the pipeline from the gravity tank to the carburettor. A third filter is fitted on the inlet side of the valve unit of the thermostatic control.

Heat Exchanger

12. The heat exchanger (Fig. 6) transfers heat, generated by the combustion of gasoline, to the air being forced through it by means of a blower. To prevent an accumulation of unburnt fuel in the combustion chamber, with the consequent risk of an explosion, two holes drain any surplus fuel into the casing whence it passes out through two drain pipes. The heat from the engine exhaust gases is also utilized, and this arrangement obviates the need for a silencer. The fuel burner assembly is very similar in design and operates in the same manner as the assembly described in chapter 4 of this section. Two flexible hoses having male and female ends are used to convey the hot air from the heat exchanger delivery ducts.

Engine

13. Power to drive the blower and fuel pump, and current for the h.t. electrode in the fuel burner assembly are supplied by a Villiers, Mk. 25, single cylinder, air-cooled gasoline engine; detailed information is given in A.P. 2173A, Vol. 1 and Vol. 6, Part 1, Sect. 11, Chap. 1. It differs slightly from other Villiers Mk. 25 engines in that it incorporates an additional h.t. lead (Fig. 7). The engine is mounted on bearers in the engine compartment, the bearers being secured to the chassis by flexible rubber mountings. An earthing strip connects the bearer electrically to the chassis.

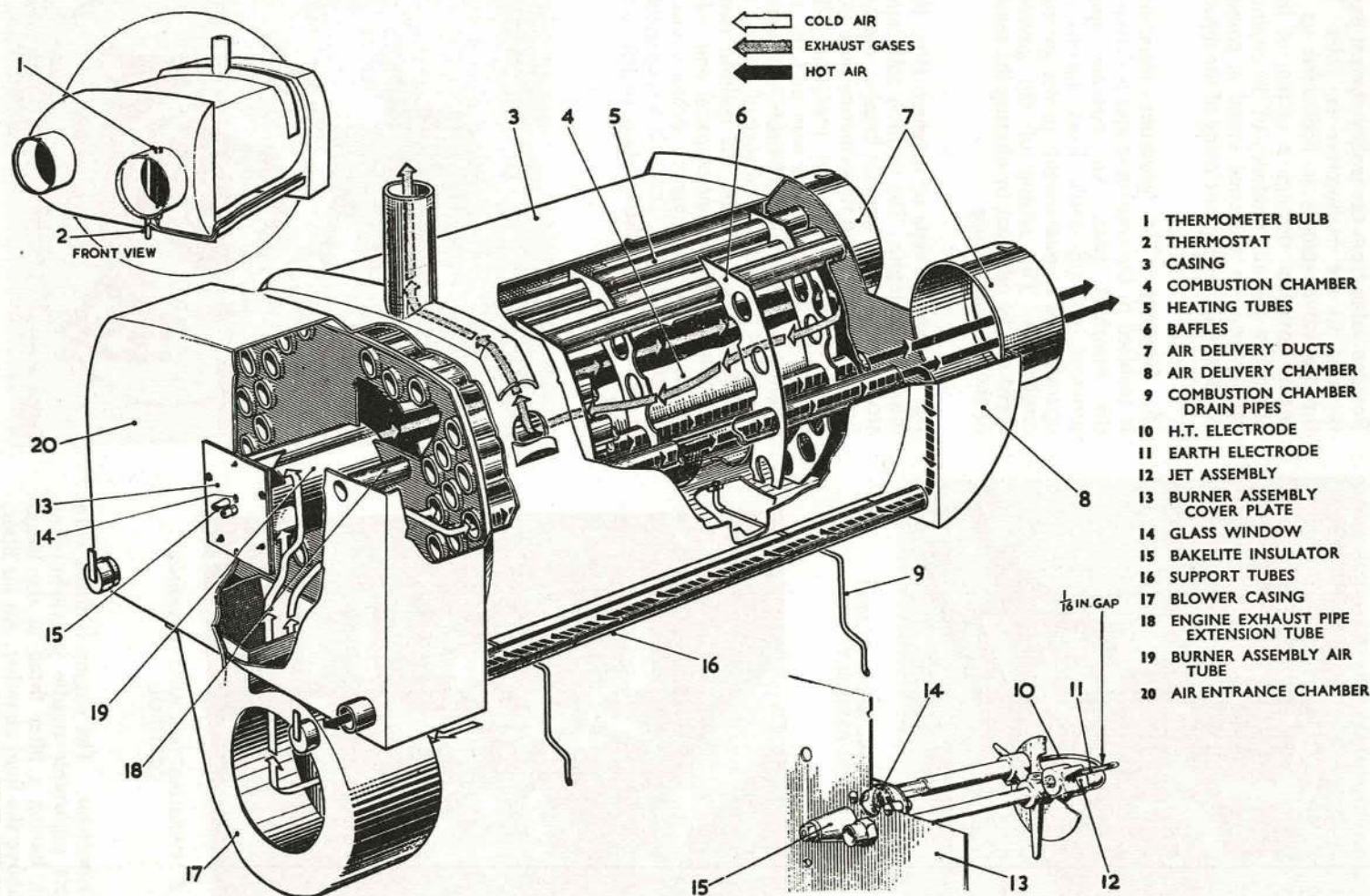


Fig. 6. HEAT EXCHANGER

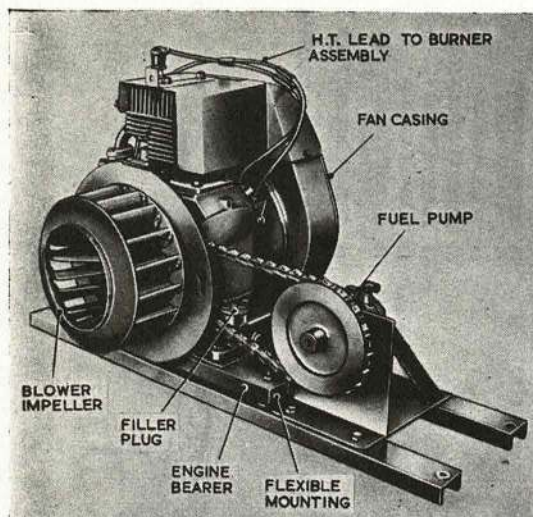


Fig. 7. ENGINE BLOWER AND PUMP ASSEMBLY

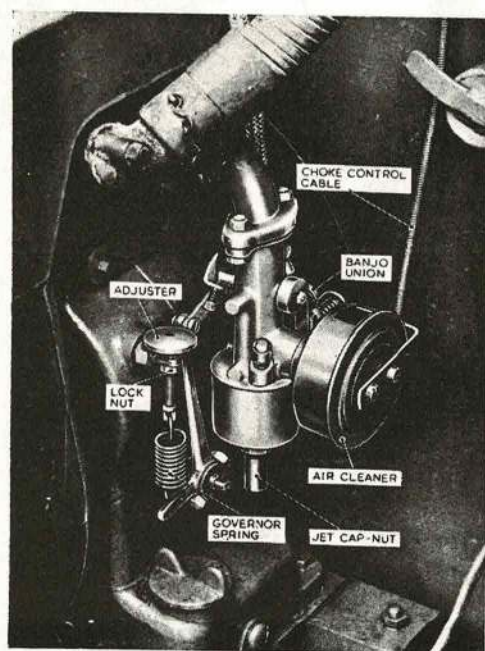


Fig. 8. CARBURETTOR AND GOVERNOR CONTROL

14. **Carburettor.** The engine is fitted with a Villiers adjustable needle jet carburettor (Fig. 8), having a filter fitted in the banjo union above the float chamber. An air filter, incorporating a choke which is operated by

Bowden cable from the trolley control panel, is fitted to the carburettor air inlet. The throttle valve spindle is connected to the engine governor through a system of links and levers and any tendency of the engine to depart from its governed speed is counteracted by the opening or closing of the throttle.

15. **Governor.** The governor mechanism is enclosed in the crankcase and is driven by the camshaft gear. An external spring provides an adjustable load against the operation of counterweights in the governor mechanism. The setting of the governor speed can be adjusted by altering the tension of the external spring.

16. A flywheel type of magneto (Fig. 9) is fitted to the engine. The ignition coil, laminated armature and contact breaker mechanism are assembled on the armature back plate which is secured to the crankcase. The contact breaker operating cam and the two magnets which produce changes of magnetic flux in the pole pieces and core of the coil are secured to the flywheel. The ignition switch is mounted on the control panel and, when closed, earths the magneto primary circuit and stops the engine. This switch is connected in parallel with the thermostatic switch on the heat exchanger.

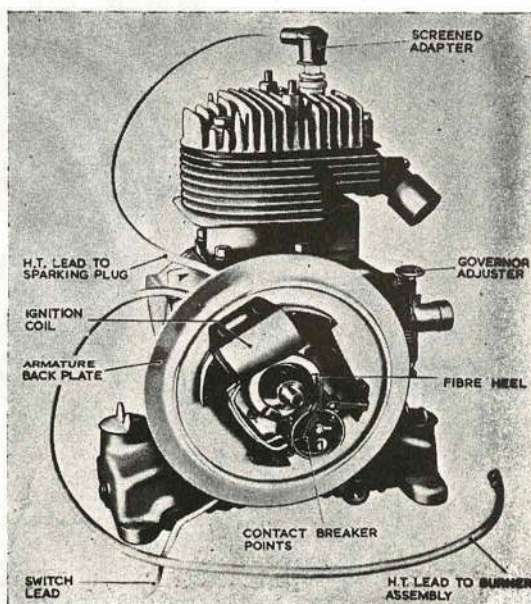


Fig. 9. FLYWHEEL MAGNETO

Fire Extinguisher System

17. An automatic fire extinguisher system (Fig. 10), which also incorporates an emergency hand control, is fitted to the engine

compartment of the trolley to deal with a possible fire in the engine or heater compartments. The system will operate most efficiently when the engine compartment doors are closed.

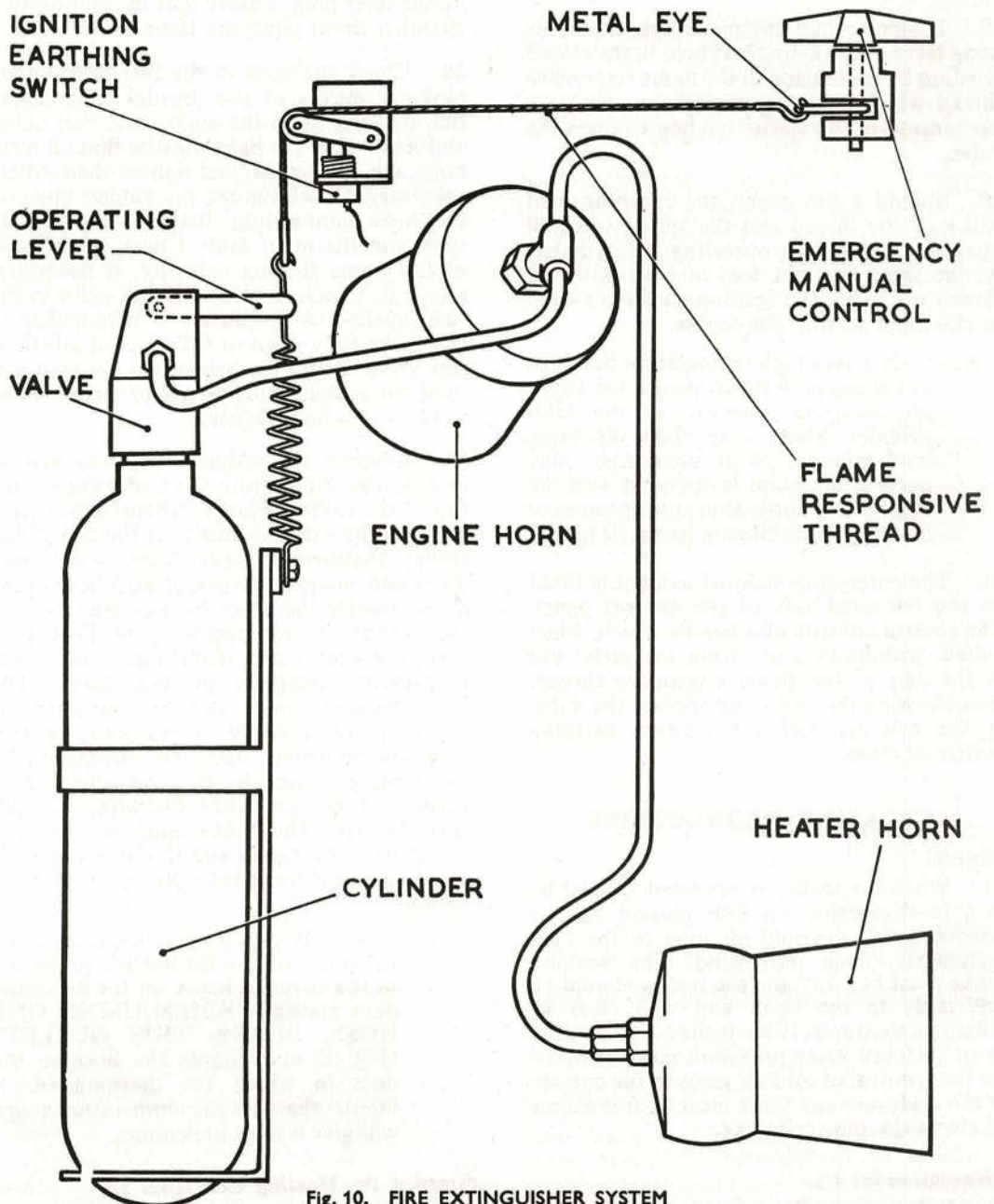


Fig. 10. FIRE EXTINGUISHER SYSTEM

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18. The system comprises a CO₂ cylinder attached to the side of the engine compartment; two horns which direct the spray on to the engine and heater compartments respectively; an ignition earthing switch; an emergency manual control; and a flame responsive thread.

19. Under normal circumstances, the operating lever of the cylinder is held in the closed position by the tension of the flame responsive thread which is strong enough to overcome the tension of the spring tending to open the valve.

20. Should a fire occur, the resulting heat will melt the thread and the spring will pull open the valve, thus operating the cylinder. At the same time the loss of tension in the thread will cause the ignition earthing switch to close and so stop the engine.

Note.—If a very high temperature develops in the engine compartment it will cause an excessive pressure in the CO₂ cylinder which may then discharge inadvertently. Such conditions may occur if the plant is operated with the engine bay doors shut during summer in a temperate climate (para. 32 (a)).

21. The emergency manual control is fitted on the left-hand side of the control panel. The control consists of a handle which, when pulled, withdraws a pin from the metal eye in the end of the flame responsive thread, thus allowing the spring to operate the valve in the cylinder and the ignition earthing switch to close.

OPERATING INSTRUCTIONS

General

22. When the trolley is operated it must be in a level position on firm ground and, if possible, with the cold air inlet to the heat exchanger facing into wind. The parking brake must be "on" and the trolley should be preferably in the open and well clear of inflammable stores. If the trolley is to be used in an enclosed space provision must be made for the removal of exhaust gases to the outside of the enclosure and there must be free access of air to the blower intake.

Preparation for Use

23. Before the trolley is used, particularly if it has been standing idle for some time,

ensure that it is serviceable. Examine the engine filter bowl and, if necessary, drain off any water or sediment in the bottom of the bowl. Ensure that the unions on the gravity tank, filter and carburettor are tight. Check the level of the oil in the engine sump, and top up if necessary to the level of the shoulder on the filler plug. Ensure that the combustion chamber drain pipes are clear.

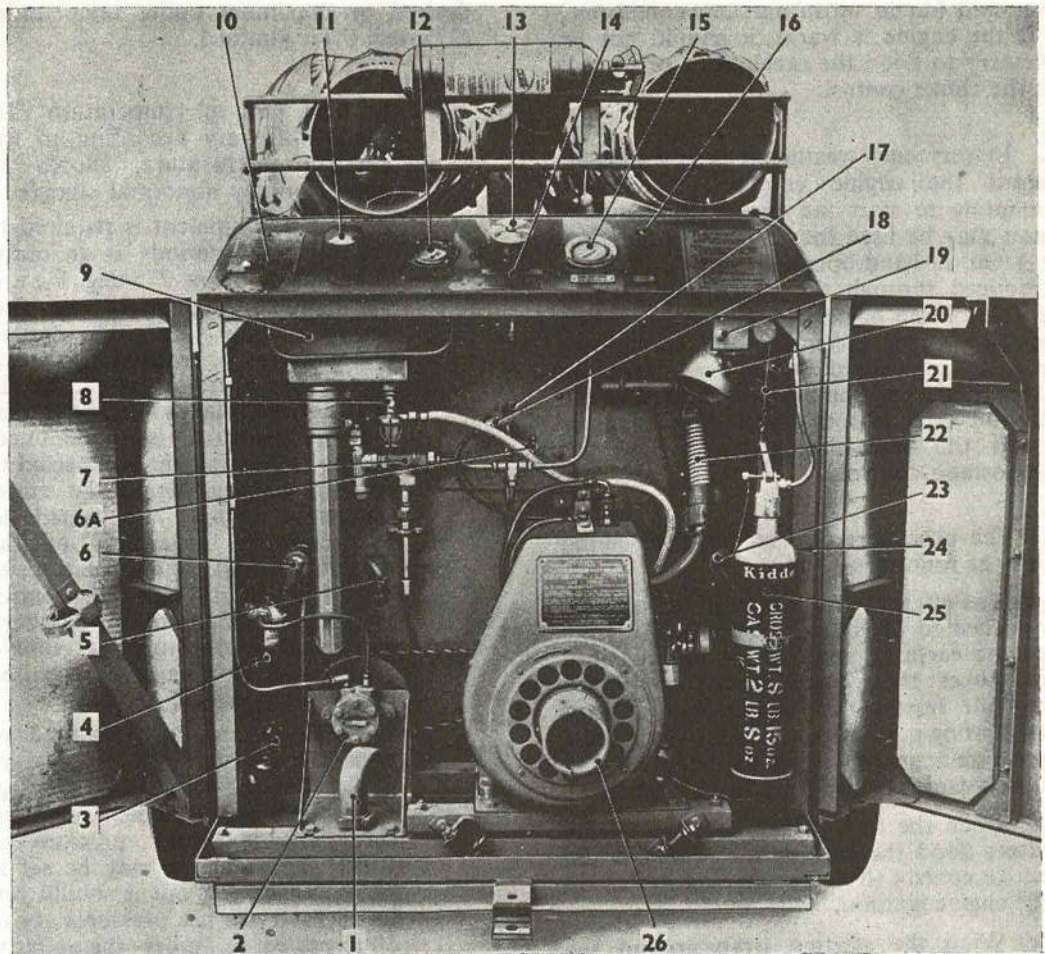
24. Check the level of the fuel in the main tank by means of the dipstick and ensure that the unions on the main tank, fuel pump and main filter are tight. Ensure that all nuts, bolts, etc. are secure, and tighten them where necessary. Check-tighten the Jubilee clips on the hose connections between the gravity tank and the main tank. Check the tension of the pump driving belt and, if necessary, adjust it. Check that the shut-off valve in the fuel pipeline to the burner is wire-locked in either the fully open or fully closed position; this valve should be open when the trolley is used for heating purposes, and closed when used for cooling purposes.

25. Remove the exhaust pipe extensions and flexible hoses from their stowage on the top of the trolley. Fit the exhaust pipe extensions to the exhaust outlet on the top of the trolley. Remove the covers from the air outlet ducts and connect one end of each hose to the ducts; couple the other ends to the inlets on the aircraft or equipment to be heated or cooled. Avoid undue stretching of the hoses to prevent damage to the hose fabric. The bore diameter must not be restricted or reduced, otherwise the thermostatic control and thermometer may be damaged by overheating caused by the consequent congestion of hot air when operating at high temperatures. The hoses must not be subjected to acute bends and the aircraft outlet apertures must be at least 50 sq. in. in cross section.

Note.—If only one hose is required when using the trolley for heating purposes, fit the cover to blank off the air outlet duct marked "WHEN USING ONE HOSE, BLANK THIS OUTLET" (Fig. 1) and couple the hose to the duct in which the thermometer is fitted, otherwise the temperature gauge will give a false indication.

Starting the Heating Unit (Fig. 11)

26. In temperate conditions the heating unit should be started as described in para. 28.



- | | |
|---|--|
| 1. Fishtail or Blanking Plug Stowage | 14. Ignition Switch |
| 2. Fuel Pump | 15. Fuel Pressure Gauge |
| 3. Main Tank Drain Cock | 16. Choke Control |
| 4. Main Tank Fuel Filter | 17. Burner Inspection Window |
| 5. Fuel Dipstick | 18. Burner Electrode |
| 6. Heating Duct (Blanked) | 19. Ignition Earthing Switch |
| 6A. Fuel Shut-off Valve | 20. Horn |
| 7. Thermostatic Valve Unit | 21. Flame Responsive Thread |
| 8. Fuel Cock and Filter | 22. Engine Exhaust Pipe |
| 9. Fuel Gravity Tank | 23. Heater Duct Blanking Cap |
| 10. Fire Extinguisher System Emergency Manual Control | 24. Engine Earthing Plug |
| 11. Fuel Tank Filler Cap | 25. Fire Extinguisher CO ₂ Cylinder |
| 12. Temperature Gauge | 26. Starting Pulley |
| 13. Fuel Pressure Regulator | |

Fig. 11. ENGINE COMPARTMENT AND CONTROL PANEL

(A.L. 18, May 64)

The instructions cover starting the engine from cold but in warm ambient conditions, or if the engine is warm, it should not be necessary to flood the carburettor or to pull out the choke control.

27. In very cold weather it is advisable to preheat the engine compartment before attempting to start the engine. A flameless heater may be used for this purpose, or hot air from a hand-operated heater may be introduced through the ventilating port in the side of the engine compartment. When operating under extremely cold conditions, the caps (23) should be removed from the heating ducts and the fishtail (1) fitted to the left-hand duct (6); this will direct hot air around the valve-closing element of the thermostatic control.

28. The procedure for starting the heating unit is as follows:—

(a) Ensure that the h.t. lead is securely attached to the burner electrode (18); the engine earthing plug (24) is plugged into its socket; there are no restrictions in the hot air hoses; the engine compartment ventilating port is open; and the burner fuel pressure regulator is set at minimum, i.e. the control is turned fully anti-clockwise.

(b) Open the fuel cock (8) on the engine filter; flood the carburettor; pull out the choke control (if necessary) and switch on the engine ignition.

(c) Wind the starting strap around the starting pulley (26) and pull sharply to rotate the crankshaft, pulling the strap clear of the pulley.

(d) When the engine starts, push in the choke control gradually until the engine runs smoothly with the choke fully open.

(e) Slowly turn the fuel pressure regulator clockwise and, when the flame is established, gradually adjust the fuel pressure to 10 lb per sq. in. (max.).

Note.—If combustion is not established, immediately reduce the fuel pressure to zero (control fully anti-clockwise) and stop the engine. Refer to para. 29 before attempting to restart.

(f) Allow the burner to operate at 10 lb per sq. in. for at least 10 minutes, then increase the fuel pressure slowly in stages of approximately 5 lb per sq. in., allowing

five minutes for each stage, until the desired or maximum outlet temperature (275 deg. F.) is attained.

Notes.—

1. The rate of temperature rise, which will vary according to the ambient temperature, should be noted for any abnormal change.

2. If the equipment is required to run for short periods at an outlet temperature below 275 deg. F., it is permissible to increase the fuel pressure only until the desired temperature is reached. At such times an operator must be in constant attendance to ensure that the temperature is maintained. Where the equipment is expected to run for a long period the outlet temperature must be raised to 275 deg. F., regardless of the desired air delivery temperature, to verify that the thermostatic control is effective. When control has been confirmed the fuel pressure should be reduced to obtain the required outlet temperature.

3. The fuel pressure required to raise the air delivery temperature to the designed maximum (275 deg. F.) depends on the ambient temperature. The maximum pressure to which the regulator may be set is 40 lb per sq. in., but it should not be necessary to use pressures above 30 lb per sq. in., unless the ambient temperature is very low.

29. If after several attempts the engine fails to start and flame is not established in the heat exchanger, allow the unit to stand idle for a few minutes before again attempting to start the engine. This will allow any fuel which has collected in the combustion chamber to drain away, thus obviating the risk of an explosion due to an excess of fuel in the combustion chamber when the engine starts and combustion is established.

30. The air delivery temperature is dependent upon the fuel pressure and, to a lesser degree, upon the ambient conditions. Up to its designed maximum the air delivery temperature is controlled by regulating the fuel pressure manually. When maximum temperature (275 deg. F.) is reached, the thermostatic control will reduce the fuel pressure by about

half. This will cause the outlet temperature to fall slowly, the total drop depending upon the new fuel pressure and the ambient temperature, until the control restores the fuel pressure to its original value. This cycle is repeated each time the maximum temperature is reached.

Cooling

31. The following procedure should be adopted when the equipment is required to supply cool air:—

(a) Remove the locking wire from the shut-off valve (6A in Fig. 11) and fully close the valve by turning the handwheel clockwise; re-lock the valve in the closed position.

(b) Start the engine as described in para. 28 (a) to (d); ensure that the fuel pressure regulator is set in the OFF position to allow the fuel to by-pass back to the tank.

Note.—On no account disconnect or earth the burner h.t. lead when using the trolley for cooling purposes, otherwise the engine ignition coil, which is designed for dual ignition, may be burnt out.

Precautions

32. The following precautions must be observed when the trolley is in use:—

(a) Under extremely cold conditions the engine compartment doors must be closed. In temperate climates the doors may be opened to prevent a high temperature developing in the engine compartment. The amount of opening must be no more than is necessary to prevent overheating, since opening these doors reduces the effectiveness of the fire extinguisher system (paras. 17–20).

(b) When using the trolley for heating purposes, never allow the engine to run if combustion is not taking place in the combustion chamber.

(c) Do not allow the hands to come into contact with the hot air as it emerges from the flexible hoses, and use only the asbestos loops when handling the ends of the hoses.

(d) Do not lean against the trolley or place articles on the top cowling.

(e) Do not top up the fuel tanks nor remove the filler cap when the trolley is being operated.

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(f) In the event of failure of the thermostatic control do not attempt to operate the plant at its maximum output. By using the pressure regulator to control the fuel pressure, the plant can still be used to provide air at temperatures below the permitted maximum.

WARNING . . .

Under these conditions the controls must not be left unattended as the air delivery temperature may rise above the permitted maximum if the hoses are in any way restricted.

(g) If the engine stops whilst the trolley is in operation, turn the fuel pressure control fully anti-clockwise and disconnect the flexible hoses to prevent localized overheating of the heat exchanger and the trolley cowling.

(h) To prevent seizure of the fuel pump and “blow-back” in the burner assembly air tube, do not allow the main fuel tank to run dry. When the heater is being used the level of fuel in the tank must be above the danger level marked on the dipstick.

(j) In temperate climates, to prevent the engine from overheating, the hot air outlet shutter on the side of the engine compartment must always be kept open.

Stopping the Heating Unit

33. The procedure for stopping the heating unit is as follows:—

(a) Reduce the burner fuel pressure to minimum (control fully anti-clockwise).

(b) Allow the engine to run until the heater thermometer registers 100 deg. F.

(c) Ensure that the burner flame is extinguished and turn off the engine fuel.

(d) Switch off the ignition when the engine stops.

Procedure After Use

34. When the trolley is out of use ensure that the fuel cock on the engine filter is closed. The flexible hoses should be stowed in the rack on top of the trolley and the exhaust pipe dismantled and the two halves placed one on each side of the exhaust outlet from the heat exchanger. To preserve as much heat as possible in the engine compartment the doors must be kept closed.

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SERVICING

General

35. The non-toxic ground heating trolley Mk. 3 should be serviced in accordance with the instructions contained in the basic servicing schedules. Servicing includes cleaning, inspecting and testing, lubricating and rectifying defects, and is necessary to maintain the trolley as an efficient item of equipment.

36. The permissible repairs to the trolley are principally those which involve the renewal of unserviceable components. Reconditioning, however, involves the complete dismantling of the equipment, cleaning, a thorough inspection of components, the renewal of defective parts, assembling, testing and final painting. The following information includes servicing and minor repair instructions but does not include major repair and reconditioning instructions.

Magnet

37. Access to the contact breaker is obtained by removing the engine cowl, the dust cover on the flywheel, and the contact breaker cover (Fig. 12). If the points are pitted, dirty or worn unevenly, they should be cleaned and

refaced with an equalizing file. After they have been refaced, all traces of dirt should be removed with the aid of clean cloth moistened with gasoline.

38. Adjustment of the points is made by releasing the lock-screw and positioning the point bracket until the gap is 0.012 in. to 0.016 in. when the rocker pad is on the top profile of the flywheel boss. After the gap has been set, tighten the lock-screw and re-check the gap.

39. The magneto is timed so that the contact breaker points commence to open when the piston is $\frac{3}{16}$ in. before T.D.C. on the compression stroke. Accurate timing can be done only when the cylinder head is removed, but if the ignition timing is in doubt a rough check can be made without removing the head. To do so, the crankshaft should be turned by hand until the contact breaker points are just about to open; if the timing is correct, the keyway which is visible on the driving end of the crankshaft should then be about 20 deg. before T.D.C.

40. If it is necessary to re-time the ignition, proceed as follows:—

(a) Detach the h.t. lead and remove the sparking plug.

(b) Remove the engine cowl.

(c) Remove the top part of the fan casing and unscrew the cylinder head bolts. Remove the cylinder head.

(d) Loosen the flywheel retaining nut until the flywheel is free on the crankshaft.

(e) Turn the crankshaft in its normal direction of rotation until the piston is $\frac{3}{16}$ in. before T.D.C. on the compression stroke.

(f) Position the flywheel so that the contact breaker points are just about to open.

(g) Tighten the flywheel retaining nut firmly and then turn the crankshaft until the piston is again $\frac{3}{16}$ in. before T.D.C. on the compression stroke. Check that the timing is correct.

(h) Finally ensure that the flywheel nut is fully tightened. Refit the cylinder head, sparking plug, fan casing, engine cowl and h.t. lead.

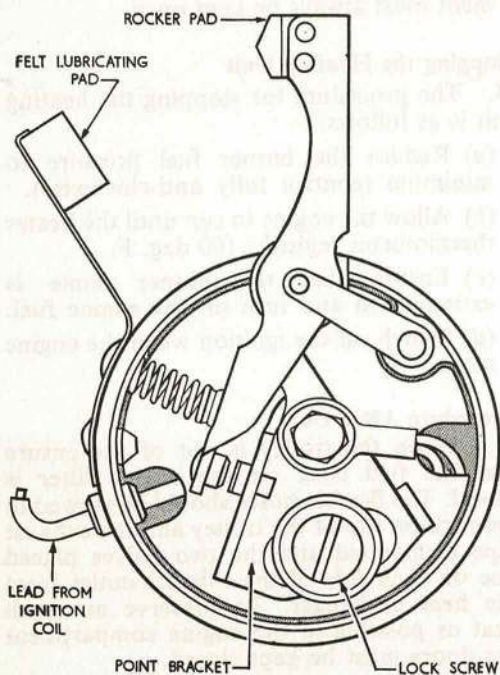


Fig. 12. CONTACT BREAKER

41. It should be noted that if, during the normal operation of the engine, the ignition requires re-timing, a careful examination of the tapered end of the crankshaft and the bore of the flywheel should be made. Incorrect timing during normal operation can only be as a result of the flywheel slipping on the crankshaft and any such movement will be apparent from marking or scoring of the tapered surfaces.

Sparking Plug

42. The sparking plug should be serviced as described in Sect. 6, Chap. 7, paras. 63-65 of this publication; the spark gap should be set to 0.015 in. to 0.018 in. Lightly smear the plug threads with grease ZX-13 before screwing the plug into the cylinder.

Carburettor

43. The carburettor should be cleaned as follows:—

- (a) Remove the jet cap-nut and fibre washer at the bottom of the float chamber.
- (b) Unscrew the nut securing the float chamber and remove the fibre washer.
- (c) Carefully separate the float chamber from the carburettor body to prevent damage to the joint washer.
- (d) Remove the float and wash the float chamber in clean gasoline.
- (e) Remove the banjo union on the side of the body and clean the banjo bolt, filter and inside of the union in gasoline. Ensure that the fibre washers are in good condition and assemble the banjo union. Re-lock the banjo union bolt.
- (f) Turn on the fuel to flush the inlet passage and the needle valve and seating.
- (g) Ensure that the joint washers are serviceable; refit the float chamber, the securing nut and the jet cap-nut.

44. During service, flooding of the carburettor may be caused by dirt on the needle valve seating. The dirt can usually be dislodged by allowing fuel to flow freely when the tickler is operated.

45. **Needle Adjustment.** The procedure for checking the setting of the adjustable jet, and for re-setting it to suit changes in climatic conditions, is as follows:—

(a) Start and run engine until it is warm, then switch off the ignition and remove the cap-nut and the washer at the base of the carburettor float chamber.

(b) Slacken the locknut and turn the needle valve in a clockwise direction to close the valve.

(c) Open the needle valve to an approximately correct setting by turning it between 2 and 2½ turns in an anti-clockwise direction.

(d) Start the engine, and make the final setting when the engine is on full load by turning the needle to the position at which smooth running is obtained.

(e) Tighten the needle valve locknut and fit the cap-nut and washer.

Governor

46. The engine speed of 2,800 r.p.m. is set by the makers of the plant and, under normal conditions, adjustment of the governor should not be required. If, however, the plant performance is not satisfactory and the cause is suspected to be incorrect engine speed, adjustment of the governor will be necessary.

Tappet Adjustment

47. When the engine is cold and the valves are closed, there should be a clearance of 0.006 in. to 0.010 in. between the end of each valve stem and its operating tappet cap. To adjust this clearance proceed as follows:—

(a) Remove the tappet cover and rotate the crankshaft until both valves are closed and the piston is at T.D.C.

(b) Increase or decrease, as required, the number of shims which are fitted between each tappet cap and the end of the tappet.

Note.—To gain access to the shims, each valve spring in turn must be compressed to open the valve and so enable the tappet cap to be removed. Removal of a single shim will increase the valve clearance by 0.006 in.

(c) After adjustment of the tappets, rotate the crankshaft through two revolutions and re-check the clearances.

(d) Refit the tappet cover.

Pump Driving Belt

48. The pump driving belt should be adjusted so that when a reasonable pressure is exerted by hand on one run of the belt, at a point midway between the pump and the engine, there is approximately 1 in. deflection of the belt. To tighten the belt, remove laminated links as required.

Main Filter

49. To service the main filter (Fig. 5) proceed as follows:—

(a) Unscrew the air release and drain plugs, and drain the case.

(b) Unscrew the cap-nut and break the joint between the head and the case.

Note.—If the components are difficult to separate, a light tap with a hide-faced hammer on the lower part of the case will free the joint.

(c) Withdraw the filter assembly from the case and straighten the fixing strips at the top of the assembly.

(d) Remove the end caps, the top and bottom pads, and the filter element from the inner and outer perforated tubes.

(e) Wash the components thoroughly in clean gasoline and allow them to dry.

Note.—Do not use compressed air to clean or dry the filter element as this is liable to damage the filtering medium.

(f) Examine the components for damage and obtain replacement parts as necessary.

Note.—The fixing strips should be renewed at each complete dismantling of the filter and the filter element after 2,000 working hours.

(g) Assemble the filter element and perforated tubes. Place the felt pads in position, fit the end caps and secure the assembly by bending the fixing strips over the top cap. When doing this, press the assembly firmly together.

(h) Ensure that the seating washer is in position and insert the filter assembly in the case.

(j) Press the joint ring firmly in position in the head and lightly smear the jointing face of the ring with oil.

(k) Assemble the case to the head and refit and tighten the cap-nut.

(l) Fit the drain plug and, when the plant is running and all air has been expelled from the filter, tighten the air release plug.

Engine Filter

50. To clean the bowl and the gauze strainer of the engine fuel filter proceed as follows:—

(a) Close the fuel tap, slacken the knurled nut and slide the clip from the bowl. Remove the bowl and the gauze strainer.

(b) Wash the bowl and the gauze in clean gasoline, and direct a jet of air through the gauze to remove any remaining particles of foreign matter.

(c) Ensure that the gauze, bowl, seating washer and clip are serviceable. Reassemble the components and tighten the securing nut.

(d) Turn on the fuel tap and check the filter for leaks.

Pressure Regulator

51. To service the pressure regulator (Fig. 13) proceed as follows:—

(a) Disconnect the pipelines from the regulator body.

(b) Remove the handwheel, unscrew and remove the gland nut and locknut, and remove the regulator from the panel.

(c) Unscrew and remove the non-return valve and withdraw the extension tube from the body.

(d) Unscrew and remove the spindle nut complete with the gland, packing and spindle.

(e) Withdraw the spring carrier, the spring and the piston from the body.

(f) Remove the spindle, the gland and the packing from the spindle nut.

(g) Wash the components in clean gasoline and examine them for wear or damage. Ensure that the piston slides freely but is not slack in the body and that the ball in the non-return valve operates correctly.

(h) Screw the spindle into the spindle nut and repack the gland housing with graphited asbestos string. Insert the gland into the gland housing.

(j) Fit the piston into the regulator body, slide the extension tube into the adapter and screw-in and tighten the non-return valve.

Note.—Ensure that the extension tube is fitted in the correct way so that the V-shaped end bears on the ball of the non-return valve.

(k) Fit the spring carrier and the spring and screw-in and tighten the spindle nut.

(l) Use the locknut to secure the regulator to the control panel. Refit the gland nut and the handwheel and adjust the gland nut to provide free movement of the spindle in the gland.

(m) Refit the fuel pipes and check the action of the regulator when the equipment is operating.

Thermostatic Control

52. No servicing is necessary and no repairs are permitted to the thermostat, capillary and

valve-closing element of the control, but the fuel filter and valve unit (Fig. 14) must be serviced as necessary. The procedure for dismantling, cleaning and re-assembling the filter and valve unit is as follows:—

(a) Disconnect the fuel pipelines, unscrew the nut at the top of the valve-closing element and remove the valve unit and filter.

(b) Unscrew the plug (8) and remove the filter (10).

(c) Unscrew the nut (7) remove the valve guide and valve (6).

(d) Remove the pipe adapter (4) and the bypass jet (3). Do not remove the valve seat (5) unless it is damaged and a new one is required.

(e) Wash the parts in clean gasoline and use compressed air to blow out the gauze mesh of the filter, the valve body (2) and the jet.

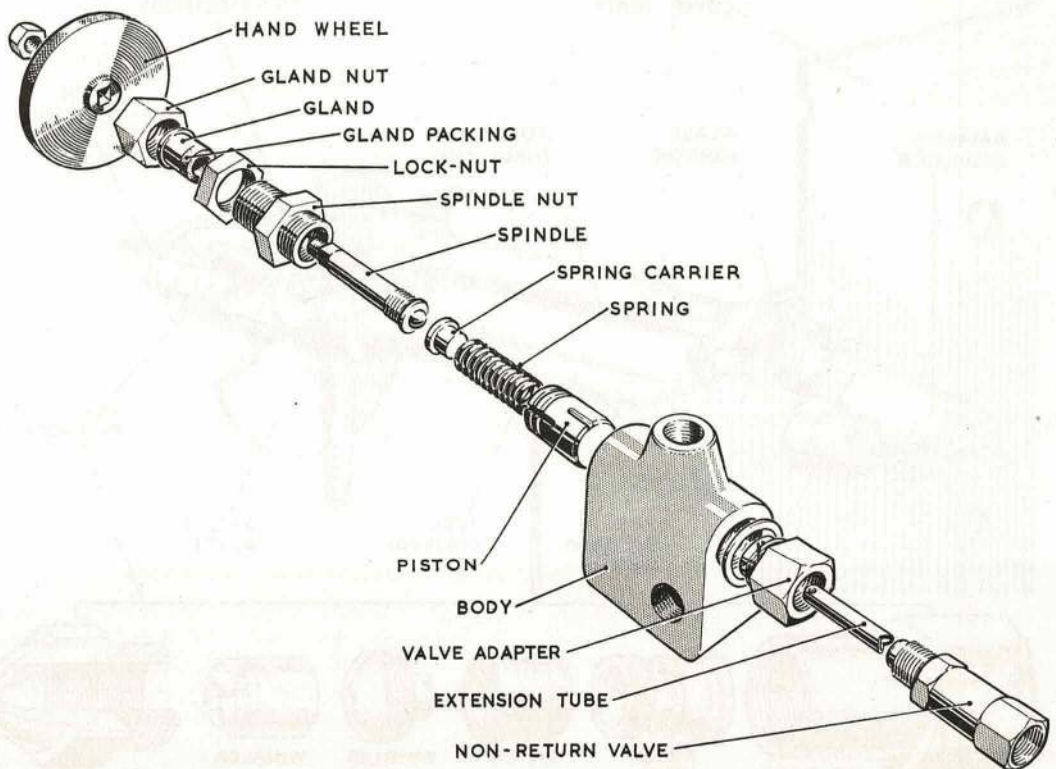
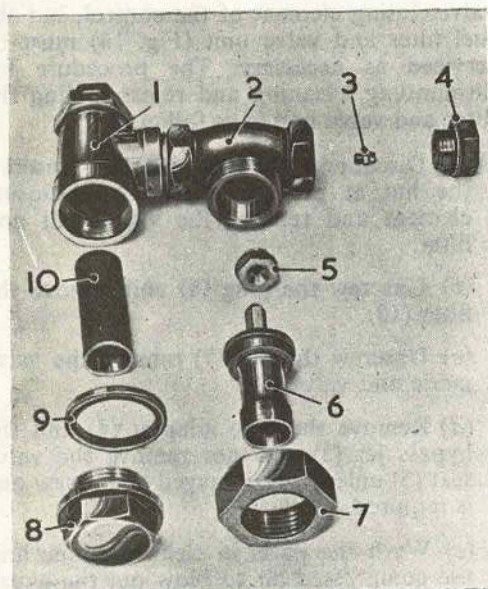


Fig. 13. PRESSURE REGULATOR

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1. Filter Case
2. Valve Body
3. By-pass Jet
4. Pipe Adapter
5. Valve Seat
6. Ball Valve, Plunger and Guide
7. Retaining Nut
8. Filter Plug
9. Plug Washer
10. Filter

(f) Examine the components for damage and ensure that the valve moves freely in its guide.

(g) Re-assemble the components in the reverse order to dismantling and refit the unit.

(h) Check the assembly for leaks when the equipment is operating.

Fig. 14. VALVE UNIT

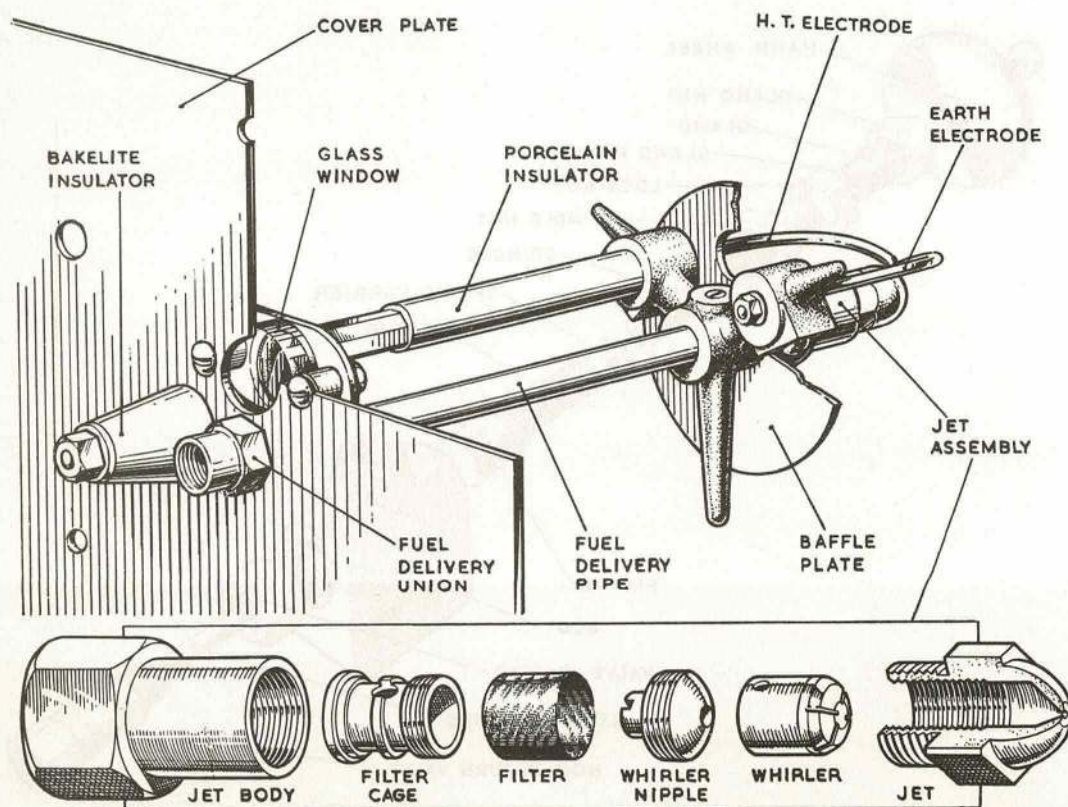


Fig. 15. BURNER ASSEMBLY

Burner Assembly

53. To service the fuel burner assembly (Fig. 15) proceed as follows:—

- (a) Disconnect the h.t. lead from the h.t. electrode and the fuel delivery pipe from the union on the cover plate.
- (b) Unscrew and remove the three nuts which secure the cover plate to the bulkhead and remove the cover plate, complete with the burner assembly, from the air tube.
- (c) Unscrew the jet body from the fuel delivery pipe.
- (d) Unscrew the jet from the jet body and remove the filter, filter cage, whirler nipple and whirler from the jet.
- (e) Clean each component of the jet assembly in kerosine. Use a hard wood probe to clean the jet orifice; on no account should a piece of wire or steel be used as this will damage the orifice.
- (f) Clean the h.t. and earth electrodes and the porcelain insulator in kerosine, then thoroughly wipe them dry.
- (g) Refit the filter into the filter cage, the whirler, whirler nipple and filter cage into the jet, and screw the jet into the jet body.
- (h) Adjust the position of the h.t. and earth electrodes (Fig. 16) so that the electrode gap is $\frac{1}{16}$ in.; the vertical distance between the centre of the electrode gap and the jet orifice is $\frac{1}{4}$ in.; and the horizontal distance between the centre of the electrode gap and the jet is $\frac{1}{8}$ in.

Note.—It is important that the dimensions are correctly set, otherwise the fuel will either burn intermittently or will not be ignited.

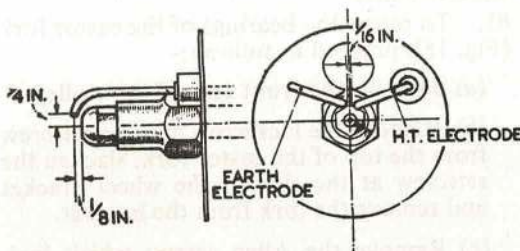


Fig. 16. ELECTRODE ADJUSTMENT

(j) Refit the burner assembly into the air tube and secure the cover plate to the bulkhead.

(k) Connect the h.t. lead to the h.t. electrode and connect the fuel delivery pipe to the union on the cover plate.

Fire Extinguisher System

54. To remove a flame-responsive thread:—

- (a) Open the rear doors of the trolley.
- (b) Unlock and remove the fulcrum pin from the valve; withdraw the operating lever.
- (c) Release the flame-responsive thread from the hook of the spring.
- (d) Release the thread from the emergency manual control.

55. To fit a flame-responsive thread:—

- (a) Attach the flame-responsive thread to the emergency manual control.
- (b) Pass the thread over the ignition earthing switch pulley, ensuring that its passage is unobstructed.
- (c) Attach the thread to the hook of the spring.
- (d) Line up the operating lever with the slot in the top of the cylinder valve and insert the fulcrum pin; lock the pin in position.
- (e) Measure the length of the spring; this should be $7\frac{3}{8}$ in. between pin centres.
- (f) To adjust the length of the spring, unlock and remove the fulcrum pin and disconnect the thread from the spring; adjust by knotting the thread until the length of the spring is $7\frac{3}{8}$ in. Refit and lock the fulcrum pin in position.

(g) Close the rear doors of the trolley.

56. To remove a carbon dioxide cylinder:—

- (a) Open the rear doors of the trolley.
- (b) Release the copper pipe.
- (c) Remove the operating lever from the valve.
- (d) Release the cylinder quick-release clamp and withdraw the cylinder.

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57. To fit a carbon dioxide cylinder:—

- (a) Fit the cylinder in the quick-release clamp and lightly secure the clamp.
- (b) Connect the copper pipe to the gas outlet of the valve and tighten the clamp.
- (c) Line up the operating lever and fit the fulcrum pin; lock the pin in position.
- (d) Check, and adjust if necessary, the length of the spring (para. 55 (e) and (f)).
- (e) Close the rear doors of the trolley.

Trolley

58. **General.** Examine the casing for evidence of damage caused by striking against other objects. Remove the panels and inspect the fuel tank and heat exchanger for damage and cracks, particularly in the vicinity of welded joints. Structural defects to the trolley must be repaired in accordance with normal engineering practice, and all defective paint-work renewed to prevent corrosion.

Main Wheel Bearings

59. To examine the main wheel bearings (Fig. 17), treat each wheel as follows:—

- (a) Jack up the trolley so that the wheel is clear of the ground.

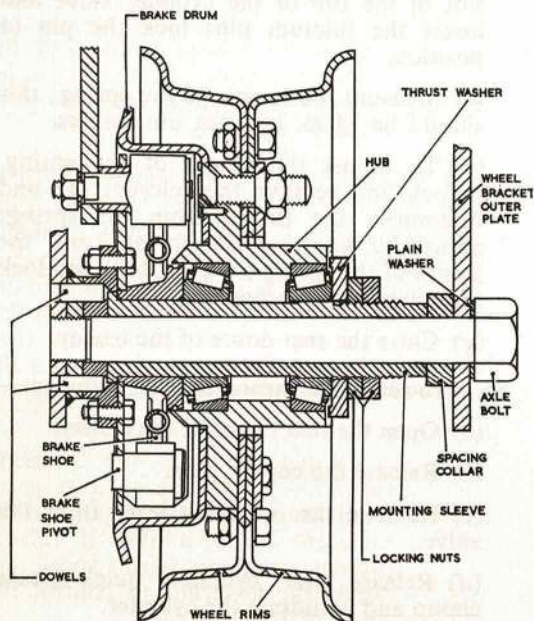


Fig. 17. WHEEL ASSEMBLY

- (b) Remove the axle bolt and spacing collar.

Note.—On right-hand wheels the spacing collar is located at the inner end of the hub.

- (c) On left-hand wheels, remove the locking pin from the brake lever and press the lever down until it clears the quadrant.
- (d) Withdraw the wheel.
- (e) Remove the locking nuts and thrust washer and draw the free portion of the wheel from the mounting sleeve.
- (f) Clean and examine the bearings.

60. Pack the bearings with grease LG-280 and assemble and refit the wheel in the reverse order to dismantling. The final adjustment of the bearings is left until the wheel is mounted on the trolley. During assembly and adjustment the wheel must be rotated frequently in both directions for several revolutions to ensure that the rollers are correctly positioned. Adjust the bearing end play as follows:—

- (a) Screw up the inner locking nut by hand until there is no end play.
- (b) Unscrew the locking nut one-sixth of a turn and lock it in this position with the outer locking nut. Check the wheel for correct rotation.

On completion of assembly ensure that the brake functions efficiently.

Note.—Some wheels may be fitted with ball bearings: in such cases the examination procedure is similar but no adjustment is possible.

Castor Wheel

61. To renew the bearings of the castor fork (Fig. 18), proceed as follows:—

- (a) Jack up the front end of the trolley.
- (b) Remove the lockscrew and the setscrew from the top of the castor fork, slacken the setscrew at the side of the wheel bracket and remove the fork from the bracket.
- (c) Remove the Allen screws which lock the bearings in the castor wheel bracket.
- (d) Use a metal drift to tap the bearings out of the wheel bracket.

(e) With the chamfered face of the bearing uppermost, insert a new bottom bearing into the bracket and, using a hide-faced hammer, tap the bearing gently into position.

(f) Insert a new top bearing in the same manner.

(g) Screw in and tighten the Allen screws.

(h) Refit the wheel fork and check the castoring action.

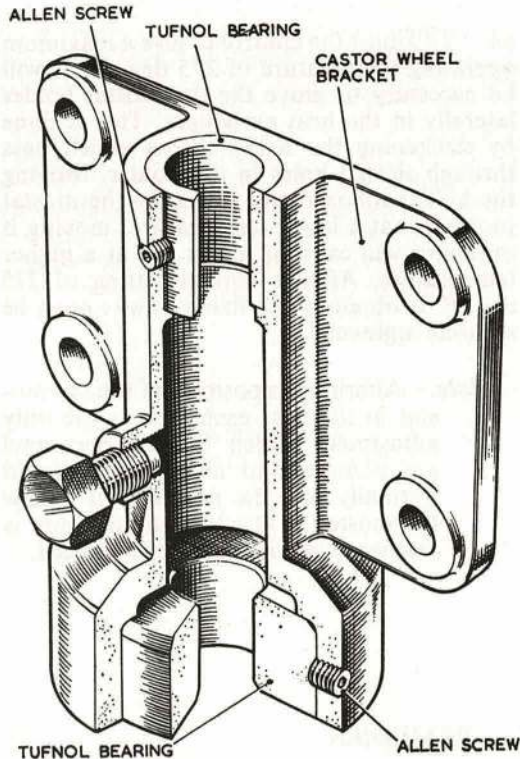


Fig. 18. CASTOR WHEEL FORK BEARINGS

FUNCTIONAL TESTING

General

62. After reconditioning or major repairs which involve extensive dismantling of the equipment, the plant should be tested and any necessary adjustments made. To facilitate this, the cowl panels should not be refitted until after completion of the test run. The procedure for testing the plant is as follows:—

(a) Ensure that the main fuel tank is full and the engine sump is filled with oil to the correct level.

(b) Position the trolley and apply the parking brake as described in para. 22.

(c) Fit the exhaust pipe to the heat exchanger and fit an air hose to each delivery duct; the bore diameter must not be restricted or reduced by bends or other causes.

(d) Ensure that the h.t. lead is securely attached to the burner electrode; that the two-pin earthing plug is plugged into its socket; and that the engine compartment ventilating port is open. Fully close the pressure regulator by turning the hand-wheel anti-clockwise.

(e) Open the engine fuel cock and flood the carburettor; pull out the choke control; switch on the ignition and start the engine.

(f) When the engine is running evenly, push the choke control in gradually until the engine runs smoothly with the choke fully open.

(g) Turn the handwheel of the pressure regulator slowly clockwise and, when the flame is established, adjust the fuel pressure to 10 lb per sq. in. (max.).

Note.—If combustion in the combustion chamber is not established immediately, reduce the fuel pressure to zero, stop the engine and check the burner assembly (para. 53). Refer to para. 29 before attempting to restart.

(h) Allow the burner to operate at 10 lb per sq. in. for at least ten minutes, then increase the fuel pressure slowly in stages of approximately 5 lb per sq. in., allowing five minutes for each stage, until maximum outlet temperature is reached. During this period note the rate of temperature rise; this should increase progressively with the increase in fuel pressure.

Notes.—

1. When opening the pressure regulator, check the exhaust gases from the combustion chamber for excessive black smoke. If this is present, check the engine speed and adjust the governor to control the speed at 2,800 r.p.m.

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2. If the air delivery temperature does not rise steadily as the fuel pressure is increased, close the pressure regulator, stop the engine, and check the burner assembly (para. 53).

3. The fuel pressure required to produce air at 275 deg. F. will depend on the ambient temperature. Pressures greater than 30 lb per sq. in. should be necessary only when the plant is tested under extremely cold conditions.

(j) Check the operation of the thermostatic control. The fuel pressure should reduce when the control cuts out at 275 deg. F., and return to its preset value when the control cuts in between 265 and 275 deg. F. If the control is functioning correctly, increase the fuel pressure to 40 lb per sq. in. and confirm that the control operates satisfactorily at this pressure. It is important that the pressure of 40 lb per sq. in. is not maintained longer than is necessary for the test because of the risk of damage to the thermometer and control.

Note.—During the earlier cycles of operation the air temperature will tend to overswing, and normal operating temperatures may not be obtained until about the seventh cycle.

Adjustments

63. If the fuel pressure drops to zero when the control cuts out this would indicate a blocked by-pass jet in the valve unit; if the pressure does not fall this would indicate that the thermostatically operated ball valve is sticking or is not seating correctly. In the event of either of these conditions arising, dismantle the valve unit and take any necessary action as described in para. 52.

64. To adjust the control to give a maximum operating temperature of 275 deg. F., it will be necessary to move the thermostat holder laterally in the heat exchanger. This is done by slackening the fixing screws which pass through slotted holes in the holder. Moving the holder inboard will cause the thermostat to cut out at a lower temperature; moving it outboard will cause it to cut out at a higher temperature. After a correct setting of 275 deg. F. is obtained the fixing screws must be securely tightened.

Note.—Altering the position of the thermostat in the heat exchanger is the only adjustment which Service personnel are permitted to make. This should normally only be necessary if a new thermostat is fitted or the old one is removed and not correctly refitted.

FAULTS — CAUSES — REMEDIES

Fault	Possible Cause	Remedy
1. Failure to start.	Ignition switched off. Spark plug faulty. Incorrect setting of contact breaker gap, dirty or pitted points. Fuel turned off. Fuel supply faulty.	Switch ignition on. Service or renew plug. Clean points and reset gap to 0.012 in. to 0.016 in.
	Carburettor faulty (needle sticking, jet blocked, etc.).	Open fuel tap. Clean engine filter and carburettor banjo connection filter. Flush out fuel pipe. Service carburettor.

Fault	Possible Cause	Remedy
2. Erratic running.	Sparking plug faulty. Loose connection in ignition switch circuit. Contact breaker gap incorrect. Partial stoppage in fuel supply. Water or ice in fuel system. Air leaks in induction system.	Service or renew plug. Check continuity of switch circuit. Reset gap to 0.012 in. to 0.016 in. Clean out fuel feed pipe, engine filter, and carburettor banjo union filter. Drain tanks, clean system and refill tanks with clean fuel. Tighten induction pipe and carburettor joints.
3. Engine starts but combustion fails to take place in heat exchanger.	Main fuel tank empty. No spark at h.t. electrode. Pump driving belt slipping. Main fuel filter blocked. Valve unit filter blocked. Dirty filter or jet in jet assembly.	Refill tank. Check wiring to h.t. electrode, clean electrode and reset gap. Clean belt and pulleys and adjust tension of belt. Clean filter. Clean filter. Service jet assembly.
4. Intermittent combustion and "blow-back" in burner assembly air tube during warming-up period.	Fuel pressure regulator opened too rapidly after engine has started. Incorrect gap and wrong positioning of electrodes in relation to the jet assembly.	Reduce fuel pressure to minimum and then slowly open up to 10 lb per sq. in. Position electrodes correctly and reset gap.
5. Flame failure during operation.	Main fuel tank empty. Burner jet assembly blocked. Blocked metering jet in maximum temperature valve unit (when operating at maximum temperature only).	Refill tank. Dismantle and clean jet assembly. Dismantle valve unit and clean jet.
6. Excessive black smoke from exhaust pipe.	Low engine speed.	Check and adjust engine speed to 2,800 r.p.m.

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