BR 33003/6.

# MISCELLANEOUS INSTRUCTIONS

BR 33003/6. Revised Nov. 1957.

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## THE 4-STROKE CYCLE DIESEL ENGINE.

The four-stroke engine is so named because it has one power stroke to every four strokes of the piston.

The sequence of operation is as follows :—

**1st. — Suction Stroke,** which is a downward stroke during which a charge of air is drawn into the cylinder through the air filter and the open inlet valve.

**2nd. — Compression Stroke.** Just after the piston begins its upward travel, the inlet valve closes and compression of the charge of air commences. Due to the air being compressed, its pressure rises, accompanied by a rise in temperature, which may reach approximately 950°F.

A charge of fuel is sprayed into the cylinder by means of the fuel injector and fuel pump just prior to the piston reaching top dead centre. This charge ignites spontaneously in the compressed air which is sufficiently hot to ignite the fuel.

**3rd. — Power Stroke.** The burning fuel further heats the air and in its rapid expansion forces the piston down on its power stroke. Expansion of the gases continues until just before the piston reaches bottom dead centre when the exhaust valve opens and the expanded gases are then exhausted to atmosphere through the exhaust system.

**4th. — The Exhaust Stroke.** The scavenging of the spent gases is completed during the piston's upward stroke.

## THE 2-STROKE CYCLE DIESEL ENGINE.

The operation of this type of engine differs from the 4-stroke type in that each downward stroke of the piston is a power stroke. There are two common types of 2-stroke engine.

On one type the valves are dispensed with and their function carried out by the piston which, on its downward stroke, uncovers exhaust gas ports in one side of the cylinder and air inlet ports in the other side. The exhaust gases escape at high velocity through the exhaust ports and scavenging air blown through the air inlet ports into the cylinder under

pressure from the air pump or blower blows out any remaining gases and at the same time fills the cylinder with clean air. The upward stroke of the piston closes both the exhaust and air inlet ports before the air is compressed in the cylinder. This system is called loop scavenge.

On the other type the air enters the cylinder through ports in the cylinder wall, but the exhaust gas escapes via poppet exhaust valves. This system is called uni-flow scavenge.

**Cooling Diesel Engines.**

The engine cooling water is drawn from a vertical radiator and forced through the engine water jacket spaces by an engine-driven pump and returned to the radiator. On the majority of diesel locomotives and trains a radiator header tank is also fitted, to increase the capacity of water carried for cooling the engine. Cooling of the water in the radiator is assisted by a radiator fan which may either be belt, gear or electric motor-driven.

The normal water temperature should be between 155°F. and 180°F. when a diesel engine has been warmed up, and various methods of controlling the temperature are employed. Where electrical drive to the radiator fan is provided, the speed of the fan motor can be reduced by a thermostatic electrical control. In the case of belt or gear driven fans the flow of water to the radiator is controlled by a thermostatic valve which, when the engine is cold, closes and diverts the water directly back into the engine water jackets, through the pump, without passing through the radiator. This continues until the engine warms up to a temperature determined by the manufacturer, when the valve opens and allows the water to circulate through the radiator.

A separate section of the radiator is provided for cooling the engine lubricating oil. The lubricating oil is cooled by being pumped through this section of the radiator on its way to the engine bearings from the engine sump.

Where radiator shutters are fitted, they must normally be opened when running, but may be closed to assist warming up. They should be closed when stabling.

**Radiator Water Level.**

If there is a noticeable loss of water from the radiator and no cause is apparent, the matter must be investigated before any attempt is made to start the engine.

**Frost Precautions.**

If a locomotive is in traffic but not required for an appreciable period, the radiator shutters (where fitted) must be kept closed and the engine run periodically as necessary to prevent freezing.

**Warming Up the Engine.**

Warming up the engine should normally be done by running it at idling speed.

When starting up from cold some engines may be warmed up by running up to three-quarters of full rated speed.

**Diesel Engine Oil Sump Level.**

If, when checking the lubricating oil level in a diesel engine sump, the level is below the MINIMUM mark on the dipstick, report the fact to the Depot.

If the level is found to have risen considerably above the MAXIMUM mark, which would occur if an excessive amount of water or fuel oil had leaked into the sump, do NOT start the engine, but report the matter immediately to the Depot.

**Pressure Charging.**

On engines fitted with turbo-blowers or pressure chargers, air at slightly more than atmospheric pressure is blown into the cylinders via the inlet manifold and the air inlet valves or ports.

The volume of air thus introduced into the cylinders at each suction stroke is greater than if it were only sucked in by the downward stroke of the piston. The greater volume of air allows more fuel to be burnt in the cylinders, which in turn means a greater power output per cylinder than would otherwise be possible.

Turbo-blowers are driven by the exhaust gases of the engine and pressure chargers are mechanically driven.

**Pressure Charger Failure.**

If a turbo-blower or pressure charger fails, the engine should be run at reduced speed and the locomotive or train taken out of service as soon as possible.

**Starting the Engine.**

Under no circumstances must the master switch or starting button be kept in the "Start" position if the diesel engine fails to turn over.

The generator or starter motors must not be given long and repeated motoring if the engine fails to start.

If an engine fails to start easily the fact must be reported immediately.

Failure to comply with the above may cause damage to the electrical starting equipment and drain the battery.

**Overspeed Device.**

Some engines are fitted with an overspeed device so that should the engine overspeed for any reason, the device will operate and cut off fuel from the fuel injectors and stop the engine.

Before the engine can be restarted the device must be reset and an endeavour made to find the cause of the overspeeding.

If, on restarting the engine, overspeeding still persists the matter must be reported immediately.

If overspeeding occurs on engines NOT fitted with the overspeed device and it is not possible to reduce the engine speed or stop the engine by normal means, immediate steps should be taken to cut off the fuel supply to the engine from the fuel tanks, by closing the stop valve or by operating the emergency stop control, where fitted.

**Dead Man's Device.**

**On locomotives** the dead man's pedal must be kept depressed by the driver's foot whenever the reverser and the controller are in running positions. (ANY OTHER MEANS OF DEPRESSING THE "DEAD MAN'S" PEDAL IS STRICTLY FORBIDDEN).

If the dead man's pedal is released when the power (controller) handle is in a power position, the power is cut off from the transmission and, after a time delay of 5 to 7 seconds, the brakes are automatically applied. The diesel engine continues to run.

If the power (controller) handle is in the off position and the reverser lever is in the Forward or Reverse position, the dead man's device remains operative.

The time delay of 5 to 7 seconds before the brakes are applied, serves three purposes :—

(i) To allow time to cross from one side of the cab to the other and regain control of the dead man's device, either by the "hold-over" button or by the duplicate controls, if fitted.

(ii) To allow time to change feet on the pedal without losing control of the locomotive.

(iii) If the dead man's device operates, to allow time for the drive to come off the transmission before the brakes are fully applied.

**On diesel trains** the principle of the dead man's device is similar, but it is incorporated in the throttle handle, which must be kept depressed when the reversing handle is in either the Forward or Reverse position to prevent the device from operating, irrespective of the throttle handle position.

Where the "pull" type throttle handle is fitted, this must be held in the idling position to prevent the device from operating.

**Batteries.**

The chief function of the battery on diesel locomotives and trains is to provide a means of turning the diesel engine to start it. On diesel electric locomotives and trains the battery is connected to the main generator, causing the latter to run as a motor and rotate the engine until firing commences when the starting lever or button is placed in the "start" position. On diesel mechanical locomotives and trains the battery supplies a current to the starter motors. The batteries are kept charged by either an auxiliary generator or dynamo, dependent upon the size of the engine unit, in conjunction with voltage regulators. The latter automatically regulate the charge rate according to the state of the battery.

**Main Generator and Drive.**

On diesel electric locomotives and trains the diesel engine drives a direct current generator. This is a single bearing machine, one end of the armature shaft being coupled direct to the engine fly wheel and the other supported in a bearing housed in the generator end plate. This machine supplies current to the traction motor or motors.

**Auxiliary Generator and Exciter.**

On diesel electric locomotives and trains an auxiliary generator driven from the engine is provided to supply current for the auxiliary machine control equipment, battery charging and the excitation of the fields of the main generator. On some locomotives, in addition to an auxiliary generator, an exciter is fitted. This machine supplies current for the main and auxiliary generator fields.

**Traction Motor Blowers.**

On diesel electric locomotives and trains, motor-driven traction motor blowers are provided in order that the traction motors may be cooled by forced ventilation. Should these blowers fail, the appropriate instructions must be strictly adhered to.

**Air Compressors.**

Air compressors provide the compressed air for operating the pneumatic or electro-pneumatic control equipment, sand ejectors, warning devices, window wipers, air brakes, compressed air starting, and, in some cases, refuelling systems.

The air compressors are controlled by a governor, which is normally set to maintain the air pressure between 65 and 105 lb. per square inch, dependent upon the type of locomotive or train to which they are fitted.

**Wilson-type Epicyclic Gear-Boxes.**

These are fitted to diesel mechanical locomotives and diesel mechanical trains. To maintain to the full the automatic adjustment of the brake bands, it is necessary to "toggle-up" the gear-boxes once during each turn of duty, at a convenient time. The procedure is as follows :—

(i) Check that full air is available,

(ii) Stop the engines,

(iii) Hold the deadman's device in the "Running" position.

(iv) Place the reversing lever into the "Forward" position.

(v) Move the gear selector handle to engage 1st, 2nd, 3rd and 5th gears about six times, pausing in each gear position to allow the gear brake bands to engage fully.

(vi) Return the gear selector handle to "Neutral".

(vii) Re-start the engines. Note :— This procedure does not apply to the 4th gear which is a direct drive through a multiple disc clutch.

**Vacuum Exhausters.**

Vacuum exhausters, either motor or belt-driven, are fitted to main line diesel locomotives and diesel trains, also to most diesel shunting locomotives, in order that vacuum fitted stock may be worked.

These exhausters are so arranged that 21″ of vacuum can be maintained against a $\frac{3}{16}$″ leak disc with the brake valve in the "Running" position. (25″ in the Western Region for locomotives).

**Assistance by a Steam Locomotive.**

**In an emergency** (i.e., for line clearance purposes) a steam locomotive may be used in conjunction with a diesel locomotive, providing that under no circumstances is the maximum permissible speed of the diesel locomotive exceeded, **and that any special instruction contained in the driving instructions of the particular diesel locomotive concerned are adhered to.**

**Double-heading** with a diesel locomotive and a steam locomotive is not permitted under normal operating conditions.

NOTE : Care should be exercised to avoid excessive use of the cylinder cocks, etc., when a steam locomotive is coupled to a diesel locomotive head on.

**A disabled diesel train** may be assisted by a steam locomotive and **detailed instructions are incorporated in the driving instructions for each type of train.**

**Derailments.**

Diesel locomotives should in all cases be re-railed by jacks or crane. These locomotives must on no account be pulled on to the rails.

**Unusual Smell or Knock.**

If at any time an unusual smell or knock should develop, stop the locomotive and engine as soon as possible and investigate. If nothing can be found, send for a fitter from the Depot.

**Precautions against Crankcase Explosions.**

Do not remove crankcase doors for 15-20 minutes after stopping engine.

Keep all naked lights away from power unit during and after removal of crankcase doors.

Dispel crankcase gases by means of a non-electric blower or compressed air line as soon as doors are removed. An electric blower may be used provided hose connection is long enough to keep the motor at a safe distance.

If engine stops due to seizure or is stopped on suspicion of a bearing fault, do not attempt to restart or to bar round until it has cooled.

**Fuel Oil Economy and Exhaust Gases.**

It is essential that Drivers economise in the use of fuel oil by stopping the engines when diesel trains and locomotives are not required for traffic purposes and, to avoid the emission of exhaust gases, and noise, particularly in Stations or Depots, the diesel engines should not be allowed to run unnecessarily.

If an engine should emit smoky exhaust gas, this may be due to one of the following causes :—

(i) Faulty fuel injectors
(ii) Dirty air filters
(iii) Low engine compression.

Should the driver observe that the amount or colour of the exhaust gas is unusual he should report this to the Depot.

**Use of Open Flame Lamps.**

Lighted torch lamps and lamps with an open flame must not be used on or near diesel locomotives or diesel trains. A flexible lead socket connection for an electric hand-lamp is provided on each unit.

**Cleaning Materials.**

Sponge cloths or cotton waste MUST NOT be used under any circumstances for cleaning cans or containers for lubricating oil, or for wiping down any internal parts of the crankcase, fuel pumps or injectors, as this practice may result in considerable quantities of fluff getting into the working parts, with the possibility of causing failures.

Clean fluffless rags only should be used for this purpose.

Under no circumstances must cloths or waste of any description be left in the engine or generator compartments as these can be a contributory cause of fire.

**Fire Extinguishers.**

All types of diesel locomotives and diesel trains are equipped with portable fire-fighting equipment.

Diesel trains are also fitted with automatic fire extinguishers over the power units.

The larger types of diesel locomotives have a $CO_2$ gas system installed, with electrical detectors.

Instructions regarding the operation of the fire extinguishing arrangements on diesel trains and large locomotives are included in the driving instructions.

## APPARENT DEATH FROM ELECTRIC SHOCK

Men are rarely killed outright by electric shock, they can be saved by immediate first-aid. Send for but never wait for a Doctor.

**Danger in touching injured person in contact with live conductor.**

Before touching the injured person make sure he is not in contact with a live conductor. If he is, do not try to move him with the bare hands but first switch off the current if the switch is near. If it is not, pull the victim clear by the coat tail, if dry, or use your own coat for grasping his body. Your belt or braces can be slipped round his leg or arm to pull him away, or you can use a piece of dry wood to knock or push aside the body from the live conductor, or any electrical appliance, which is touching his body. You can also protect yourself by standing on dry wood, or on a folded newspaper, or a dry mackintosh.

IN CASE OF CIRCUITS ABOVE 750 VOLTS DO NOT TOUCH THE VICTIM UNTIL THE CURRENT HAS BEEN CUT OFF.

## ARTIFICIAL RESPIRATION TO BE APPLIED AT ONCE

**For urgent artificial respiration use the method you know, if you have not been taught the Holger Nielsen method use the Schafer method.**

**General Instructions.**

DO NOT RELAX EFFORTS TO SAVE LIFE—Artificial respiration must be continued perseveringly until natural breathing is restored, unless a doctor decides that further efforts will be of no avail. It should be noted that life has been restored after a period of several hours.

HANDLE PATIENT CAREFULLY—The unconscious Patient should be handled carefully at all times. It is not uncommon for fractures to be found in cases of severe electrical injury.

DO NOT MOVE THE PATIENT UNTIL BREATHING IS NATURAL.

BURNS—Cover any burnt areas with sterilized dry dressings and do not attempt to remove any clothing which is in contact with the burnt areas. If no sterilized dressings are available use any clean dry material that is available.

WARMTH, FRESH AIR AND REST ARE ESSENTIAL.

STIMULANTS—Do not attempt to give anything by the mouth until the Patient is fully conscious. Do not give alcohol except under Doctor's orders. Warm sweet tea or a few drops of sal volatile in water may be given.

As soon as the Patient is able to swallow he should be given half-a-pint of water in which one teaspoonful of sodium bicarbonate has been dissolved. The same dose should be repeated hourly until the Patient is under medical care.

SEND PATIENT TO HOSPITAL BY AMBULANCE—He should not be allowed to walk until Doctor advises him to do so.

**Holger Nielsen Method.**

First make certain that the nose and mouth are not obstructed in any way. Quickly loosen all tight clothing. Dentures must be removed.

Lay Patient very carefully, face downwards. Place his hands one over the other, under his forehead. If this is insufficient to keep the nose and mouth from the ground, the head must be turned slightly to one side. (Figure 1).

Operator kneels on one knee at the head of the Patient with his other foot near the Patient's elbow. He then places his hands on the Patient's back, palms on shoulder blades and thumbs on spine. (Figures 2 and 3).

Keeping arms straight, the operator moves gently forward until arms are in an upright position, effecting a steady pressure by weight of the body (not force). This will cause air to leave the lungs. Movement takes place 2½ seconds counting "one", "two", three". (Figure 4).

The operator now moves slowly backwards counting "four" and slides his hands to Patient's arms near elbow, and grasps the arms at that point. (Figure 5).

Continuing the backward movement the operator pulls and slightly raises the Patient's arms for a period of 2½ seconds, counting "five", "six", "seven". (Figure 6).

Counting "eight" the arms are lowered to the ground and the operator replaces his hands on back to repeat the operation.

Repeat the movement nine times per minute. When natural breathing begins, continue raising and lowering the Patient's arms only at rate of about twelve times a minute.

Fig. 1



Fig. 2

Fig. 3

Fig. 4

Fig. 5



Fig. 6

**Schafer Method.**

First make certain that the nose and mouth are not obstructed in any way. Quickly loosen all tight clothing. Dentures must be removed. Lay patient very carefully face downwards, head to one side to keep mouth clear from the ground, with his arms above his head and palms of the hands on the ground.

The operator should kneel to one side of the Patient's buttocks facing the head and place his hands on the small of the back between the ribs and hip bones, one on each side, and fingers pointing to the ground, with the thumbs close to and parallel with the Patient's spine. (Figure 7).

With a steady and rhythmic movement the operator must then alternate between :—

(i) The weight of the operator's body is thrown well forward upon the hands so as to press the air out of the Patient's lungs keeping elbows quite straight. (Figure 8).

(ii) With the hands in the same position, the operator's body is drawn back as far as possible, so that pressure is taken off and the Patient's chest allowed to expand. (Figure 7).

These movements must be continued 12 to 15 times a minute.

Fig. 7

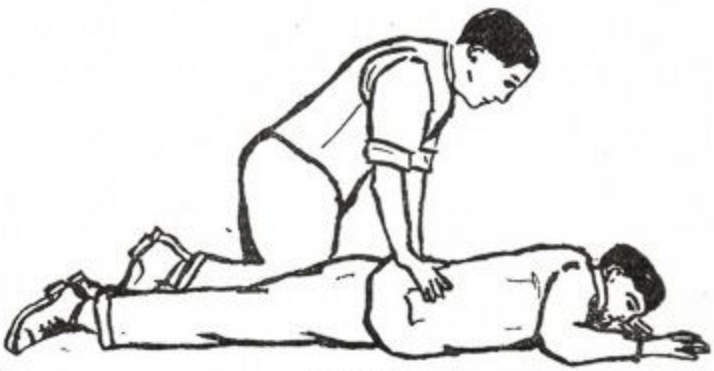

Fig. 8

## SOME FAULTS AND THEIR POSSIBLE CAUSES

It is difficult to foresee every possible contingency and the following lists do no more than act as a guide in locating faults on the various types of diesel driven units.

| Fault | Possible Cause |
|---|---|
| Lubricating Oil Pressure Low | (1) Too small a volume of oil in the engine sump. |
| | (2) Dirty lubricating oil filter. |
| | (3) Lubricating oil diluted with fuel oil. |
| | (4) Air leak on lubricating oil pump suction. |
| | (5) Defective lubricating oil pump. |
| | (6) High or low pressure relief valves or non-return valve stuck in the open position. |
| | (7) Defective crankshaft bearings or bearing clearances above normal. |
| | (8) Defective oil radiator elements, piping or joints. |
| Lubricating Oil Temperature High | (1) Too small a volume of oil in the engine sump. |
| | (2) Radiator shutters closed or elements dirty externally or internally. |
| High Water Temperature | (1) Radiator water level low. |
| | (2) Radiator shutters closed or elements dirty. |
| | (3) Radiator fan belts slipping. |
| | (4) Radiator fan drive defective. |
| | (5) Defective thermostatic valve. |
| | (6) Defective water circulating pump. |
| | (7) Flexible rubber hoses swollen in bore. |
| | (8) Faulty engine combustion. |

| Fault | Possible Cause |
|---|---|
| Engine runs erratically | (1) Worn muff couplings in camshaft.<br>(2) Sticking fuel pump racks or linkage.<br>(3) Excessive "back lash" in governor drive.<br>(4) Defective governor.<br>(5) Slack camshaft chain drive.<br>(6) Worn telescopic stub shaft bush.<br>(7) Supercharger faulty.<br>(8) Cracked fuel rail.<br>(9) Valve gear bent or broken.<br>(10) Water in fuel.<br>(11) Leaks in fuel system.<br>(12) Partly choked fuel filters. |
| Engine Knocks | (1) Excessive clearances in gudgeon pin bushes or big end bearings.<br>(2) Idling speed too low.<br>(3) Governor hunting.<br>(4) Fuel injector delivery pressures too high.<br>(5) Sticking fuel pump rack.<br>(6) Fuel pump timing out of adjustment.<br>(7) Engine cooling system choked. |
| Dirty Engine Exhaust | (1) Engine air filters choked.<br>(2) Fuel pump timing out of adjustment or rack setting too high.<br>(3) Fuel injector delivery pressures too low.<br>(4) Faulty fuel injectors.<br>(5) Engine valves require reconditioning.<br>(6) Valve timing incorrect.<br>(7) Poor compression.<br>(8) Piston rings passing lubricating oil. |

| Fault | Possible Cause |
|---|---|
| Starter Motor or Generator will not motor from battery when attempting to start the engine | (1) Battery isolating switch open.<br>(2) Battery in a low state of charge.<br>(3) Starting contactor fails to close.<br>(4) Control fuse blown.<br>(5) Lubricating oil pressure switch not operating.<br>(6) Lubricating oil pressure too low.<br>(7) Faulty contacts on master switch.<br>(8) Water in engine cylinders.<br>(9) Engine seized.<br>(10) Low water level.<br>(11) High water temperature. |
| Engine will turn on battery but will not fire | (1) Fuel cock closed.<br>(2) Fuel filter choked.<br>(3) Air lock in fuel system.<br>(4) Hand throttle at the stop position.<br>(5) Engine governor control valve inoperative.<br>(6) Cylinder relief valves open.<br>(7) Faulty fuel injectors or fuel pumps.<br>(8) Governor oil strainer dirty.<br>(9) Overspeed governor tripped.<br>(10) Low water switch tripped. |
| Engine shuts down after running a short period | (1) Fuel shut off cock closed.<br>(2) Partially choked fuel filter.<br>(3) Air lock in fuel system.<br>(4) Dirty lubricating oil filter.<br>(5) Lubricating oil level in engine sump low.<br>(6) Governor not operating properly.<br>(7) Governor oil strainer dirty. |

| Fault | Possible Cause |
|---|---|
| Locomotive or train will not move when the power handle is moved to a power notch | (1) Brakes not releasing.<br>(2) No compressed air.<br>(3) No vacuum.<br>(4) Dead man's pedal not depressed or defective.<br>(5) Protective device is operating.<br>(6) Faulty contacts on master controller.<br>(7) Faulty contacts on generator starting contactor interlocks or earth fault, etc.<br>(8) Faulty control circuit governor.<br>(9) Emergency starting switch not fully closed. |
| Power is cut off on moving the controller to a higher position | (1) Faulty contacts on the motor contactor interlocks.<br>(2) Faulty contacts on master controller.<br>(3) Earth fault or overload relay operating. |
| No increase in power obtained when moving power handle or controller handle from 'ON' towards full power | (1) Faulty contacts in control gear.<br>(2) Linkage adrift between controller and governor.<br>(3) Engine speed solenoids defective.<br>(4) Defective air valve in controller. |
| Locomotive or train pulls badly | (1) Engine air filters dirty.<br>(2) Torque control out of adjustment.<br>(3) Weak field contactors not operating correctly.<br>(4) Faulty fuel injectors.<br>(5) Poor compression.<br>(6) Fuel pump rack settings too low or engine timing out of adjustment. |

| Fault | Possible Cause |
|---|---|
| Locomotive or train pulls badly—*continued* | (7) Defective governor or Sticking fuel control linkage. |
| | (8) Control voltage low. |
| | (9) Faulty contacts on master controller. |
| | (10) Partly blocked fuel filters. |
| | (11) Insufficient oil in fluid coupling. |
| | (12) Gearbox brake bands slipping. |
| Engine will not shut down when the master switch is moved to the 'OFF' position | (1) Pistons passing lubricating oil. |
| | (2) Engine governor control valve sticking. |
| | (3) Sticking fuel pump racks or control leakage. |
| Battery Volts low | (1) Exciter or generator belts slack. |
| | (2) Defective voltage regulator. |
| | (3) Defective exciter. |
| | (4) Faulty contacts on control gear. |
| | (5) Faulty generator or dynamo. |
| Vacuum low | (1) Defective exhauster(s) or motor(s). |
| | (2) Defective snifter valves. |
| | (3) Defective cut-out valves. |
| | (4) Exhauster isolated. |
| | (5) Fuse blown. |
| | (6) Leak in vacuum system. |
| Air pressure low | (2) Leak in air system. |
| | (3) Defective Air Governor or reducing valve. |
| | (4) Defective compressor motor. |
| | (5) Compressor fuse blown. |
| Traction Motor Blowers not running | (1) Fuses blown. |
| | (2) Defective motor. |
| Excessive vibration in pressure charger | (1) Broken turbine blades. |
| | (2) Defective bearings. |
| | (3) Distorted shaft. |





McCorquodale, Newton-le-Willows