Chapter 25

CLEANING AND PROCESSING DURING COMPLETE OVERHAUL

Contents

Illustrations

THIS CHAPTER describes the procedure for cleaning and processing the component parts of the engine after dismantling. The instructions assume that the engine has completed the full time before overhaul and that the condition of the components is consistent with that of a time-expired engine. If the engine has not run the full permitted period it may not be necessary to carry out the full cleaning processes specified, but the components must always be cleaned to an extent that will render them suitable for efficient detail inspection.

The principal components of the engine, and the recommended sequence of cleaning operations, are listed in a series of tables which also contain a cross-reference from which the more detailed information can be located. The processes described in this chapter are those to which the components are normally subjected at each overhaul; cleaning and processing instructions which are peculiar to certain repair processes only, are contained in chapters 28 to 32.

For full specifications of recommended process and cleaning equipment, reference should be

made to the Service Department at the address given on page ii of this handbook.

PRECAUTIONS

Special care should be taken to keep component parts of sub-assemblies together during cleaning, and all large components should be clearly labelled, by means of wire-attached metal discs, in such a way that they can be readily identified. Small components should be placed in similarly labelled, strongly constructed, wire baskets so that immersion in and removal from the degreasing, cleaning, and processing tanks is facilitated. Shims and packing washers should be secured by wire to their respective components.

To ensure that the degreasing or cleaning medium penetrates and acts fully on any component, it is essential that the component is stripped to the fullest permissible extent before it is immersed in the relevant solution. Although the time of immersion in the cleaning solutions must, necessarily, depend on the state of the components and the condition of the solution, the times given in this chapter will provide a reliable working guide.

To prevent damage to joint faces, care must be taken when packing the smaller components into wire baskets or when placing larger components into the process tanks. Special slings and lifting equipment when available should always be used to hoist and suspend components in the tanks; levering or sliding larger components about in the tanks must be avoided. Under no circumstances should rope or electrically-driven hoists be employed, owing to the risk of acid damage to the rope, and ignition of fumes by the electric hoist; more suitable hoists are those driven by compressed air or chain operated.

To prevent unnecessary fouling of the degreasing and cleaning solutions, all loose carbon, superfluous oil and grease should be removed from components by kerosene washing and the components wiped dry before they are immersed in the cleaning solution.

Thorough washing of components in hot fresh water is essential after they have been immersed in caustic soda, chromic acid, sulphuric acid, or Zonax solutions. If not completely removed by washing, any chemical residue will inevitably cause corrosion.

Fire and health precautions applicable to inflammable or toxic solvents, degreasing and cleaning agents, must be exercised at all times when applying the instructions described in this chapter.

EQUIPMENT REQUIRED FOR CLEANING AND PROCESSING

The following equipment will be sufficient to clean and process the components from one engine per day. The tanks containing caustic soda, hot water, chromic acid, sulphuric acid, and Zonax should be double-lagged and thermostatically controlled. All tanks should be fitted with drain cocks.

1. Pressure type kerosene cleaning plant.

2. Vapour type trichlorethylene degreasing plant having a tank about 5 ft. 6 in. × 4 ft. × 8 ft. 6 in. deep.

3. Mild steel tank for caustic soda cleaning, about 5 ft. × 6 ft., provided with fume extractor ducts. It is recommended that the outside of the tank should be painted with an alkaline-resisting paint.

4. Four mild steel tanks for hot water wash, about 5 ft. × 3 ft. × 6 ft. An air-water gun is recommended for use when clearing components of caustic soda solution, sludge and paint, as it will facilitate the removal of the caustic soda, etc., from crevices and pockets. The caustic soda, the chromic acid, the sulphuric acid, and the Zonax cleaning process tanks should each have their own hot water wash tank, to prevent contamination of the hot water.

5. Mild steel tank for chromic acid, about 5 ft. × 3 ft. × 6 ft., provided with fume extraction ducts and a fume condenser.

6. Mild steel tank for Zonax cleaning, about 6 ft. × 3 ft. × 6 ft.

7. Mild steel tank for de-watering oil, about 4 ft. × 4 ft. × 4 ft.

8. Mild steel tank for sulphuric acid pickling, about 4 ft. × 4 ft. × 4 ft., lined with chemically pure lead $\frac{1}{4}$ in. thick, the lead being carried over the lagging. The outside of the tank should be painted with acid-resisting paint. It must be thermostatically controlled to $66\frac{1}{2} \pm 3°$ C. ($150 \pm 5°$ F.), and provided with double-sided fume extraction with motor-driven exhaust fan.

9. Plant (de Havilland equipment No. WD5126) incorporating filters and pumps, for white spirit cleaning of ball and roller bearings.

CLEANING AND PROCESSING DURING COMPLETE OVERHAUL

During complete overhaul, after the engine has been dismantled as described in chapters 23 and 24, the individual components must be passed through a number of cleaning and processing operations in order to prepare them for rebuilding into the complete engine. In some instances the sequence of these operations is most important and, therefore, the sequence of operations for each of the principal components is presented as a series of tables. As far as possible, these tables follow in the same order as the dismantling described in chapters 23 and 24; it will be appreciated that it has not been possible to adhere rigidly to this order in every instance.

TABLE 1

RIGID PIPES

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Inspection and pressure test	Chapter 27M
Rebuilding	Chapter 34

TABLE 2

FLEXIBLE PIPES

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Inspection and pressure test	Chapter 51
Rebuilding	Chapter 34

TABLE 3

PROPRIETARY COMPONENTS

(Essential engine accessories; e.g., fuel pumps, control valve assembly, barometric pressure control, air-fuel ratio control, and burners.)

Operation	*Refer to*
Pressure type kerosene wash, exterior only; do not remove blanks from openings	Page 7
Pass to appropriate specialists	Chapter 39 et seq
Rebuilding	Chapter 34

TABLE 4

TOP AND BOTTOM WHEELCASES

(except starter gear bottom cover—see below)

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Caustic soda solution for paint removal	Page 9
Hot water wash	Page 9
Chromic acid tank	Page 9
Hot water wash	Page 10
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27E and 27F
Major repair, if required	Chapter 28D
Chromate treatment	Chapter 32
Repainting	Chapter 32
Rebuilding	Chapter 33D and 33E

The friction ring (the starter dog seal) is not removed from the starter gear bottom cover, unless it is faulty. Therefore, the sub-assembly must not be degreased by the normal chemical methods but should be wiped clean, using a dry cloth only.

TABLE 5

OIL SUMP

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Caustic soda solution for paint removal	Page 9
Hot water wash	Page 9
Chromic acid tank	Page 9
Hot water wash	Page 10
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27G
Pressure test	Chapter 27G
Chromate treatment	Chapter 32
Repainting	Chapter 32
Rebuilding	Chapter 33F

TABLE 6

CENTRE HOUSING

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27D
Major repair, if required	Chapter 28D
Rebuilding	Chapter 33C

The centre housing having an aluminium bush shrunk in and machined in position, must not be cleaned in caustic soda.

TABLE 7

FERROUS COMPONENTS FROM THE WHEELCASES, CENTRE HOUSING, SUMP AND OIL PUMP

Operation	*Refer to*
Trichlorethylene vapour degreaser	Page 7
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27D, E, F, and G
Rebuilding	Chapter 33C, D, E, and F

TABLE 8

BLADED TURBINE DISC

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Shot blast, sand blast, or prunous blast	Chapter 28C
Crack detection (disc only)	Chapter 26
Crack detection (blades)	Chapter 26
Trichlorethylene vapour degreaser	Page 7

Detail inspection	Chapter 27B
Repair of blades, if required	Chapter 28C
Rebuilding	Chapter 33A

The bladed turbine disc must not be treated with any cleaning preparation except kerosene or trichlorethylene vapour as residual moisture, or sodium deposits, below the "fir-tree" roots will cause corrosion. All traces of corrosion on the disc must be removed in accordance with T.R.340 chapter 28C. Oxide film on the turbine blades must be removed with very fine emery tape.

TABLE 9

COMBUSTION CHAMBER OUTER CASING

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Zonax cleaner	Page 11
Hot water wash	Page 11
Detail inspection	Chapter 27K
Major repair, if required	Chapter 30
Nickel stripping, if required	Chapter 32
Nickel plating, if required	Chapter 32
Rebuilding	Chapter 33J

TABLE 10

COMBUSTION CHAMBER EXPANSION CHAMBER

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27K
Major repair, if required	Chapter 30
Rebuilding	Chapter 33J

TABLE 11

FLAME TUBES

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Wire brush, Ardrox 670, air circulating furnace, or caustic soda solution (see below)	Page 9
Hot water wash	Page 9
Detail inspection	Chapter 27K
Major repair, if required	Chapter 30
Rebuilding	Chapter 33J

The cleaning of flame tubes can be achieved by wire brushing. This is a lengthy, tedious process involving many man-hours. The recommended cleaning agent is Ardrox 670, see page 12. Alternatively, carbon can be removed from the flame tube assemblies by heating for approximately half an hour in an air circulating constant temperature furnace at 550 deg. C. When the components are removed from the furnace, any loose particles should be blown off with compressed air, or removed by rinsing in kerosene. Flame tubes can also be cleaned by immersion in caustic soda solution, but this is not recommended as it is difficult to ensure that every trace of caustic soda has been removed. If, however, immersion in caustic soda is carried out, thorough washing in hot water is essential. Use a compressed air-water gun to wash all seams and crevices until every trace of caustic soda is removed. Although the solution is not deleterious in itself, there is the possibility that inadequate washing of the component may leave caustic soda trapped in the overlapping joints and crevices and that the subsequent heating, when the engine is run, may result in interaction between the residual caustic soda and the metal, and may result in harmful deposits on the nozzle and turbine blades.

TABLE 12

DISCHARGE NOZZLE

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27J
Major repair, if required	Chapter 28F
Rebuilding	Chapter 33I

TABLE 13

NOZZLE DIAPHRAGM; BAFFLE PLATE; FLEXIBLE DISC, AND BAFFLE RING; SUPPORT CYLINDER, AND STRUTS

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Zonax cleaner	Page 11
Hot water wash	Page 11
Detail inspection	Chapter 27J
Rebuilding	Chapter 33I

TABLE 14

NOZZLE BLADES AND RINGS, AND NOZZLE SHROUD

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Polish the leading edges of all blades, the inner ring adjacent to the blade slots, and both flanges of the nozzle shroud (see below).	
Detail inspection of blades	Chapter 27J
Major repair, if required	Chapter 28F
Rebuilding	Chapter 33I

After being subjected to the kerosene wash and trichlorethylene vapour degreasing processes, the leading edges of all nozzle blades, the inner nozzle blade ring adjacent to he blade slots, and both flanges of the nozzle shroud and of the turbine shroud should be polished with fine emery cloth to facilitate the inspection for cracks.

TABLE 15

TURBINE SHROUD

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Polish both flanges of the shroud	Table 14
Detail inspection	Chapter 27B
Major repair, if required	Chapter 28F
Rebuilding	Chapter 33A

TABLE 16

CENTRE CASING (FRONT AND REAR SUPPORT CONES), AND INSULATING PLATE, AND COOLING MUFF

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27I
Major repair, if required	Chapter 28F
Rebuilding	Chapter 33H

TABLE 17

SEALING PLATE, AND INSPECTION COVERS

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27H
Major repair, if required	Chapter 28E
Chromate treatment	Chapter 32
Rebuilding	Chapter 33G

TABLE 18

CENTRE SHAFT, HUB SHAFT, AND EXTENSION SHAFT

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27B
Major repair, if required	Chapter 28B
Rebuilding	Chapter 33A

TABLE 19

IMPELLER COMPLETE WITH PIVOT

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Hot oil tank for pivot removal	Chapter 24A
Pivot removal	Chapter 24A
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27B

If the pivot is not removed from the impeller, provided that the tooling, introduced by mod. 627, part 1 is available, the complete assembly follows the sequence of operations given for the impeller alone, subject to the following conditions.

The special masks must be used when vapour blasting, re-anodising and applying the Rockhard lacquer.

When re-anodising, the masks fitted to the impeller must be pressurised with air at 10 lb. per sq. in. to prevent ingress of the electrolyte and its deleterious effect on the steel components.

TABLE 20

PIVOT

Operation	*Refer to*
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27B
Major repair, if required	Chapter 28A

TABLE 21

IMPELLER LESS PIVOT

Operation	*Refer to*
Vapour blast to remove Rockhard lacquer	Chapter 28A
Crack detection	Chapter 26
Detail inspection	Chapter 27B
Trichlorethylene vapour degreaser	Page 7
Scurfing, and major repair, if required	Chapter 28A
Dimensional check and frequency check	Chapter 27B
Vapour blast using coarse grit	Chapter 28A
Inspect for signs of corrosion and cracks between coarse and fine vapour blasting; vapour blasting tends to expose these defects and this inspection avoids proceeding with the fine vapour blasting when further scurfing is required.	
De-watering oil to prevent corrosion, if next operation does not follow immediately.	Page 11
Fine vapour blast	Chapter 28A
Re-anodising	Chapter 28A
Crack inspection	Chapter 28A
Rockhard lacquer	Chapter 28A

TABLE 22

IMPELLER AND PIVOT

Operation	*Refer to*
Pivot insertion	Chapter 33A
Inspection	Chapter 33A
Rebuilding	Chapter 33A

TABLE 23

BALL AND ROLLER BEARINGS

(See also overleaf)

Operation	*Refer to*
White spirit tank	Overleaf
Detail inspection and oil	Chapter 27A
Rebuilding	Chapter 33

Inspection should take place immediately after cleaning in order that the bearings may be oiled as soon as possible to prevent corrosion. The handling of clean, dry bearings with bare hands causes tarnishing and initiates corrosion, and it is recommended that operators wear gloves when handling bearings. The bearings should be washed in a standard type of cleaning tank with an integral pump, Fig. 1, there to be soaked and sprayed with filtered white spirit to loosen hardened grease and foreign matter. A jet of white spirit should be directed on to the cage and balls, causing them to rotate slowly continuously while the outer race is held stationary in one hand. The cleaning must be continued until the bearing is freed of all traces of hardened grease and foreign matter and until it is perfectly clean. The cleaning of ball and roller bearings in trichlorethylene is not recommended.

Preliminary washing in a kerosene washing tank is not recommended as experience has shown that the standard pressure type kerosene washing plant is most unsuitable for cleaning ball and roller bearings owing to the very critical nature of the standard of cleanliness required for these bearings. Normally, the average kerosene washing plant is used to clean a wide range of dirty components, and, often, the kerosene is not changed as frequently as necessity demands; furthermore, the filtration generally leaves much to be desired. All these considerations increase the likelihood of bearings becoming contaminated with foreign matter instead of being cleaned. The high standard of cleanliness required for all gas turbine ball and roller bearings, particularly the main shaft bearings, cannot be over-emphasied; the consequence of main shaft bearing failure being particularly serious.

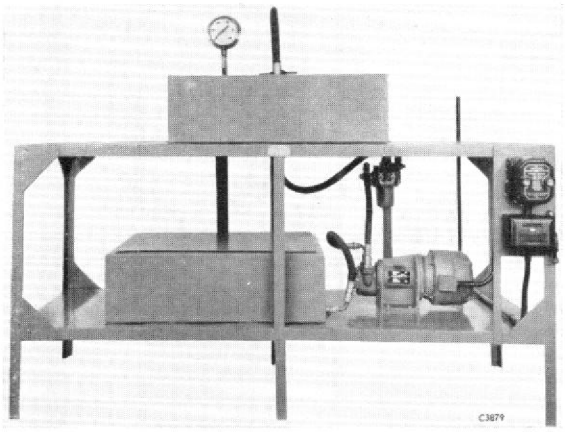

Fig. 1. Plant (DH equipment No. WD 5126) for cleaning ball and roller bearings with white spirit.

TABLE 24

AIR-INTAKE

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Caustic soda solution for paint removal	Page 9
Hot water wash	Page 9
Chromic acid tank	Page 9
Hot water wash	Page 10
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27C
De-scurf	Standard Process
Major repair, if required	Chapter 28D
Chromate treatment	Chapter 32
Repainting	Chapter 32
Rebuilding	Chapter 33B

TABLE 25

DEFLECTOR VANES AND CASINGS
(Pre-mod. 843)

Operation	*Refer to*
Trichlorethylene vapour degreaser*	Page 7
Sand or vapour blast, if required*	T.R. 351, Chapter 28E
Crack detection	Chapter 26
Trichlorethylene vapour degreaser*	Page 7
Detail inspection	Chapter 27H
Major repair, if required	Chapter 28E
Trichlorethylene vapour degreaser*	Page 7
Rockhard lacquer, if required*	Chapter 28E
Rebuilding	Chapter 33G

* *If there is no evidence of corrosion, it is not necessary to sand or vapour blast and re-Rockhard lacquer these components; washing in kerosene will be sufficient, but do not bring the Rockhard lacquer coat in contact with trichlorethylene vapour or liquid as the resultant chemical action will, if prolonged, reduce the effective hardness of the lacquer.*

TABLE 26

INVESTMENT CAST DEFLECTOR VANES AND CASINGS (Mod. 843)

Operation	*Refer to*
Trichlorethylene vapour degreaser	Page 7
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27H
Major repair, if required	Chapter 28E
Rebuilding	Chapter 33G

TABLE 27

DEFLECTOR COVERS

Operation	*Refer to*
Trichlorethylene vapour degreaser	Page 7
Caustic soda solution for paint removal	Page 9
Hot water wash	Page 9
Chromic acid tank	Page 9
Hot water wash	Page 10

Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27H
Major repair, if required	Chapter 28E
Chromate treatment	Chapter 32
Repainting	Chapter 32
Rebuilding	Chapter 33G

TABLE 28

DIFFUSER BOLTS

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Buffing, if required	Standard process
Cadmium plating, if required	Chapter 32
Detail inspection	Chapter 27H
Rebuilding	Chapter 33G

TABLE 29

DIFFUSER CASING, AND REAR COVER

Operation	*Refer to*
Trichlorethylene vapour degreaser	Page 7
Caustic soda solution for paint removal	Page 9
Hot water wash	Page 9
Chromic acid tank	Page 9
Hot water wash	Page 10
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27H
De-scurf	Standard process
Major repair, if required	Chapter 28E
Chromate treatment	Chapter 32
Repainting	Chapter 32
Rebuilding	Chapter 33G

TABLE 30

EXHAUST SYSTEM COMPONENTS
(including fireguard, exhaust cones, etc.)

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Caustic soda or sulphuric acid, if required (see below)	Page 9
Hot water wash	Page 9
Detail inspection	Chapter 27L
Major repair, if required	Chapter 31
Rebuilding	Chapter 33K

It is unnecessary to remove any baked-on film of burnt inhibitor or oil from the exhaust system components, except so far as is essential for efficient inspection of the component. Where repair by welding is necessary, the area to be repaired must be cleaned locally right down to bare metal in order to ensure a sound weld. If it is required to remove the baked-on film of burnt inhibitor or oil, the exhaust system components, being made of stainless steel, may be cleaned by immersion in the caustic soda solution or in any other detergent. A final brightening of the surface of the material can be obtained by immersing them in a hot 7 to 10 per cent solution of sulphuric acid in water for a period not exceeding 60 seconds. When the components have been immersed in any of these solutions, they must immediately be thoroughly washed in hot water to remove all traces of the chemicals. Where the processing tanks are not large enough to accommodate the complete component, it is permissible to clean them by immersing first one portion of the component and then another.

TABLE 31

MISCELLANEOUS

Operation	*Refer to*
Pressure type kerosene wash	Page 7
Trichlorethylene vapour degreaser	Page 7
Crack detection	Chapter 26
Trichlorethylene vapour degreaser	Page 7
Detail inspection	Chapter 27H
Rebuilding	Chapter 33G

KEROSENE WASHING

The plant, installed and operated in accordance with the manufacturer's instructions, should be a pressure type, incorporating a separate pumping unit which draws the kerosene from the sump passing it under pressure out through a flexible pipe having a quick-acting on/off cock controlled by the operator.

For the smaller and more delicate components which are not normally quite so soiled, a smaller tank set aside for cleaning these components would be advantageous, and a separate small tank containing clean kerosene and used for final swilling, will ensure cleanliness of the components.

The tanks should be provided with a compressed-air jet so that the components can be dried and any pockets of trapped liquid removed from oilways and small passages.

TRICHLORETHYLENE VAPOUR DEGREASING *Fig. 2*

The plant must be installed and operated in accordance with the manufacturer's instructions, and the tank must be of a size sufficient to cope with the quantity of engines to be overhauled. The components to be cleaned are suspended in

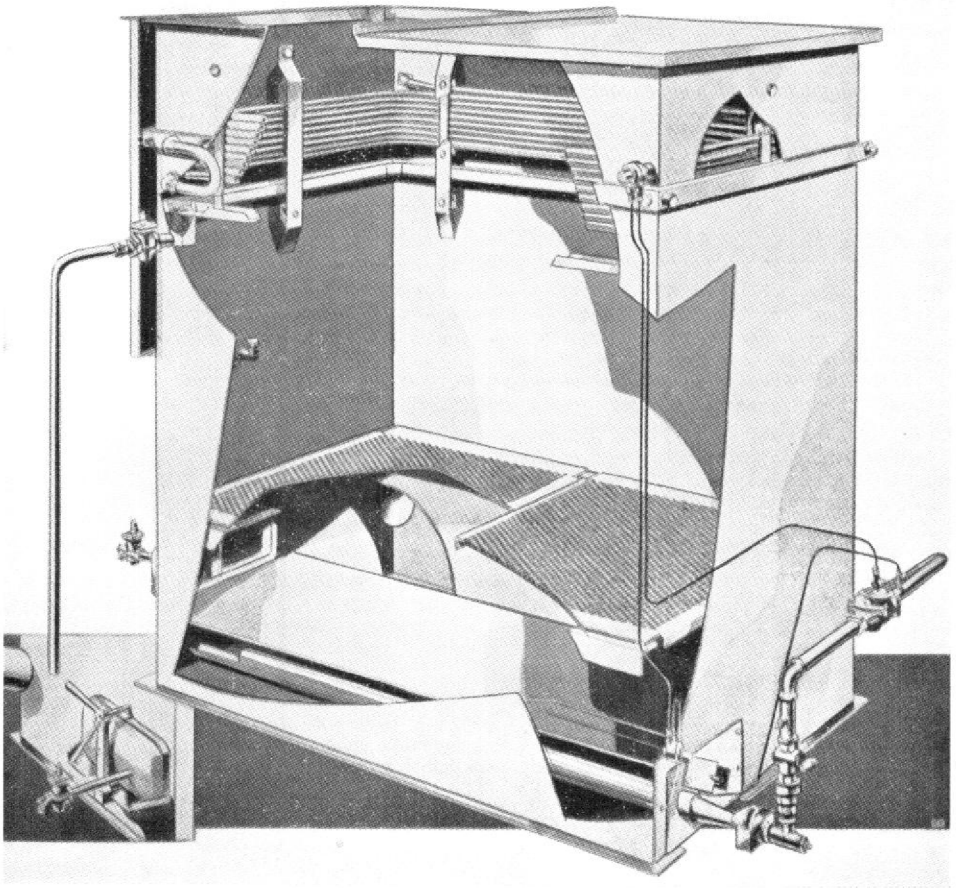

Fig. 2. Cut-away view of typical vapour degreasing plant.

the vapour of the boiling liquid which condenses on the cold component and thus dissolves the grease. When the component becomes heated to the temperature of the vapour, the cleaning action ceases, and, therefore, if further cleaning is considered necessary, the component must be removed from the vapour, allowed to cool, and the process repeated.

If the plant is fitted with an auxiliary pumping attachment, a stream of hot, clean trichlorethylene can be directed over components inside the tank to remove dirt which the vapour treatment itself will not remove.

Components which have been coated with Rockhard lacquer must not come in contact with trichlorethylene liquid or vapour, as the resultant chemical action will, if prolonged, reduce the effective hardness of the lacquer.

Trichlorethlylene and caustic soda when brought into contact can initiate a chemical reaction which is dangerous, therefore, a component which has been in the degreasing tank must first be allowed to dry and any trapped pockets of liquid removed before it is brought into contact with caustic soda.

Aluminium, magnesium, and alloys of these metals when in the finely divided form i.e., powder or filings, are chemically highly reactive, and under certain conditions, can react with trichlorethylene to produce hydrochloric acid, which will attack both the copper pipes and body of the plant, and also components which are subsequently passed through the plant. If the light alloy is allowed to build up in the trichlorethylene, the reaction can become violent and dangerous; therefore, components in which light alloy powder, filings, or swarf is suspected must be thoroughly cleaned either by an initial wash in kerosene or by using a jet of compressed air.

Aluminium components of complicated form or containing blind holes must not be subjected to heat until all traces of liquid trichlorethylene have been removed, as this condition is conducive to corrosion. Similarly, components manufactured from corrodible materials, when removed from the trichlorethylene are in an extremely clean and grease-free condition and consequently, more susceptible than usual to corrosive attack; therefore, where a delay between cleaning, inspection, and reconditioning is envisaged, steps should be taken to obviate the possibility of corrosion by oiling the component or, applying its normal pro-

tective coat as soon as possible after it has been degreased.

CLEANING MAGNESIUM ALLOY COMPONENTS
(D.H. Process Specification No. 185, October, 1954)

Before applying process specification No. 185, operators should contact the Service Department at the address given on page ii of this handbook.

The following process is approved for the removal of paint, soil, and corrosion products from the magnesium alloy components including the top and bottom wheelcases, the sump, the air-intake, the deflector covers, the diffuser casing and its rear cover, to facilitate inspection and re-processing. The sequence of operations includes degreasing in trichlorethylene vapour, the removal of paint by boiling in caustic soda solution, and immersion in a chromic acid bath to remove corrosion, after immersion in caustic soda solution the component must be throughly washed in hot water to remove all traces of the caustic soda. Caustic soda is the most effective paint remover but it also attacks the chromate film, effecting a chemical change and producing a reduced film so that it possesses a lower protective value. This reduced chromate film must be removed before re-chromating. After immersion in any of the solutions or hot water, ensure that there are no pockets of trapped liquid and that the component is dry before proceeding to the next operation.

Caustic soda solution

The caustic soda solution should be contained in a mild steel tank which can be heated to maintain the solution at boiling point. Prepare and use the caustic soda solution as follows.

1. Fill the tank to the required level with cold tap water.
2. Add commercial caustic soda gradually and stir well until the solids have been dissolved. To obtain the required solution, add 1 lb. caustic soda for each gallon of water ; this gives a 10 per cent solution.
3. When the solids have been dissolved, **but not before,** heat the solution until it is at, or near, boiling point, to ensure rapid paint removal.
4. Ensure the parts are dry and then immerse the parts in the solution for between 5 and 20 minutes, the exact time depending upon the type of paint to be removed.
5. Remove the parts from the solution and allow them to drain for a few seconds.
6. Rotate components such as diffuser casings and sumps, to ensure that no pockets of solution remain trapped which will contaminate the hot water wash ; if available, use a compressed air-water gun to remove loose paint and sludge from pockets and crevices.
7. When satisfied that all paint and sludge have been removed, transfer the components to the hot water wash tank.

As caustic soda solution is liable to remove oil impregnation from components, any component required to be leakproof must be pressure tested after being treated. **Aluminium parts must not be immersed in caustic soda,** therefore, the centre housing having an aluminium bush shrunk in and machined in position, must not be cleaned in caustic soda solution. The strength of the solution should be kept between the limits of 6 per cent to 12 per cent to ensure that efficient working is obtained, and a weekly analysis must be made. About fifty-six pounds of caustic soda will be required per week, assuming a weekly output of 25 engines.

Caustic soda must never be used within the vicinity of trichlorethylene, as mixing of the two will set up a dangerous chemical reaction, therefore, where immersion in the caustic soda is specified to precede degreasing in the trichlorethylene, the component must be thoroughly washed free of all traces of caustic soda before being placed in the trichlorethylene tank.

HOT WATER WASH AFTER CAUSTIC SODA SOLUTION

The hot water used for washing components after they have been immersed in caustic soda solution should be contained in a mild steel tank which can be heated to maintain the water at a temperature of approximately 70 deg. C. (158 deg. F.). Wherever possible, running water should be used, where this is not possible the water should be changed frequently to prevent undue contamination. The parts to be washed should be immersed in the hot water for about one minute and agitated to remove all traces of caustic soda. Rotate components such as diffuser casings and sumps to ensure that no pockets of water remain trapped. Dry all the parts with a compressed-air jet.

Chromic acid treatment

The chromic acid solution should be between the limits of 10 per cent and 12 per cent and should be contained in a mild steel tank which can be heated to maintain the solution boiling vigorously. Chromic acid spray is injurious to the nasal tissues and efficient extraction ducts must, therefore, be provided. The solution will gradually attack any welded joints in the tank, which are exposed to it, and any such joints should be reinforced. When magnesium is immersed in chromic acid there is a danger of electrolylic corrosion ; under some conditions, an actual visible electrical discharge, in the form of sparking, may occur. To prevent these effects, components must be suspended in the solution so that there is no possibility of them touching the tank. It is also necessary to ensure that either the tank, or the sling used to hoist the components, is insulated. Therefore, a Tufnol insulator connection in the sling is recommended. When prepared, the solution must be 10 per cent weight/volume chromic acid in distilled water or condensate. The chromic acid must be a pure brand in flake form.

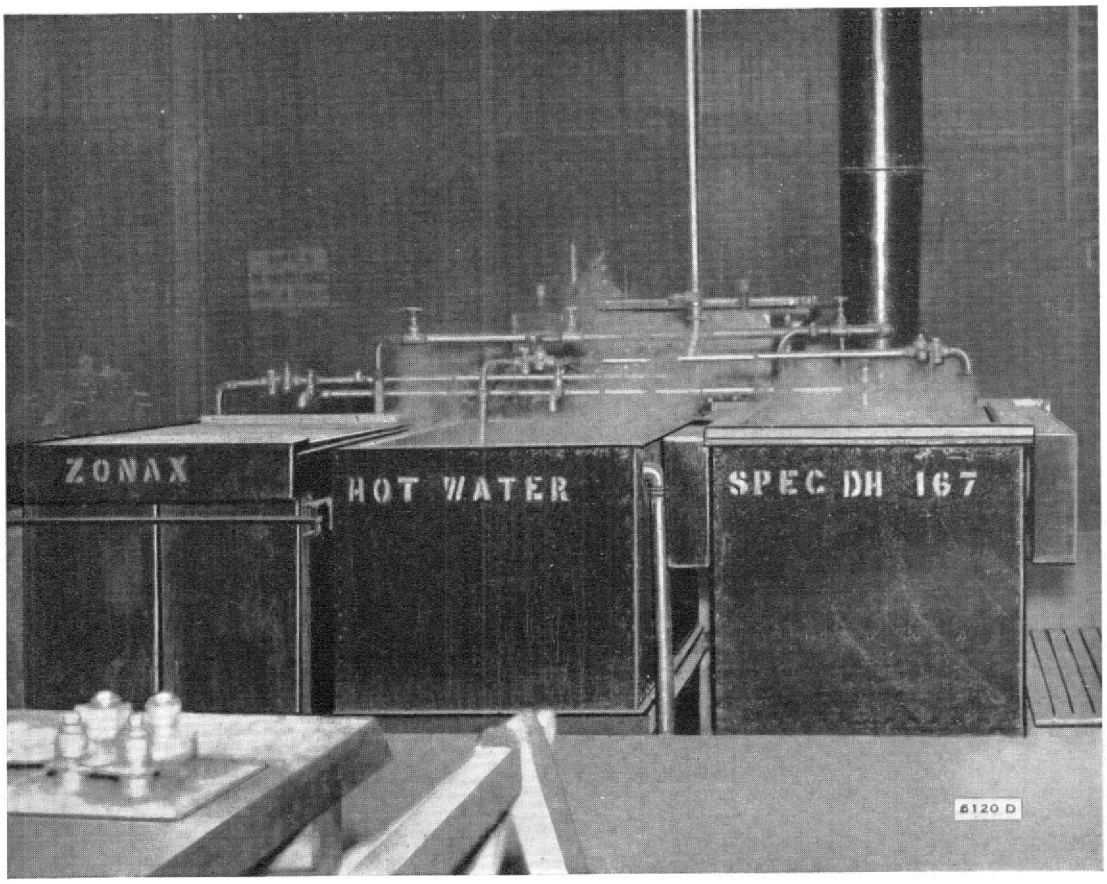

Fig. 3. Part of a typical cleaning and processing shop showing the tanks for Zonax, hot water, and chromate treatment (D.H. process specification No. 167).

The following composition is acceptable:—

Free chromic acid ..	99·750 per cent
Sulphate	0·050 to 0·120 per cent
Chloride	0·010 per cent

After cleaning in caustic soda, washing in hot water and thoroughly drying off by a compressed air jet, the parts should be immersed in the boiling chromic acid for between 5 and 10 minutes. Drain all surplus chromic acid from the parts, ensuring that no pockets of chromic acid remain, before transferring them to the hot water wash, to prevent rapid contamination of the water. After this treatment the parts should be completely free from paint and chromate film. However, it will be appreciated that some paints and chromate film may be more difficult to remove than others. It may, therefore, be necessary to re-immerse the parts in the caustic soda and chromic acid solutions for half minute intervals, with the intervening hot water washes, before the required condition is obtained.

Controlling the chromic acid solution

The solution should be under laboratory control. To replace the fluid lost by evaporation, frequent additions of distilled water or condensate will be necessary. This loss may be as much as 20 per cent per day. Depending upon the output, a daily or weekly test must be carried out by immersing a polished zirconium rare earth (Z.R.E.) alloy test piece in the chromic acid for 20 minutes and the weight loss calculated. If the loss exceeds *0,200* gm. per square decimeter it indicates that the contents of the bath should be discarded and a new solution prepared. In this instance, before using the new solution, a weight-loss test with the Z.R.E. test piece should be applied as described above.

Experience has proved that a tank containing 600 gallons of chromic acid will treat the magnesium alloy components from 65 Ghost engines without corrosion trouble. In addition to the solution initially prepared, about 1000 lb. chromic acid will be required to keep the solution to the correct strength for efficient operation.

Hot water wash after chromic acid treatment

Whenever possible, a separate hot water wash tank, identical with the one described on page 9, should be used. If, however, it is not possible to use a separate hot water wash tank, the one described on page 9 may be used if the water is changed frequently.

ZONAX CLEANER AND HOT WATER WASH

Zonax metal cleaner is a proprietary chemical compound of an alkaline nature, composed of 40 per cent sodium carbonate and 20 per cent sodium silicate. It is approved as a mild cleaner for general use and it is particularly useful for non-ferrous metals. The solution, which should be contained in a mild steel tank, should be prepared by dissolving the quantity of Zonax as indicated in the table and stirring the solution until the chemicals are thoroughly dissolved. Ferrous parts require a stronger solution than that used for non-ferrous metals. The bath prepared to clean components before anodising must be used for that purpose only, to prevent contamination. The Zonax treatment should be followed by a thorough wash in hot water. The table gives the recommended working temperatures for each particular purpose and an estimate of the amount of the Zonax which will be required per week, assuming a weekly output of 25 engines.

DE-WATERING OIL ANTI-CORROSION SOLUTION

Dicks I.L.O. No. 5 de-watering oil is approved for use on Ghost impellers as a temporary protection against corrosion in the workshop. When delay occurs during the vapour blasting of an impeller, due to the necessity for an inspection, or for any other purpose, immediate protection against corrosion is imperative. The de-watering oil should be contained in a mild steel tank provided with an inlet and outlet in the base. A suitably protected sight glass should also be fitted in the side of the tank, as close to the bottom as possible, to enable the operator to see that water is not present in bulk. The de-watering oil floats on water and if the latter is not drained frequently, the lower portion of a component may not receive the anti-corrosion treatment. This de-watering oil is used cold and will give protection against corrosion up to six days.

PROPRIETARY CLEANING AND PAINT-REMOVING PREPARATIONS

The proprietary cleaning and paint-removing preparations listed below are approved for use on Ghost engine components as alternatives to caustic soda. The comments against each are based on several years experience in the use of these preparations by The de Havilland Engine Company, and these comments should therefore be read in conjunction with the special instructions and recommendations issued by the makers of the preparations.

Stripalene 300 (formerly No. 3)
Stripalene 702
Magnus 755
Ardrox 670
Ardrox 666
Ardrox 20
Quickerstrip 32

Operators who contemplate using these proprietary preparations are advised to write first to the Service Department at the address given on page ii of this handbook; fuller details and recommendations based on laboratory tests and practical workshop applications will then be provided.

Stripalene 300 (formerly No. 3)

Stripalene 300 may be used as a general purpose cleaner and paint remover for most engine parts; an immersion time of 30 minutes has generally proved to be sufficient. There is some evidence to show that lead-indium bearing shells are adversely affected by the solution. The tank must incorporate efficient fume extraction. The preparation should be used as a 25 per cent boiling solution together with Zonax and potassium dichromate inhibitors in the following proportions to make 100 gallons.

Stripalene 300	25 gallons
Water	75 gallons
Zonax	2½ lb.
Potassium dichromate ..	0.3 lb.

It should be noted that corrosion of aluminium and magnesium components will occur in Stripalene 300 if Zonax and potassium dichromate inhibitors are not added.

The life of Stripalene 300 is not indefinite, and, as a guide, the components from some 40 engines

ZONAX CLEANING SOLUTIONS

Process	*Zonax oz. per gall.*	*Working temperature*	*Zonax lb. used per week (25 engines p.w.)*
Degreasing ferrous parts	12	100 deg. C. 212 deg. F.	70 to 80
Paint stripping before chromate	8 to 10	100 deg. C. 212 deg. F.	70 to 80
Degreasing before chromate	5 to 7	85 to 100 deg. C. 185 to 212 deg. F.	32
Degreasing before anodising (this bath must not be used for any other purpose) ..	6 to 8	80 to 85 deg. C. 176 to 185 deg. F.	32

can be cleaned in 400 gallons of the diluted solution by which time, the contents of the bath should be discarded and a fresh solution made up.

Stripalene 702

Stripalene 702, which is a particularly efficient carbon remover, should be contained in a closed tank and used cold. Its life, which is indeterminate, appears to be governed only by the accumulation of insoluble matter which reduces its efficient cleaning properties, and therefore, periodic filtering is recommended. It has been found that even in constant use, the preparation will last for at least a year or more before it requires to be changed. As with Stripalene 300, there is evidence to show that lead-indium bearing shells are adversely affected by this preparation.

Ardrox 670

Ardrox 670 is a general purpose cleaner which has been found to be suitable for cleaning flame tubes. It is powerful in action, and has the advantage that it may be topped-up with a regenerating fluid (methylene chloride) and thereby maintain its cleaning efficiency at a constant level. On removal from the detergent, flame tubes should be washed in cold water and lightly scrubbed with a small bristle brush. As with all cold detergents, it is essential that facilities are provided for the removal of accumulated insoluble matter at regular intervals.

Ardrox 666

Ardrox 666 may be used as a general purpose cleaner and paint remover and should be contained in an open tank. Periodic additions should be made to compensate for losses by evaporation and drag out. It is used cold as a general paint remover and, with the exception of certain epoxy (plastic), silicone, and heat-resisting types, will remove most paints by immersion followed by a fresh water rinse. Because of its low viscosity, the preparation cannot be applied locally by brushing.

Ardrox 20

Ardrox 20 is a general purpose paint remover, and having a higher viscosity that Ardrox 666 may be applied by brushing. It has proved to be very good in removing non-stoving finishes and may be rinsed off with water. As its vapour is toxic, it should not be used in a confined working space.

Quickerstrip 32

Quickerstrip 32 is a similar preparation to Ardrox 20 and can be used for removing excess linseed oil after the impregnation of porous castings. It can also be used for removing paint which has not been completely removed by Zonax. It may be applied by brushing followed by rinsing in water or preferably a spirit such as cellusose paint thinners etc. As its vapour is toxic, it should not be used in a confined working space.

Magnus 755

Magnus 755 may be used cold or hot (max. 60 deg. C.) with a 20 per cent water seal, and is considered to be suitable as a cleaner except for magnesium alloy components.