cable wheel by slackening the cable clamp. Unscrew the union nut securing the control cable conduit to the unit and remove the conduit support clip. Remove the nuts securing the control unit and withdraw the unit slowly, allowing the control cable to feed round the cable wheel. Replace the cable wheel cover and secure with the nuts, reposition the restrictor tubes and the circlips.

To replace a hydraulic control unit, reverse the removal procedure feeding the control cable around the cable wheel and securing the unit in position with a new joint washer between the mounting face and the phasing gear case. Check the phasing of the control between the governor and the hydraulic control unit. Connect up the oil supply and delivery pipes. Connect the electrical leads to the terminal box. Check the operation of the controls.

Starting Accumulator

The remove the starting accumulator, remove the air pipe from the adapter nut and discharge the fuel by inserting the accumulator tripping tool through the orifice plate and depressing the release plunger. Disconnect the fuel pipes, remove the securing nuts and washers and remove the accumulator. Discharge the gas side of the accumulator by removing the valve cover and depressing the air release valve.

To replace an accumulator, reverse the removal procedure. Charge the gas side of the accumulator and operate the fuel priming pump to charge the fuel side.

Clutch Delay Switch

To remove the clutch delay micro-switch from the drive end of 'C' cam-shaft casing, disconnect the electrical cable at the micro-switch; release the securing bolts and remove the micro-switch.

To replace the micro-switch, reverse the removal procedure. Adjust the setting of the switch to close at a nominal 'rack' setting of 103° to 104° and open at a nominal setting of 110° to 111°.

INSTRUMENTATION

Pressure Transmitters and Temperature Phials

When pressure transmitters are removed from the engine for any reason, the capillaries should be coiled and tied clear of the working area. When replacing a transmitter, new joint washers should be fitted on each side of the transmitter banjo connection and the securing cap nut should be locked with suitable locking wire.

When temperature phials are removed from the engine, the capillaries should be coiled and tied clear of the working area. When replacing a temperature phial, tighten in position and lock with the securing nut. Ensure that the copper joint washer is in position under the union nut before inserting the phial into the adapter.

Engine R.P.M. Indicator Generator

To remove the generator from its mounting at the free end of 'B' camshaft casing, disconnect the electrical cable at the generator. Remove the securing nuts and washers and withdraw the unit.

It is not recommended that any servicing can be attempted. The generator armature shaft should not be removed as loss of magnetism will result and, if the shaft is replaced, the voltage output of the machine will be low resulting in an incorrect reading being given by the reading instrument. A special procedure, retained by the manufacturer and his accredited agents, is required when the armature shaft is removed.

To replace the generator, prepare the mating joint faces with jointing compound and secure the unit in position.

'Rack' Indicator Transmitter

To remove the transmitter, remove the cover, note the positions of the cable connections and disconnect the wires from the terminal screws. Remove the nuts and washers from the coupling stud; remove the nuts and washers securing the support bracket to the camshaft casing and remove the unit, taking care not to misplace the coupling stud. Remove the support bracket from the unit.

To ensure ease of procedure in setting the correct position of the adjustable lever, either make a note of the distance between the centre-line of the coupling-stud hole and the centreline of the lever securing pivot or, if the replacement transmitter is available, adjust the position of the lever on the replacement unit to be exactly the same as that on the unit removed from the engine.

To replace the transmitter, reverse the removal procedure, fitting the support bracket to the replacement unit and, when offering up to position, feeding the coupling stud into position between the fixed and adjustable levers. Connect the electrical cables to the terminal screws in the correct sequence as noted prior to the removal procedure.

To check the synchronisation of the reading instrument with the engine 'rack', disconnect the control rod from the governor output lever at the bell-crank lever at the drive end of 'B' camshaft casing. Switch on the electrical supply. Operate the 'B' camshaft casing bell-crank lever over the full range of movement and, at intervals of 10^{o}, check that the reading instrument indicates the same figure as that registered by the 'rack' indicator arm against the scale on the camshaft casing end cover. To

adjust, lock the 'rack' at 124° by inserting the setting pin to lock the 'rack' indicator arm. Slacken the nuts securing the fixed lever to the control shaft and adjust the position of the lever, which has elongated bolt holes, until the reading instrument registers 124°. Tighten the fixed lever securing nuts and again check the synchronisation of the reading instrument with the 'rack' reading.

Exhaust Temperature Indicators and Thermocouples
(Individual indicators)

The exhaust temperature indicators and thermocouples used with Deltic engines function in accordance with the basic principle of a thermocouple, that is, the indicator merely registers the difference between the temperature at the thermocouple probe in the exhaust manifold and the temperature at the indicator, i.e., the difference between the Electromotvie Force (E.M.F.) at the hot and cold junctions. The indicators do not register absolute temperature.

The indicators (instruments) fitted to Deltic engined installations may be graduated in degrees Centigrade or degrees Fahrenheit (dependent upon requirements) but, whichever scale is used, the procedure for the initial setting of the system is the same.

When changing a defective indicator, the replacement unit should be set at zero (0°) before the electrical connections are remade, i.e. with an open circuit. Adjustment is made by turning the small adjusting screw positioned beneath the bezel at the front of the indicator. The fact that the temperature of freezing water under normal conditions is 32°F (0°C) has no bearing, when converting the figures given in the Operating Data, since whether the indicators are calibrated in °F or °C, they should always be adjusted to zero in the open circuit condition.

Should it become necessary to change a compensating cable between the engine thermocouple junction box and the terminal block at the rear of the instrument panel, it is essential that a replacement cable of the correct length is fitted, and that the associated ballast resistor is of the correct value.

It should be noted that, due to the position of the thermocouple junction boxes on the engine exhaust manifolds the compensating cables vary in length. In order to maintain the total resistance of each thermocouple circuit (18 in number) at the same value, regardless of the length of the cables, ballast resistors are placed in the circuits (at the rear of the instrument panel) to cater for the varying lenth of the cables*. It is essential that the conjunction of matched ballast resistor and cable length be maintained, ballast resistors and cables are each marked with the same colour coding. For reference to this detail, see the relevant section of the Spare Parts Catalogue for the engine installation.

NOTE: * The compensating cable, ballast resistor and thermocouple when connected, have a total resistance of 10 ohms ± 2%.

MAJOR UNITS

The following instructions are provided should it be necessary in an emergency to replace a major unit. The layout of the engine installation will determine whether or not a unit can be replaced with the engine still installed and this may vary with installations of different types. In the following instructions therefore, removal and replacement is not considered from the stand point of an installed engine.

The tools required for the following operations form part of the Overhaul Tools (see Publication 430) but the specific tools required are listed in Appendix 2, of the Maintenance Manual.

ENGINE PHASING AND TIMING

General

Series III Deltic engines are fitted with timing scales, graduated in 360°, at the free-end of each camshaft with a register line adjacent to the timing scale. For phasing and timing operations, and in conjunction with these timing scales, a piston position indicator is provided. The engine is turned by use of the hand turning tool. The piston position indicator, supplied with the Maintenance Tool Kit, comprises an insulated flexible metal strip housed in a body which can be positioned in the injector adapter with the metal strip projecting into the cylinder. A lamp and battery box completes the indicator equipment.

> NOTE: On earlier Series engines, the camshaft casing timing collar was only graduated to 40°, and a timing dial was supplied to be fitted to the engine as required. The timing dial is still supplied for Overhaul purposes but its use is not considered in the following instructions.

Due to the geometric arrangement of Deltic engines, the exhaust pistons are considered as the datum pistons. All crankshaft phasing and camshaft timing operations are therefore carried out with the exhaust pistons of the No. 1 cylinders. As the firing sequence of the No. 1 cylinders is in the order C.1, B.1, A.1, with 40° between each, the C.1 exhaust piston is usually considered as the datum for complete phasing and timing operations.

To Determine Top Dead Centre

Remove the injector from the No. 1 cylinder of the bank in which T.D.C. is required and insert the piston position indicator with the toe of the flexible metal strip pointing toward the exhaust piston. Connect one lead from the lamp box to the contact rod of the indicator and the other lead to a convenient earth on the engine. Remove the timing cover plate from the inspection port at the free end of the associated camshaft casing and ensure that the camshaft casing drive quill-shaft is in engage-

ment. Fit the hand turning gear to the engine (see Article 9.1). Turn the engine observing the lamp on the lamp box. At the point at which the lamp is extinguished, note the reading on the camshaft timing collar (for example, say - 30°). Continue turning the engine and, at the point where the lamp is illuminated again, note the reading on the camshaft timing collar (for example, say - 70°). Half the angle between "light off" and "light on" is the true T.D.C. of the exhaust piston, thus (for the example figures quoted above) 50° on the timing collar is the T.D.C. and the datum for further operations.

To Phase the Engine Crankshafts

The operation of phasing the crankshafts is necessary after the replacement of a phasing gear case. In the following instructions, a complete phasing operation is explained.

For the following operations, it will be necessary to disengage the blower from the drive gears at the free end of the 'AB' and 'BC' crankcase torsionally flexible drive shafts. An engine cannot be phased with the blower in position as the top two crankshafts are interconnected through the blower drive gear-train and the flexible drive shafts. Remove the blower as detailed in this Chapter. Fit the hand turning gear to position and ensure that 'C' camshaft casing drive quill-shaft is engaged.

With the replacement phasing gear case in position, engage all three crankshaft quill-shafts. It is assumed for this 'repair' phasing operation that the setting of the three crankshafts has not been disturbed after removal of the defective phasing gear case. Turn the engine and determine the T.D.C. of C.1 exhaust piston. Note the datum figure on 'C' camshaft casing timing collar. All further operations will be based on 'C' camshaft casing timing collar and the datum figure noted.

Remove the piston position indicator from C.1 cylinder and position it in B.1 cylinder with the toe of the indicator toward the exhaust piston. Determine the T.D.C. of B.1 exhaust piston. Set B.1 exhaust piston at T.D.C. Temporarily disengage 'AB' crankshaft quill-shaft. Turn the engine until C.1 exhaust piston is 40° after T.D.C., that is, 40° after the datum figure noted. Engage 'AB' crankshaft quill-shaft.

Transfer the piston position indicator to A.1 cylinder with the toe of the indicator toward the exhaust piston. Determine the T.D.C. of A.1 exhaust piston. Set A.1 exhaust piston at T.D.C. Temporarily disengage 'CA' crankshaft quill-shaft. Turn the engine until C.1 exhaust piston is 80°. After T.D.C., that is 80° after the datum figure noted. Engage 'CA' crankshaft quill-shaft.

Check that the phasing is correct as follows:-

1. Insert the piston position indicator in C.1 cylinder with the toe of the indicator toward the exhaust piston. Re-determine the T.D.C. datum figure for C.1 exhaust piston.

2. Transfer the piston position indicator to B.1 cylinder with the toe of the indicator toward the exhaust piston. Check that T.D.C. of B.1 exhaust piston is $40^{\circ} \pm \frac{1}{4}^{\circ}$ after the datum figure of C.1.

3. Transfer the piston position indicator to A.1 cylinder with the toe of the indicator toward the exhaust piston. Check that T.D.C. of A.1 exhaust piston is $80^{\circ} \pm \frac{1}{4}^{\circ}$ after the datum figure C.1.

NOTE: The tolerances quoted are "non-cumulative", that is, if B.1 cylinder is on the low limit at $39\frac{3}{4}^{\circ}$, A.1 cylinder must be between $79\frac{3}{4}^{\circ}$ and 80°; if on the high limit at $40\frac{1}{4}^{\circ}$, A.1 cylinder must be between 80° and $80\frac{1}{4}^{\circ}$.

Phasing the Blower

In order that the power transmitted to the blower by the 'AB' and 'BC' flexible drive shafts shall be equal and that there shall be no "wind up" of one or other of the shafts, it is necessary, when refitting a blower to position, to phase the blower driving and driven gears. The following instructions detail the procedure for phasing the Turbo-Blower.

IT IS IMPORTANT THAT THE DRIVING FLANKS OF THE 'AB' AND 'BC' CRANKSHAFT GEARS, THEIR ASSOCIATED BLOWER DRIVE IDLER GEARS, AND THE DRIVE GEARS ON THE DRIVING ENDS OF THE TWO FLEXIBLE DRIVE SHAFTS, ARE IN CONTACT DURING THE PHASING GEAR TRAIN OF GEARS ARE IN CONTACT.

Proceed as follows:-

1. In order to achieve the above condition, remove the pressure-oil or scavenge-oil pump whichever is convenient and withdraw the drive quill-shaft. Using the special tool inserted in the phasing case oil pump drive gear, turn the engine so that 'AB' and 'BC' crankshafts move against their normal direction of rotation through at least 1°. Should the operation for phasing the blower be consequent upon replacement of a phasing gear case, and the phasing case output shaft be free, the above operation can be carried out by turning the output shaft against the normal direction of rotation to achieve the same purpose.

IT IS ESSENTIAL THAT THIS SETTING IS NOT DISTURBED DURING SUBSEQUENT OPERATIONS OF PHASING THE BLOWER GEARS.

2. Lift the compressor assembly and align it with the sandwich piece on the main triangle assembly. Ease it into position over the studs. It may be found that the blower gear train will not mesh correctly with both drive gears on the flexible shafts. This may be checked through the inspection ports on the blower casing.

3. By rotating one of the first-idler gears in the blower gear train it will be possible to partially mesh one first-idler gear with its driving gear on the flexible shaft. Mark on the blower casing, with a pencil, the position of the centre line between two teeth of the other flexible drive shaft gear.

4. Withdraw the blower and remove the gear carrier plate, ensuring that the gears remain in the blower casing and that their setting is not disturbed. Withdraw the second-idler gear from the side of the train which will not mesh, and rotate the first-idler gear until one of its teeth is aligned with the pencil mark made on the blower casing. Withdraw the layshaft gear, and re-mesh it with the impeller pinion until the second-idler gear can be meshed with both the layshaft gear and the first-idler gear in its new position. Replace the gear carrier plate, and temporarily secure it with a few nuts. Offer up the blower to the engine again; correct meshing of the gears should now be possible. If the gears still do not mesh, the operation must be repeated until the gears engage easily.

THE BLOWER MUST NOT BE FITTED WITH THE GEARS STRESSED IN ORDER TO MESH THE TEETH.

5. The turbine assembly must be temporarily fitted on completion of operation No. 4. Mount the assembly in position, securing it with a few nuts only.

6. Mount a magnetic clock gauge pillar fitted with a 10 inch pointer to the free end of each flexible drive shaft. This is achieved by passing each magnetic pillar through the inspection ports on each side of the blower casing.

7. Using a torque spanner, rotate the turbine disc in the normal direction of rotation (as specified in the table following). It will be found that the pointer on the end of one of the flexible drive shafts will move first, the second pointer will move only when additional torque is applied.

8. Note the torque required to just move the second pointer. If the torque required exceeds the figure stated in the table following, the blower must be removed and the phasing of the blower drive gears corrected as follows:-

(a) Remove the turbine assembly.
(b) Remove the compressor assembly.
(c) Remove the gear carrier plate from the compressor assembly, ensuring that the setting of the gears is not disturbed.
(d) Mark with a pencil the meshed points of the layshaft gears with the impeller pinion: remove one of the second-idler gears. Disengage the respective layshaft, rotate it as specified (see Page 20), and re-engage it with the impeller pinion.
(e) Replace the gear carrier plate.

(f) Replace the compressor assembly.
(g) Replace the turbine assembly.

9. Re-check operation and if necessary carry out further adjustments until the conditions specified in the table are satisfied.

10. When satisfactory phasing has been achieved, remove the turbine and compressor assemblies, permanently fit the gear carrier plate, prepare the joint faces and finally fit the compressor and turbine assemblies.

Phasing the Blower Drive Gears
Turbo-Blowers

Table of Acceptable Limits

Engine Type	Maximum torque Applied to move both pointers NOT TO EXCEED	Fine adjustment, Rotate layshaft	Fine adjustment figures
T18-37K	At turbine shaft 230 lb/in Turn clockwise	12 Teeth	$\pm$ 0.15° at first-idler gear which is equivalent to 190 lb/in at the flexible shaft, i.e. 64 lb/in at the turbine shaft

If 'AB' flexible drive shaft moves last, then the 'A' side layshaft gear should be rotated Anti-clockwise (viewed from the driving end).

If 'BC' flexible drive shaft moved last, then the 'B' side layshaft gear should be rotated Blockwise (viewed from the driving end).

TIMING THE CAMSHAFTS, INJECTION TIMING

The point of commencement of injection of the No. 1 fuel injection pump on a camshaft casing is, when the camshaft timing collar indicates 0° against the register mark. The exhaust piston of the associated No. 1 cylinder is set at a specified number of degrees before T.D.C. (see Leading Technical Details).

Proceed as follows:-

1. Temporarily engage the camshaft drive quill-shaft of the replacement camshaft casing. Fit the hand turning gear and turn the engine until the timing collar indicates 0°. Disengage the camshaft drive quill-shaft and maintain it out of engagement.

2. Determine the T.D.C. position of the No. 1 exhaust piston in the cylinder associated with the replacement camshaft casing. Note the T.D.C. datum figure. In this instance, the timing collar in one of the other two camshaft casings must be used as the protractor.

3. Turn the engine until the exhaust piston is positioned at the "Injection Timing Datum" (see Leading Technical Details) as indicated by the timing collar of the selected camshaft casing.

4. Finally engage the camshaft drive quill-shaft with the replacement camshaft casing and secure the locking bolt in the locating collar.

5. Check that the timing is correct by re-determining T.D.C. of the exhaust piston, as at 3 above, and turning the engine to the "Injection Timing Datum". Observe that the replacement camshaft casing timing collar indicates $0^{\circ} \pm \frac{1}{2}^{\circ}$.

REMOVAL AND REPLACEMENT OF MAJOR UNITS

Camshaft Casing

To remove a camshaft casing, disconnect the control rod at the drive end of the casing. Drain the fuel system and disconnect the fuel supply and return pipes. Disconnect the high-pressure pipes to the injectors and remove the pipes from the injection pumps. Disconnect the electrical cables, as applicable, to equipment mounted on the camshaft casing. Disconnect the lubricating oil supply and drain pipes. On 'A' camshaft casing, it will be necessary to remove the air start distributor supply pipes and the air start manifold rail. Remove the nuts and washers from the studs of the camshaft drive split half-covers and remove the covers. Remove the locking bolt from the locating collar around the drive quill-shaft and withdraw the quill-shaft. Remove the nuts and washers securing the camshaft casing and withdraw the unit. It should be noted that there is one cap nut locked with a tab washer at the extreme free end of the casing.

To replace a camshaft casing, ensure that all traces of old jointing material is removed from the mating faces and fit a new joint washer to the mounting face of the cylinder block. Renew the rubber 'O' ring seal for the split half-covers on the crankcase and on the replacement camshaft casing. Check that the drive quill-shaft and its locating collar are in position and offer up the replacement camshaft casing. Care should be taken to ensure that the threads of the securing studs are not damaged or the studs bent during this operation. Ensure that the dowels in the cylinder block mounting face are correctly entered in the dowel holes in

the camshaft casing and that the casing is seating correctly. Secure the casing in position. Ensure that the cap nut is correctly positioned on the stud at the free end of the casing and is locked with a tabwasher. Time the camshaft to the engine (see this Chapter). Complete the replacement by reversing the removal procedure. Prime and vent the fuel system.

Turbo-Blower

Drain the coolant system. Remove the exhaust collector tank. Remove the air intake silencer if fitted. Disconnect all fuel, lubricatin oil and breather pipes which obstruct the removal of the unit. Remove the plugs from the lifting eye locations on the turbine casing and screw the lifting eyes into position. With suitable lifting tackle, position the turbine sling and take the weight of the turbine but do not lift. Remove the exhaust elbows between the exhaust manifolds and the turbine inlet flanges. Remove the nuts and washers securing the turbine to the compressor and ease the unit from the mounting flange using the jacking-off screws to "break" the joint. The nuts adjacent to 'A' and 'C' exhaust inlets are "trapped nuts" and can only be removed as the assembly is eased off the mounting flange.

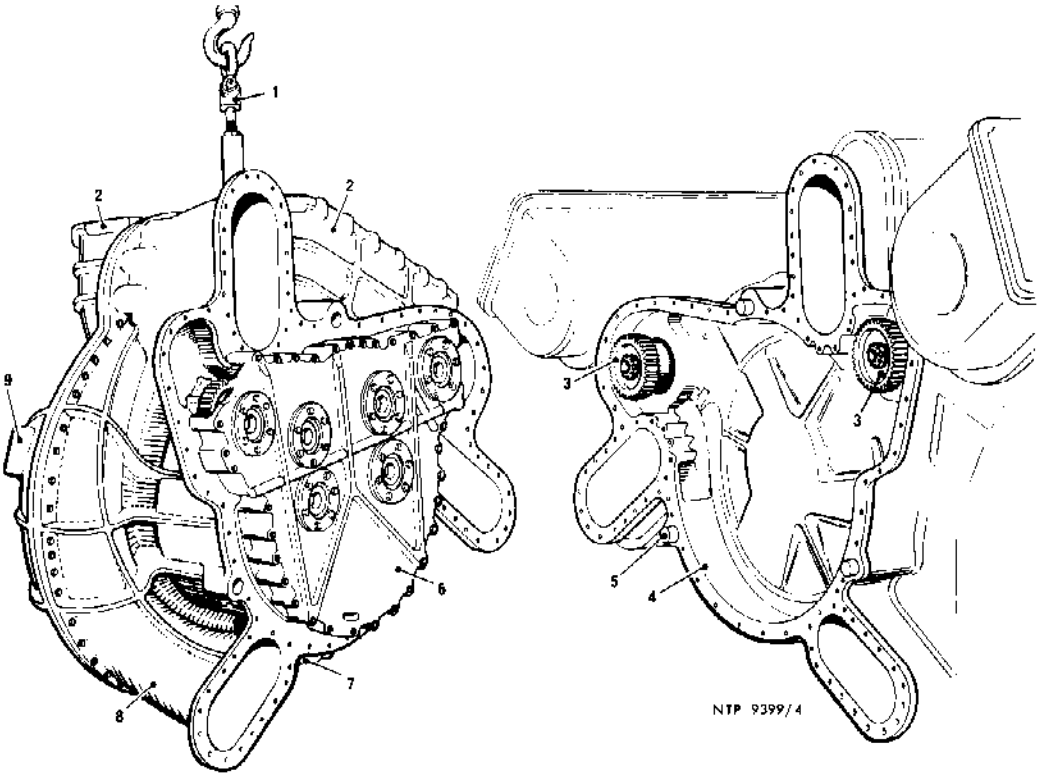
To remove the compressor assembly, remove the plug from the eye bolt location, screw in the eye bolt and attach the lifting sling. With suitable lifting tackle, take the weight of the unit but do not lift. Remove the securing nuts and washers from the mounting flange of the blower volutes with the sandwich piece. Ease the unit off the mounting studs using the jacking-off screws to "break" the joint.

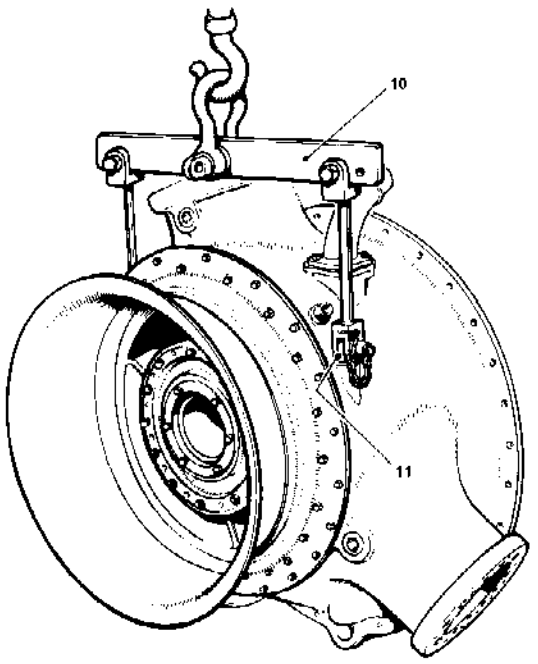
To replace the compressor and turbine assemblies, phase the driving gears (see this Chapter). After phasing, replace the assemblies by reversing the removal procedure. Fit new joint washers where applicable and 'make' the joints between the compressor and the sandwich piece and between the turbine and compressor with jointing compound. Ensure that any "trapped nuts" are fed into position as the units are offered up to position. Fill the coolant system and prime the fuel and lubricating oil systems.

Preparation of the Engine for Removal of
Bi-Directional Gearbox, End Cover or Phasing Gear Case

As the engine drive end mounting feet are secured to the bi-directional gearbox or to the end cover as applicable, the engine must be supported at its drive end by the use of slave service feet when the above units or the phasing gear case is to be removed.

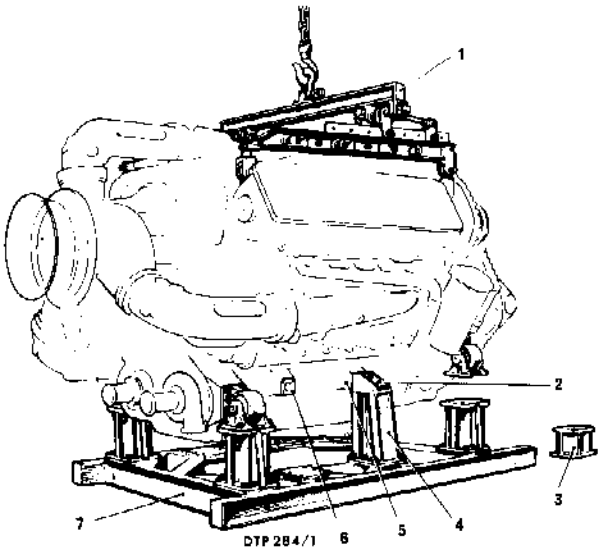
Attach the engine lifting sling to position and raise the engine clear of the transport stand. Fit the service feet to the drive end auxiliary mounting faces on each side of 'CA' crankcase. Loosely assemble the service pedestals to the service feet and lower the engine onto the transport stand, aligning the service pedestals with the base plates on the stand. Secure the holding down bolts in the service pedestals and in the free end pedestals of the stand.





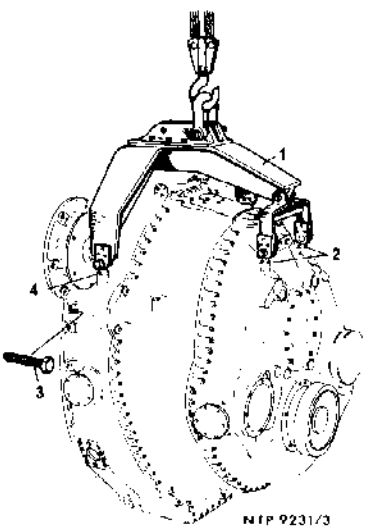
1. Compressor sling
2. Air intakes
3. Blower drive gears
4. Blower sandwich piece
5. Dowel
6. Gear carrier plate
7. Oil drain connection
8. Compressor drive-end casing
9. Turbine sling
10. Lifting eye bolt

REMOVING THE TURBO-BLOWER



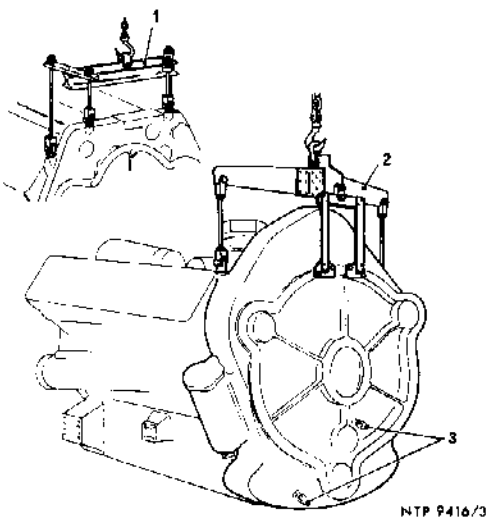
1. Engine sling
2. Service foot
3. Distance block, drive-end mounting foot
4. Pedestal
5. Auxiliary mounting, drive-end
6. Auxiliary mounting, free-end
7. Transport and service stand

MOUNTING ENGINE ON SERVICE STAND



1. Gearbox sling
2. Lifting eye bolts
3. Jacking-off screws
4. Lifting eye bolts

REMOVING BI-DIRECTIONAL GEAR BOX



1. Sling for phasing case Type Series II
2. Sling for phasing case Type Series I
3. Poker dowels

REMOVING THE PHASING GEAR CASE

Bi-Directional Gearbox

To remove the bi-directional gearbox, prepare the engine for removal of the gearbox by mounting on the service feet. Disconnect the lubricating oil pipes at their connections on the gearbox. Remove the plugs from the eye bolt locations on the gearbox casings and screw in the lifting eye bolts. Attach the lifting sling and take the weight of the unit but do not lift. Remove the securing nuts and washers and, using the jacking-off screws to "break" the joint, ease the gearbox off the mounting flange. Adjust the lifting tacke to maintain the free position of the phasing gear case output shaft within the gearbox, and move the unit clear of the engine. The gearbox must be withdrawn approximately twelve inches to clear the output shaft which will remain in the phasing gear case.

To replace, ensure that the mating faces are clean and prepare them with jointing compound. Offer the gearbox to position, easing it over the phasing gear case output shaft and ensuring that the three dowels in the phasing gear case flange correctly enter the dowel holes in the gearbox flange. Secure the gearbox with the nuts and washers. Remove the lifting tackle. Connect the lubricating oil pipes and prime the lubricating oil system.

Phasing Gear Case

To remove a phasing gear case, prepare the engine for removal of the unit by mounting on the service feet. Remove the bi-directional gearbox or end cover, as fitted. Disconnect all fuel and lubricating oil pipes which obstruct the removal of the phasing gear case. Disconnect the control rod between the governor and 'B' camshaft casing control lever and the control rods connected to the levers at the drive end of 'A' and 'C' camshaft casings.

Remove the 'AB' crankcase cover. Remove the three retaining plates by unlocking the tab washers and removing the two set bolts securing each plate to the crankshaft gear. Disengage the quill-shaft toward the drive end of the engine. Repeat the operation for 'BC' and 'CA' crankcases.

Secure the phasing case lifting sling in position and take the weight but do not lift at this stage. Unlock the tab washers and remove the securing nuts from the two poker dowels in the drive end face of the phasing case, fit the special extractor and pad, and withdraw the dowels. These dowels are approximately 10½ inches in length. Unlock the tab washers and remove the internal nuts securing the phasing gear case to the crankcases; remove the external nuts and spring washers from the phasing case to crankcase joints. Adjust the lifting tacke and ease the phasing case away from the crankcase faces, ensuring that the quill-shafts do not foul and are clear of the main assembly before lifting with the tackle.

To replace the phasing gear case, prepare the mating joint faces of the three crankcases and the phasing gear case with jointing compound and fit new rubber 'O' ring seals to the transfer tubes in the drive end face of the three crankcases. Lift the phasing case, offer up and secure it in position.

Phase the crankshafts (see this Chapter)

When the phasing of the crankshafts has been completed and checked, position the three quill-shaft retaining plates on each crankshaft gear and secure them in place with the set bolts, lock the bolts with new tab washers.

Position new joint washers on the phasing gear case, fit the quill-shaft covers to the drive end casing, securing them in position with nuts and locking the nuts with the tab washers. Connect up the engine control rods and check the control setting. Connect the fuel and lubricating oil pipes. Re-fit the bi-directional gearbox or end covers as applicable.

Auxiliary Drive Gearbox

To remove the gearbox, prepare the engine for removal of the unit by mounting the engine on the service pedestals, with the service feet secured to the free end auxiliary mounting positions on 'CA' crankcase. Disconnect the lubricating oil drain and supply pipes from the gearbox. Remove the coolant circulating pump and sea- or raw-water pump. Remove the central ovalshaped cover plate from the free end of the gearbox to give access to the ring nut securing the auxiliary gearbox driving gear to the flexible drive shaft of 'CA' crankcase. Unlock the locking washer and remove the ring nut. Remove the internal nuts, tab washers, and locking plates from the gearbox, also the external nuts and spring washers securing the unit to 'CA' crankcase. Separate the gearbox from 'CA' crankcase and withdraw the unit.

To replace, reverse the removal procedure, preparing the joint faces with jointing compound and ensuring that the dowels in the crankcase face are correctly entered in the dowel holes in the gearbox. Fit new joint washers as applicable.

For repair and overhaul procedures beyond those detailed in this Chapter see Napier Publication 430.