CHAPTER III

Washing Machines

1. Washing machines of various makes are installed in H.M. ships and fleet shore establishments. In general these are of either 30 or 12½ cu. ft. inner cage capacity.

Many machines at present in service are of the side-opening type, but end-opening type, which are largely of fabricated construction, are now being included in future installations.

SIDE OPENING TYPE

2. Description of a typical machine (*Figs. 6 and 7*)

The outer casing is securely attached to the end frames and is provided with a sliding door giving access to the inner cylinder. The inner cylinder is of perforated construction, carrying internal lifters designed to tumble the load and so arrange for maximum penetration by the washing liquor. A hinged lid of ample size to permit easy loading and unloading of the machine, and usually secured by means of spring type locking catches, is incorporated into the construction of the inner cylinder. A metal apron is hinged to the outer casing, and during loading and unloading it covers the annular space between the outer casing and inner cage, thus preventing small articles from falling between the cages.

The inner cylinder is supported on trunnions, and suitable sealing arrangements are provided to prevent water passing into the bearing housing, or grease passing to the inner cylinder. The drive to the inner cylinder is effected by an electric motor, normally mounted on the top of the machine, through vee belt or chain and spur gearing. In some machines the drive is arranged through a patent clutch.

To prevent the "roping" of the load, all machines are provided with a reversing gear which causes reversal of the inner cage every two or three revolutions. Reversal can be effected by various means, namely crossed belting, mechanical reversing gearbox or reversing motor with control panel. Inching gear, usually hand operated, is provided to bring the inner cylinder door to the loading position, and means are provided for locking the cylinder door in this position. Safety interlocking is provided to prevent the opening of the outer casing door while the machine is in motion, and alternatively to prevent starting the machine with the doors in the open position, or with the hand turning gear engaged. Safety catches are fitted to keep the inner door open when loading and unloading.

To facilitate the control of the washing process, a thermometer of the distant reading type, and a dip gauge, which may be of either the direct reading or float type, are provided. A process clock, which provides a ready method of recording the various stages in the washing process, is fitted on some types of machine.

Steam and cold water valves, with in some instances an additional connection for hot water, are provided. The water is drained from the machine by means of a foot or hand operated dump valve of large area.

3. Operation

The construction of individual types of machines varies, but the following instructions refer generally.

(1) Move the starting lever to the "stop" position, thus releasing the interlock on the outer casing door, and enabling the hand turning gear to be engaged.

(2) Slide the outer cylinder door to the open position.

(3) Engage the hand turning gear and rotate the inner cylinder until the door is in the loading position.

(4) Lock the hand turning gear in position to prevent further movement during the loading operation.

(5) Open the inner cylinder door and secure it in the open position by means of the spring clips provided.

(6) Swing the metal apron into position to bridge the gap between the inner and outer cages.

(7) Load the machine to the rated capacity (see remarks below).

(8) Turn the metal apron back.

(9) Close the inner cylinder door making sure that no work is trapped and that the securing catches are firmly engaged.

(10) Close the outer door.

(11) Disengage the hand turning gear.

(12) Switch on the motor and start the machine by moving the starting lever to the "starting" position.

(13) Proceed with the washing process in accordance with the approved formula.

Notes.—(i) The doors of all machines can be opened, or the hand turning gear engaged, only when the machine is brought to rest.

(ii) Steam must on no account be admitted unless there is water in the machine.

4. Loading rate

In Admiralty practice the accepted loading rate for cotton and linen work is 3½ pounds per cubic foot, and for woollens 2½ pounds per cubic foot. The rated capacity should not be exceeded because overloading reduces mechanical action resulting in poor finish.

Underloading reduces total production and wastes time, detergents and water.

5. General maintenance

The motor should always be stopped when the machine is standing idle including the loading and unloading periods.

Steam and water valves should be maintained in an efficient condition, particular attention being directed to leaky glands.

All bearings should be efficiently lubricated and the oil in gear-boxes, where fitted, maintained at the correct level.

If the cylinder tends to lag under load, this can usually be attributed to the slipping of the clutches

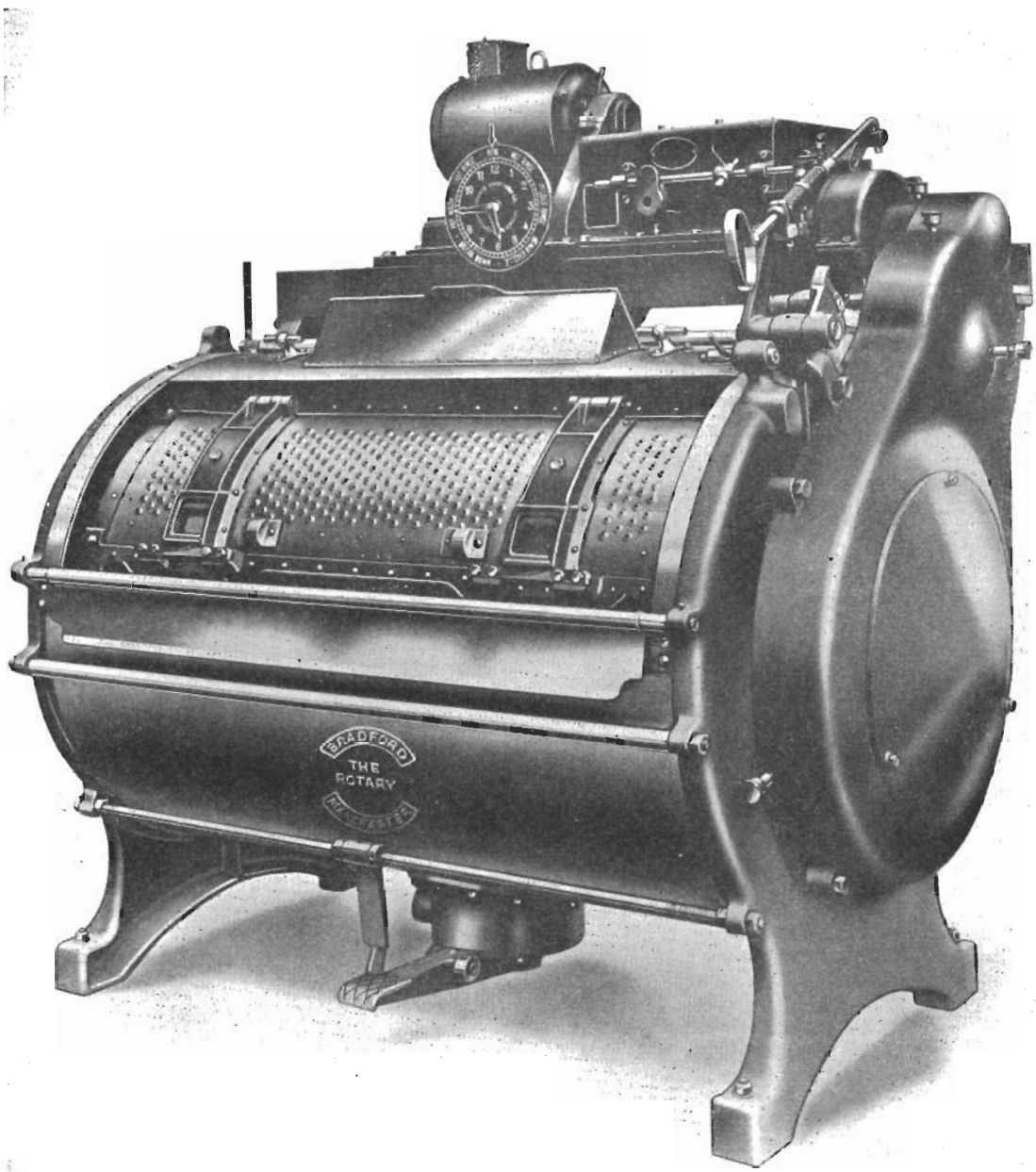

Fig. 6.—30 cu. ft. side opening type washing machine, motor driven.

in the gearbox (or belts in the case of belt-driven machines). These should be adjusted immediately.

Interlocking gear and door safety catches and clips should be inspected at regular intervals and adjusted if necessary to ensure their efficient working.

The end covers should be removed periodically, and a little grease smeared on the face of the pinion and gearwheel teeth.

Driving belts or chains should be constantly maintained at the correct tension.

6. Cleaning the internal surface

The use of hard water for laundry purposes results in the formation of a scale on the cage and inner surfaces of the washing machine. The hardness element in the water is precipitated by the alkali used in the washing process and the chemical action of the soap on this precipitate causes it to be deposited in the form of a hard scale (*e.g.*, lime soap deposit). The presence of even small quantities of this scale is troublesome inasmuch as minute particles become detached and settle on the work with resultant deterioration in whiteness; heavy scaling may cause partial blocking of the perforations in the cage and so interfere with the efficient circulation of water through the machine.

It is essential therefore that such scaling be removed periodically, and this can be done by a suitable acid treatment, followed by an alkali boil.

Note.—Great care must be exercised in the use of acid to prevent damage to the metal of the machine.

PROCEDURE

(1) Revolve the cage by means of the hand turning gear and scrape and brush off as much scale as possible from the external surface.

(2) Remove the cage door and turn the cage gradually by hand turning gear so enabling the inside

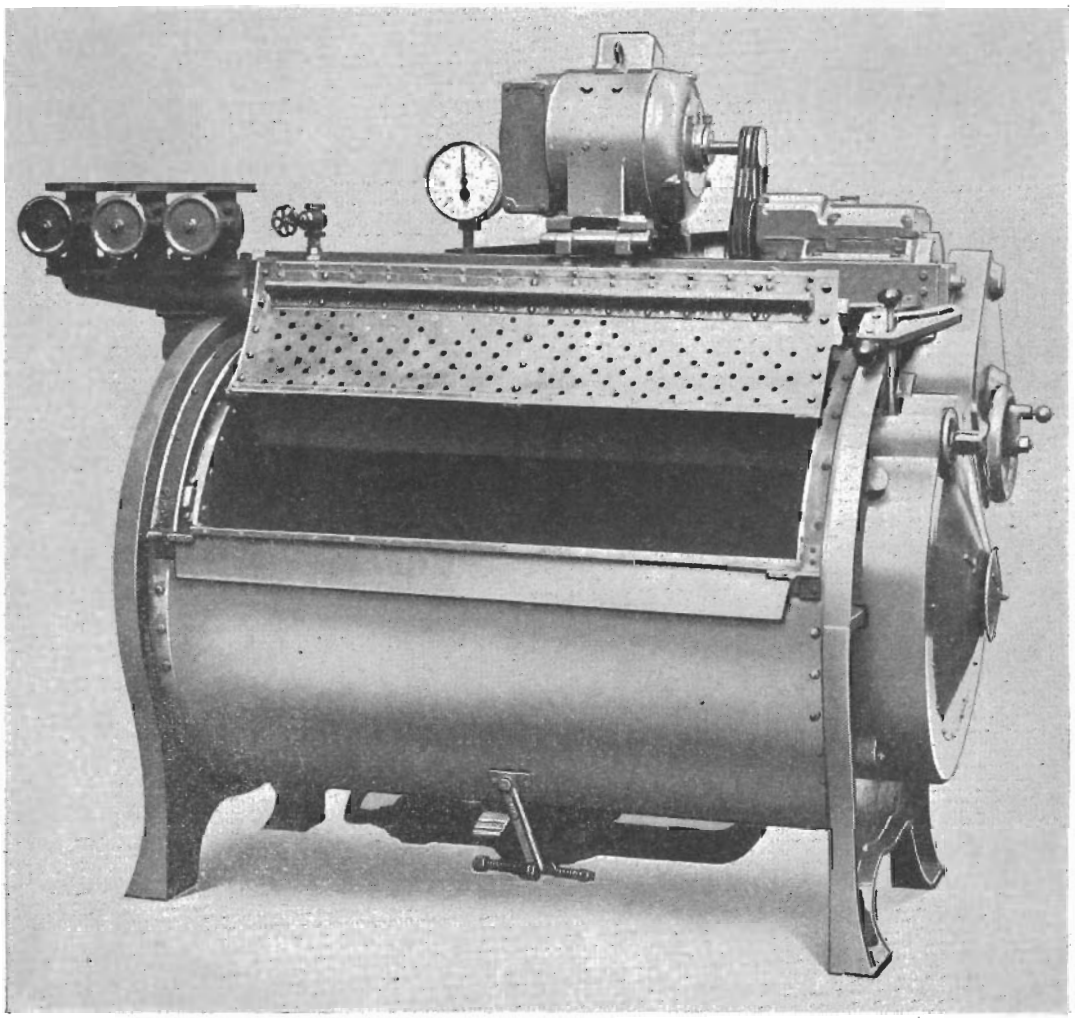

Fig. 7.—30 cu. ft. side opening type washing machine, motor driven.

of the cage and as much as possible of the inside casing to be similarly scraped and brushed by a man inside the cage. Lock the cage each time before cleaning.

Note.—In operations (1) and (2), great care must be taken to ensure that the power supply to the machine is " off "; care must also be taken not to raise " burrs " on the surface of the cage as these will cause tearing of the fabric.

(3) Replace the cage door and set the machine ready for running.

(4) Thoroughly rinse the machine.

(5) Run hot water at a temperature of about 160°F. into the machine to a dip of 6 in. Add small quantities of acid, about 2 ozs. at a time, at intervals until the water remains acid to litmus after 5 mins. running. Glacial acetic acid should be used, as this has the minimum corrosive effect on the metallic construction of the machine.

(6) Run out the acid liquid and rinse thoroughly with soft water.

(7) Add hot water at a temperature of about 160°F. into the machine to a dip of 6 in. Add 1 lb. of alkali (soda ash), and boil for 15 minutes.

(8) Run out the solution and rinse the machine thoroughly.

(9) Repeat processes 7 and 8 if the cage still appears greasy.

(10) If possible, descaling should be done prior to some period at which it may be anticipated that the machine will be idle. After cleansing as above, a solution of sodium silicate (water-glass) should be left in the machine overnight to protect the cage against subsequent corrosion; 1 oz. of syrupy sodium silicate in a full 100 lb. capacity machine is sufficient for this purpose. The cage should be revolved at intervals.

GEARS

7. Typical Interlocking Gear

(*As fitted on the Smith & Paget 36 in. diameter motor driven washing machine with gearbox drive*) (Fig. 8.)

In the position shown, in Fig. 8, the machine is idle and is started by moving the machine control lever (1) to the left. The machine control lever carries the door interlock bracket (2) which operates in conjunction with the striking piece (3) mounted on the

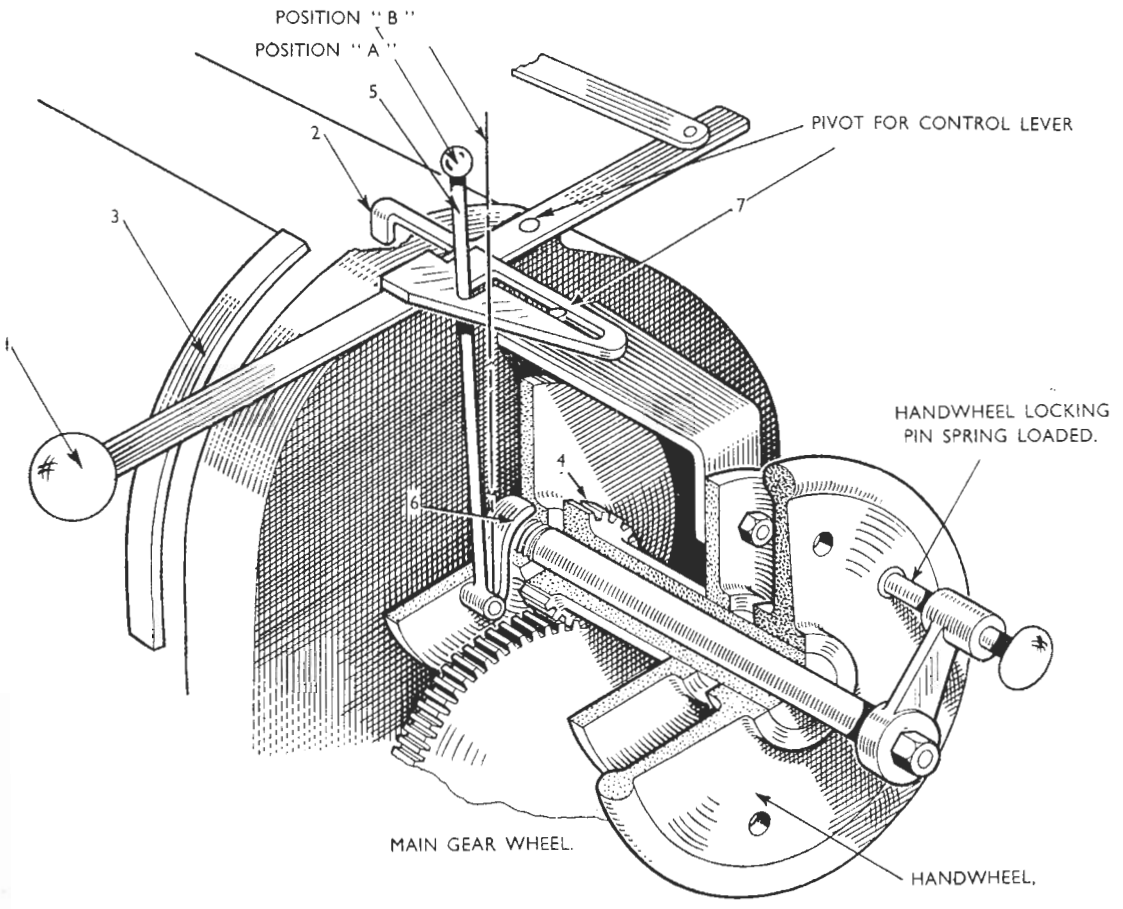

Fig. 8.—Diagrammatic arrangement of interlocking gears for Smith and Paget washing machine.

sliding door of the outer cylinder. Thus with lever (1) in the running position, the interlock bracket (2) passes behind the striking piece (3) and prevents the door from being opened. Similarly, with the door in the open position the striking piece (3) passes in front of the interlock bracket (2) thus locking the control lever (1) in the off position preventing the machine from being started until the door is closed.

The hand turning gear comprises a pinion (4) capable of lateral movement along its shaft into or out of mesh with the main driving wheel. By pulling the handwheel outwards towards the operator the gear is engaged; opposite movement releases it. The position of the pinion (4) is controlled by the lever (5) operating a claw (6) which embraces the pinion. Lever (5) passes through an " L " shaped slot in the connector casting (7) carried on control lever (1). Thus when the pinion (4) is engaged as shown in the sketch the lever (5) cannot be moved since the claw (6) is in line with the pinion (4) and since the lever (5) is engaging the slot in the connector casting (7). As shown in " position A " therefore, the control lever (1) is effectively held in the off position.

If the hand turning gear is pushed out of engagement, lever (5) can be moved to " position B " when the claw (6) falls in front of the pinion (4) thus preventing it from being drawn into mesh with the main gear. In this position, the control lever (1) may be moved to the " on position," lever (5) travelling along the opposite arm of the slot and thus being firmly held in " position B " until the machine is once more stopped. Therefore the hand turning gear cannot be engaged until the machine is stopped and must be disengaged before the machine can be restarted.

8. The 'Crown' Reversing Gearbox

This gearbox, Figs. 9 and 10 is fitted on the Smith & Paget type washing machines.

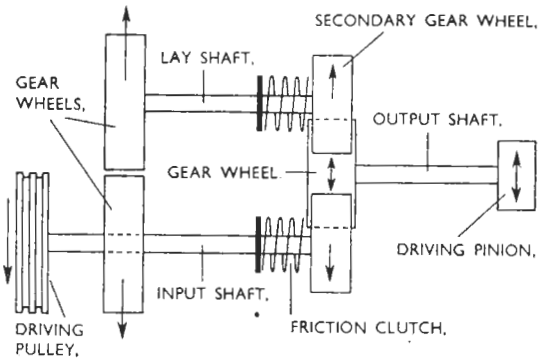

Fig. 9.—Diagrammatic arrangement of Crown reversing gearbox.

The unit comprises an assembly of three shafts two upper and one lower. The two upper shafts, namely the front or input shaft and the back or lay shaft, are directly geared and so rotate in opposite directions; drive is communicated by vee belting from the motor to a grooved pulley wheel mounted on an extension to the input shaft.

The input and lay shaft each carry a second smaller wheel free to rotate on the shafts and both engaging with a large gearwheel mounted on the lower or output shaft, the extension to which carries the main driving pinion wheel. This third shaft is positioned immediately below and centrally between the two upper shafts. Each of the two upper shafts also carries a multigrip friction clutch capable of separate engagement with the secondary gear wheels previously referred to.

Automatic engagement of the clutches is effected by spring loaded plungers controlled by a cam so arranged that the clutches cannot both be engaged at the same time. The cam is circular and is freely mounted on the lower shaft. The cam is driven by a two-stage worm reduction timing gear and causes engagement of the clutches alternately, disengaging one before permitting the engagement of the other, thus imparting reversal of motion to the output shaft.

Assuming the clutch on the input shaft to be engaged, the lower shaft would be directly driven and would rotate in a direction opposite to that of the input shaft. When the clutch on the lay shaft becomes engaged, the lower shaft is driven through the layshaft with a resultant reversal of motion.

9. 'Lightburn' patent reversing clutch

In certain makes of washing machine the reversing motion of the inner cage is obtained by drive from the motor pinion through a " Lightburn " patent reversing clutch (see Figs. 11 and 12). The clutch mechanism comprises a central driving or output shaft at each end of which is secured a central driven plate capable of engagement by alternately the right or left hand driving plates, the latter being freely mounted on the central shaft.

Clockwise motion to the left hand driving plate with 5 to 1 reduction is communicated by chain drive from the motor pinion to a chain wheel mounted on the extended boss of the left hand driving plate. The extended boss also carries an intermediate chain wheel and reverse motion to the back shaft is effected through a jockey wheel by drive from the intermediate wheel. Anticlockwise motion is communicated from the back-shaft by chain drive to a wheel mounted on the extended boss of the right hand driving plate.

In the neutral position of the clutch, therefore, the central output shaft and driven plates remain stationary while the right and left hand driving plates run independently in their respective clockwise and anti-clockwise directions.

A spring-loaded central bobbin is freely supported on the central output shaft between the two central-driven plates and lateral movement of the bobbin exerts a gradual pressure by means of a wedge action to the presser plates, and in turn to the clutch-plate and lining-rings engaging with the associated fixed-driven plate. The clockwise or anticlockwise motion is thus communicated to the output shaft through the right or left-hand driving plates, and hence by direct drive to the main gearwheel of the washing machine. A worm mounted on the back shaft drives a worm-wheel, mounted concentrically with which is a roller

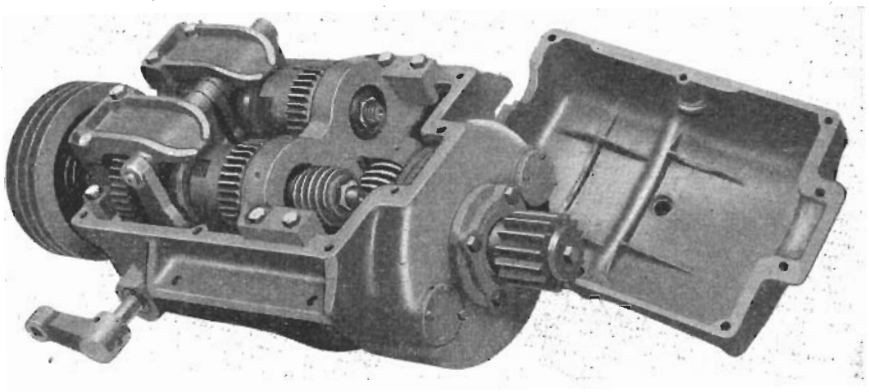

Fig. 10.—Assembly arrangement of Crown reversing gearbox.

and crankpin. Automatic engagement of alternately the right and left-hand driven plates, is obtained by the conversion of the rotary motion of the wormwheel and roller to lateral movement of the central bobbin through a rocker lever and striking arm.

The number of machine reversals is capable of variation through a train of gearwheels mounted behind the wormwheel assembly, the central spindle of which carries the spindle of the engagement roller referred to above.

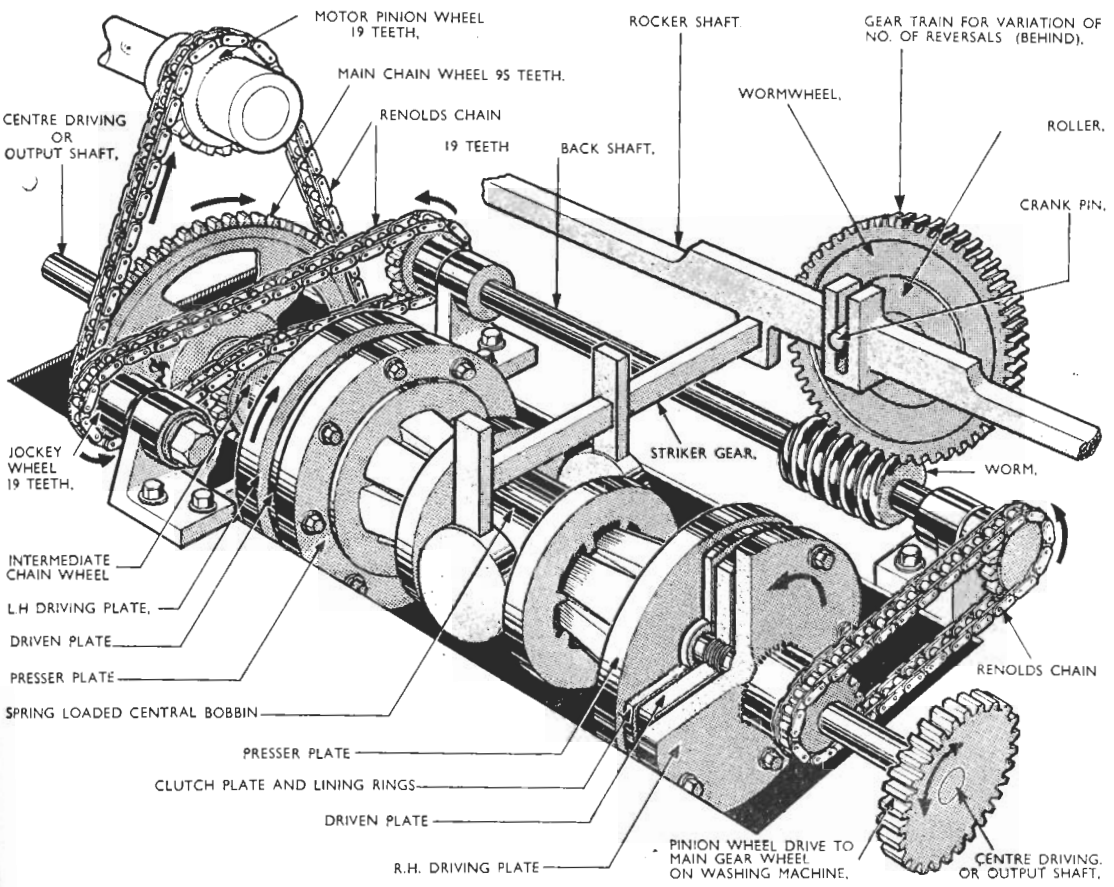

Fig. 11.—Diagrammatic arrangement of Lightburn reversing clutch.

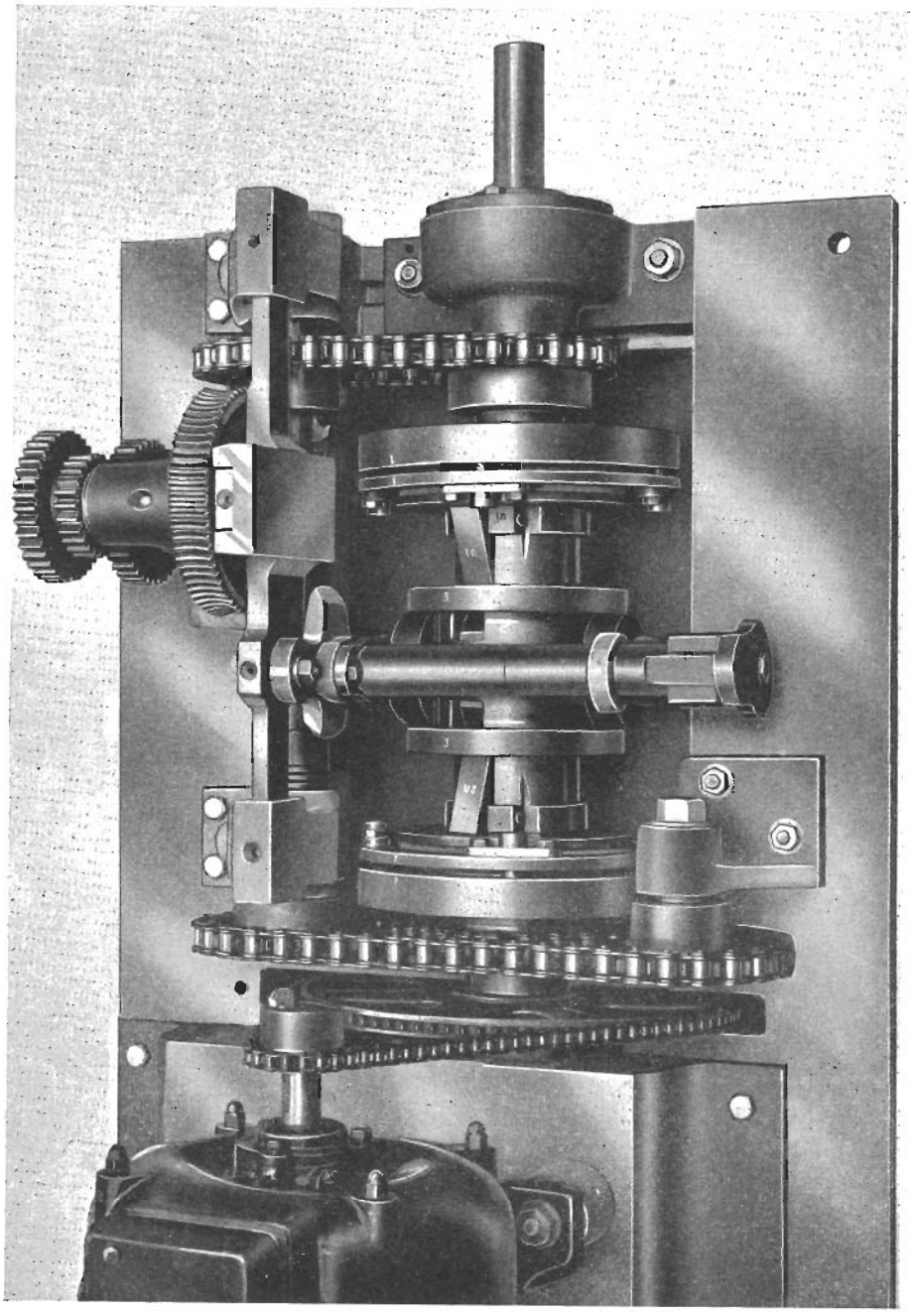

Fig. 12.—Assembly arrangement of Lightburn reversing clutch.

MAINTENANCE

All grease cups should be filled and charged daily, those on the ends of the clutch being most important.

The clutch assembly should be lubricated daily through the nine oil cups provided.

The bearing in the operating-rod bracket should be lubricated daily.

The depth of oil in the chain oil-bath should be tested every three months, the correct level being such that the chain just reaches the oil.

The utmost care should be taken to prevent oil reaching the clutch plates.

The main driving chain should be examined at intervals and any apparent slackness taken up by meant of the adjusting screws on the main motor mounting.

10. Interrupter gear

Excessive mechanical action when washing woollens tends to produce " felting," with consequent damage to the material. To minimise this effect, machines engaged in washing woollens are provided with interrupter gear by means of which the machine is automatically stopped at predetermined intervals, thus enabling the load to soak at rest. One of the most widely applied types in use is the B.L.R.A. Interrupter Gear, developed by the British Launderers' Research Association.

Some machines are provided with a two-speed motor, the lower speed being used (in lieu of interrupter gear) to reduce the mechanical action on the load when washing woollens.

Other machines in Admiralty Service have no positive provision for washing woollens, and in these instances the rest period must be obtained by the hand stopping and starting of the machine.

THE B.L.R.A. INTERRUPTER GEAR

The B.L.R.A. interrupter gear comprises a cam mechanism which, working in conjunction with the unit controlling the reversing motion of the inner cage, produces an interruption or " pause " of predetermined period in the rotation of the cage. The device is illustrated diagrammatically in Fig. 13, and the following should be read in conjunction with the description of the belt striking gear and Fig. 15.

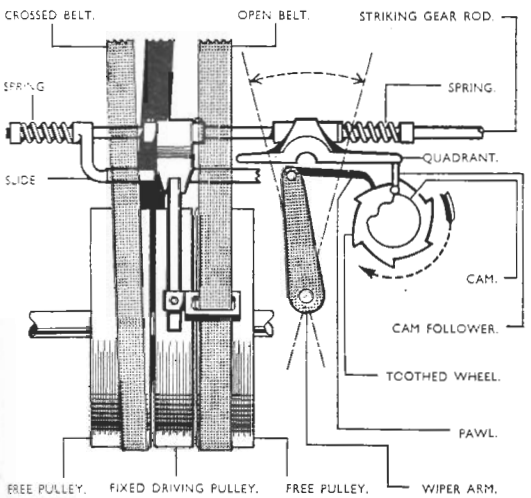

Fig. 13.—Diagrammatic arrangement of the B.L.R.A. interrupter gear.

The cam is mounted on a toothed wheel, motion to which is activated by a pawl attached to the wiper arm. The toothed wheel is provided with six teeth so that it carries the cam one-sixth of a revolution each time the wiper arm makes a complete to-and-fro movement. The cam is also divided into six sections. The belt striking gear rod carries a quadrant which when engaged with the wiper arm moves the open or crossed belts to the driving pulley, producing clock or anti-clockwise motion to the inner cylinder.

The position of the quadrant is determined by spring loading so that when disengaged from the wiper arm the quadrant centralizes itself, returning the belts to the neutral position. A cam follower engages the profile of the cam and thus raises or lowers the quadrant. During that period of revolution of the toothed wheel when the cam follower is engaged with the low portion of the cam, the quadrant drops and engages with the wiper arm which in turn moves the belts to the driving position causing revolution of the inner cylinder.

When the raised portion of the cam is in contact with the cam follower the quadrant is lifted clear of the wiper arm and the springs return the belts to the neutral position; during this period the inner cylinder is at rest and motion is therefore interrupted.

Three ratios of rest and motion are normally incorporated in the construction of the interrupter gear, and the appropriate cam is selected by a sliding mechanism. In the 1:1 ratio the six portions of the contour of the cam are alternately high and low. In the 1 : 2 ratio the contour of the cam follows as—one-sixth high, two-sixths low, one-sixth high, two-sixths low. In the 1 : 5 ratio the cam has one-sixth of its circumference low and the remaining five-sixths high. The normal clockwise and anti-clockwise motion of the cylinder is retained as the interrupter gear operates irrespective of the direction in which the cylinder is rotating.

The interrupter gear is capable of simple disengagement, leaving the machine free for normal washing operations. Individual manufacturers of washing machines adopt designs of the B.L.R.A. interrupter gear suitable to their own products and in such instances the name of the maker is used as a prefix. The interrupter gear brings the machine to frequent " rest " positions which may cause an unsuspecting operator to think that the machine is stopped. In all machines, therefore, the interrupter gear operating lever is incorporated as an integral part of the safety mechanisms which ensures that the outer door cannot be opened until the machine is stopped.

11. Belt-driven machines

A number of belt driven washing machines are installed in H.M. ships, the Ritchie No. 2 style CHH Dreadnought type as illustrated in Fig. 14 being a typical example.

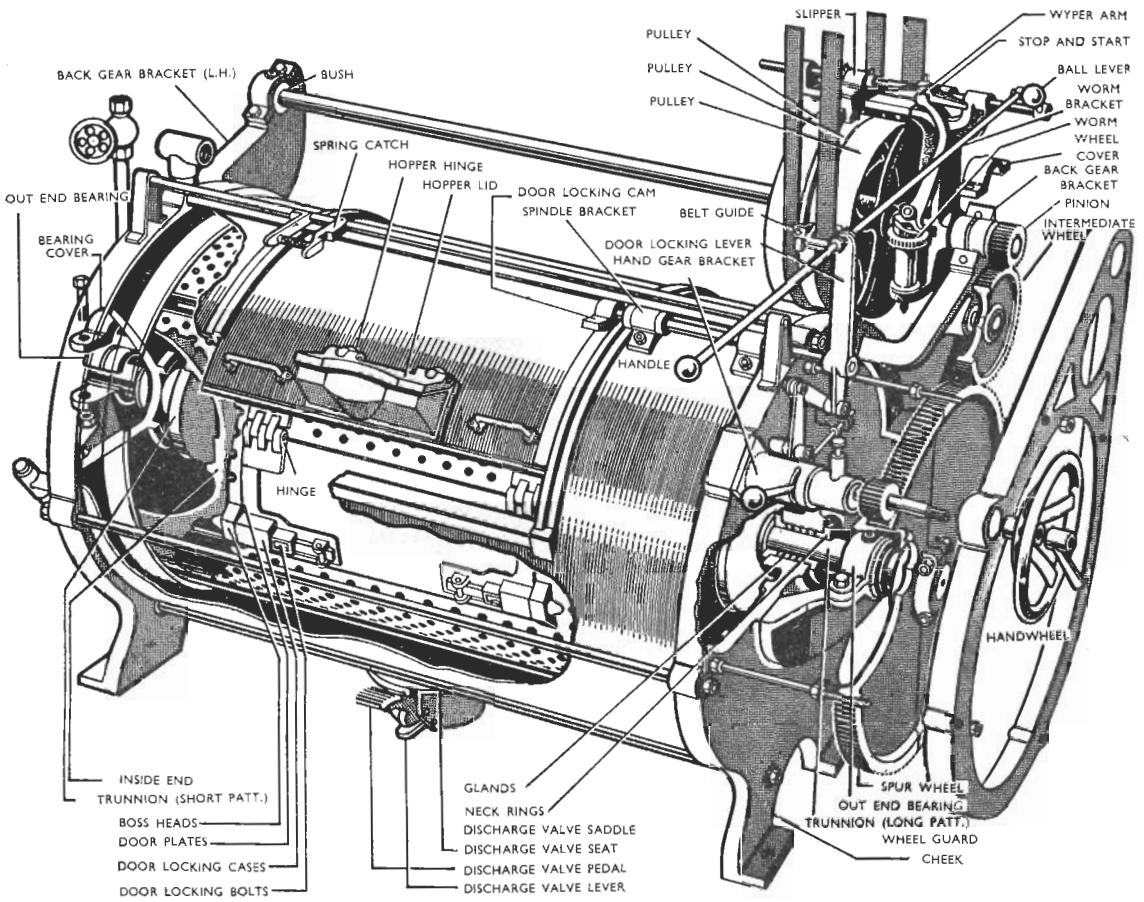

Fig. 14.—Arrangement of Ritchie No. 2JCHH belt driven washing machine.

With this type of machine the motor is separately mounted on the deck or deck head and driven through countershafting, the " fast" and " loose " pulleys being mounted on the machine driving shaft. A pinion on the driving shaft transmits the drive through an intermediate wheel to the main gearwheel mounted on the trunnion of the inner cylinder. Reversal of the motion of the inner cylinder is obtained by open and crossed belting. The construction of the machine and the names of component parts are generally similar to those previously described.

12. Striking gear

The belt striking gear is illustrated in Fig. 15 which shows the assembly with the gear in the neutral position and with the belts running on their associated free pulleys. A worm, sleeve mounted on the main driving shaft imparts circular motion to a worm cam wheel and hence reciprocal motion to the wiper arm, the foot of which engages with the face profile of the cam. The worm is secured to the boss of the open-belt-driven free pulley. The open belt when moved to its driving position on the fixed pulley, overlaps its free counterpart, thus permitting continuous rotation of the free pulley and maintaining the constant reciprocating motion of the wiper arm. The reciprocating motion is transferred to a quadrant mounted on the belt striking gear spindle, thus resulting in the alternate engagement of the " open " and " crossed belting " with the fixed driving pulley, with the consequent transmission of clock or anti-clockwise motion to the inner cylinder.

Motion of the inner cylinder is controlled by the engagement or disengagement of the quadrant with the wiper arm. To stop the inner cylinder, the quadrant is lifted clear of the wiper arm by means of the operating lever provided. The quadrant carries a Vee-shaped projection and when the quadrant is lifted clear, the Vee portion slides into a central position between two snugs cast on the gear arm, thus drawing the belts into the neutral position on the free pulleys. The belts remain in this position until the machine is restarted by the operating lever.

13. Door Locking Device

A typical arrangement with a description of the mechanism appended is illustrated in Fig. 16.

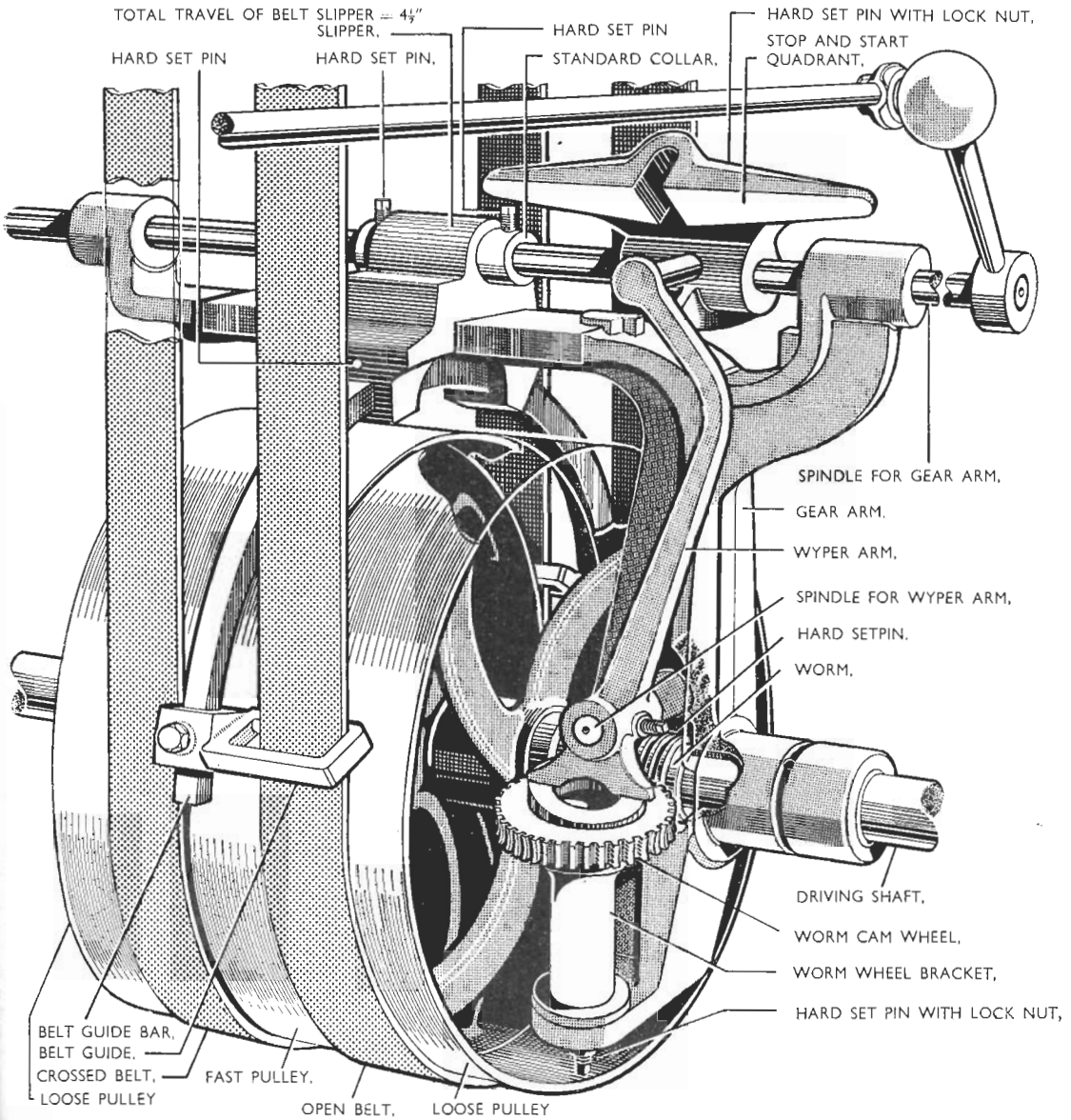

Fig. 15.—Belt striking and reversing gear.

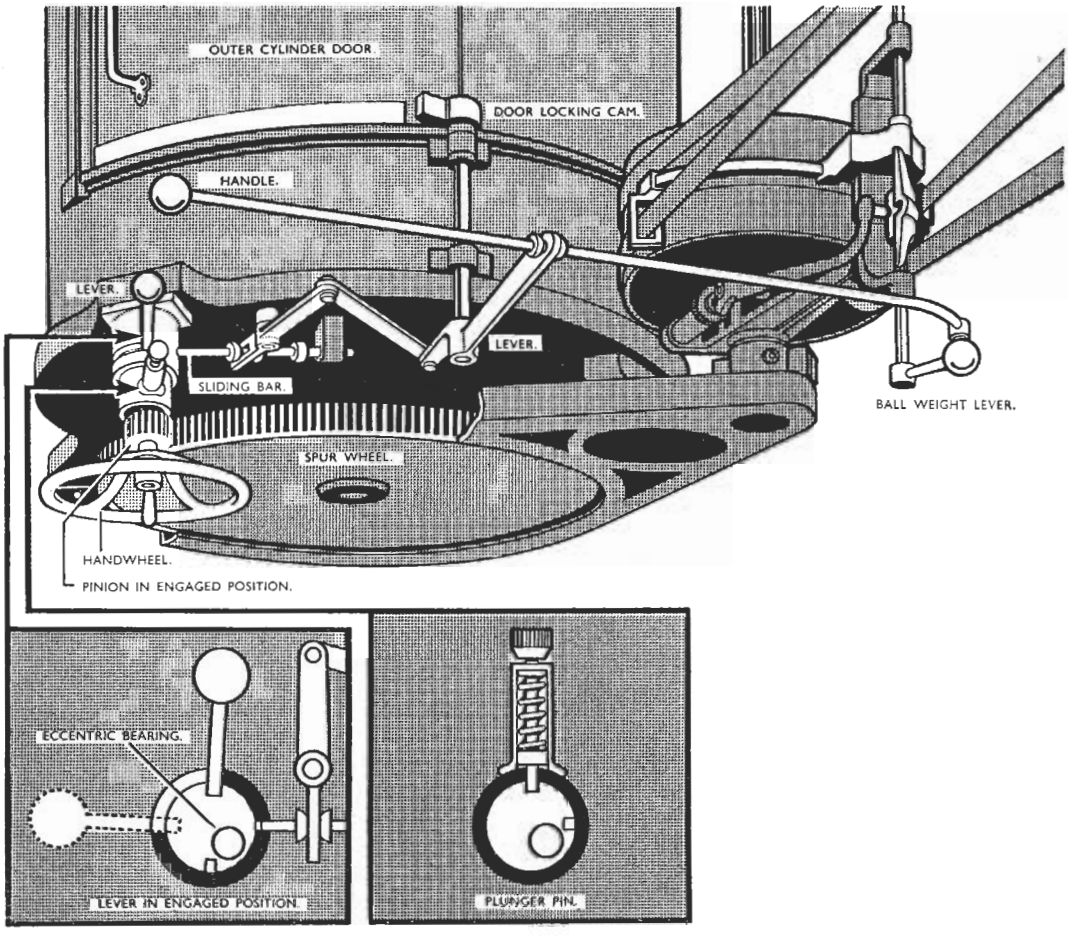

Fig. 16.—Door locking and hand turning gear for Ritchie No. 2 washing machine.

This drawing shows the machine in the neutral position, *i.e.*, the driving belt is on the free pulley and the machine cylinder is idle. In this position the outer door can be opened as the door locking cam has been lifted by its lever. The sliding bar has been drawn from the eccentric bearing thus enabling the eccentric to be turned so that the pinion engages with the spur wheel. The plunger pin locates this new position and the inner cylinder can now be revolved by means of the handwheel.

To start the machine, the hand turning gear must be disengaged, *i.e.*, the plunger is removed from the eccentric and by means of its control lever, the eccentric is turned in the bracket thus disengaging the pinion from the spurwheel. The plunger locates this new position. The starting handle is pulled by the operator. This action (*a*) drops the door cam, (*b*) operates the sliding bar which enters and locks the eccentric in the disengaged position, and (*c*) pulls over the ball weight lever which in turn engages the stop and start quadrant with the wiper arm.

OPEN END TYPE

14. Description

The machine shown in Fig. 17 consists of a perforated monel metal or brass internal cage of open end construction. The rear end of the cage is fitted with a trunnion housing of the sleeve type which revolves on roller bearings mounted on the trunnion. The trunnion is supported in a trunnion bearing bracket and can be withdrawn externally without completely removing the main drive assembly.

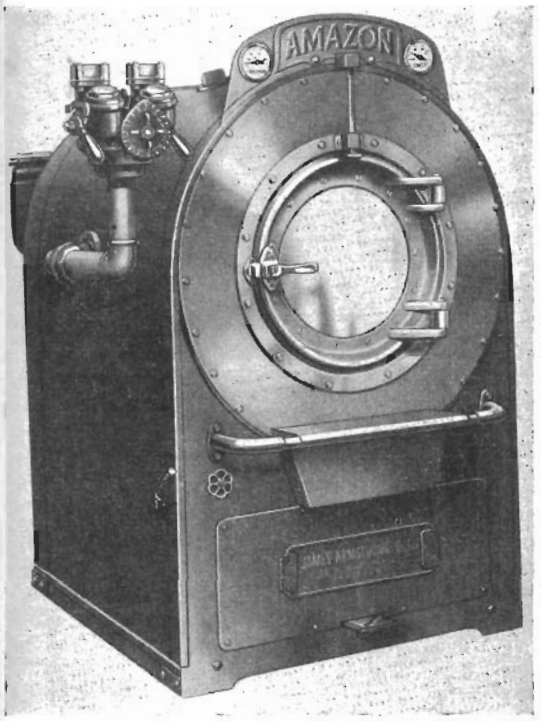

Fig. 17.—External view of the Amazon 38 in. × 44 in. open end type washing machine.

The front of the cage has a 22-in. diameter opening for loading and unloading purposes and carries a deep sectioned ring which acts as the internal track for the roller bearings on which the front of the cage revolves. The cage carries four internal beaters which continuously lift and drop the work so as to cause the maximum penetration of the washing liquor into the load.

The cage revolves in an outer steel shell which is largely of fabricated construction and supported on end frames. In some machines installed in H.M. ships this steel shell is sprayed with monel metal to a thickness of ·016 in. as a protection against corrosion. The ends of the outer shell are reinforced externally by mild steel discs, the front disc being bored to receive a gunmetal door ring on which the outer door, giving access to the cage, is hinged. The door is fitted with a toughened glass panel and watertightness is preserved by means of a rubber joint ring. A seal of the split ring type (Fig. 24) is mounted on the trunnion housing and preserves watertightness at the back of the machine. The seal serves the dual purpose of preventing leakage of water from the machine and conversely prevents oil and grease from entering the cage with consequent contamination of the load.

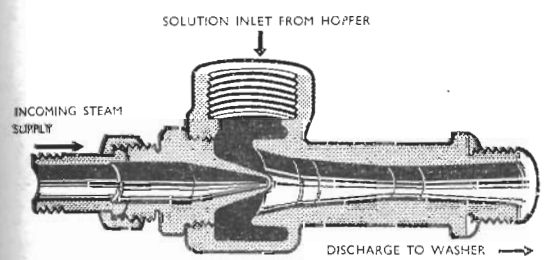

Fig. 18.—Arrangement of No. 3 "Cosmo" type steam injector.

A solution hopper is placed in the front of the machine and the predetermined quantity of stock solution, starch, bleach or blue, required by the washing formula is measured and placed in the hopper at each individual stage of the washing process. The solution is then injected into the machine by means of a steam injector (Fig. 18) controlled by a foot operated valve.

Machines are arranged with both hot and cold water inlet valves or alternatively with a "Tee" piece to take a thermostatic steam and water mixing valve and associated fittings. A separate steam boiling connection fitted with a fine adjustment valve is provided. A 2-in. vapour outlet pipe is fitted at the top of the machine and a 6-in. diameter outlet or dump valve controlled by a hand operated lever mechanism (Fig. 19) is supplied.

Machines supplied for Admiralty use are also fitted with a dummy clock, a thermometer of the distant reading type and a hydrostatic depth gauge for indicating the dip reading in the machine. Fig. 20.

15. Safety device

The outer casing door is electrically interlocked with the motor; immediately the door is opened the motor is switched off, thus bringing the inner cage to rest. Similarly the machine cannot be re-started until the outer door is positively shut.

16. Drive

All machines are arranged for washing both main classes of work, namely "cottons and linens" and "woollens." Dependent upon the preference of the user in respect of the method employed for washing woollens, two distinct types of mechanical drive and electrical control gear are supplied by the makers. Both types of drive are fitted in machines in Admiralty service.

METHOD I.—Drive to the machine is arranged by a vertically-mounted motor supported on the outer shell at the back of the machine, through a Croft $3\frac{1}{2}$-in. type "D" vertical worm reduction gearing giving a drive ratio of 15 : 1 (see Fig. 21). The output pinion, 22 teeth, engages with the main driving wheel, 94 teeth. This main gear wheel is of the split type and is rigidly secured to the cage trunnion housing. The overall reduction between the speed of the motor and the speed of the cage is approximately 64 : 1. With a speed of motor of 1,500 r.p.m. an average rubbing speed of clothing of 238 ft. per minute is produced. The motor is of the reversing type and reverses the cage six times per minute with a two seconds dwell

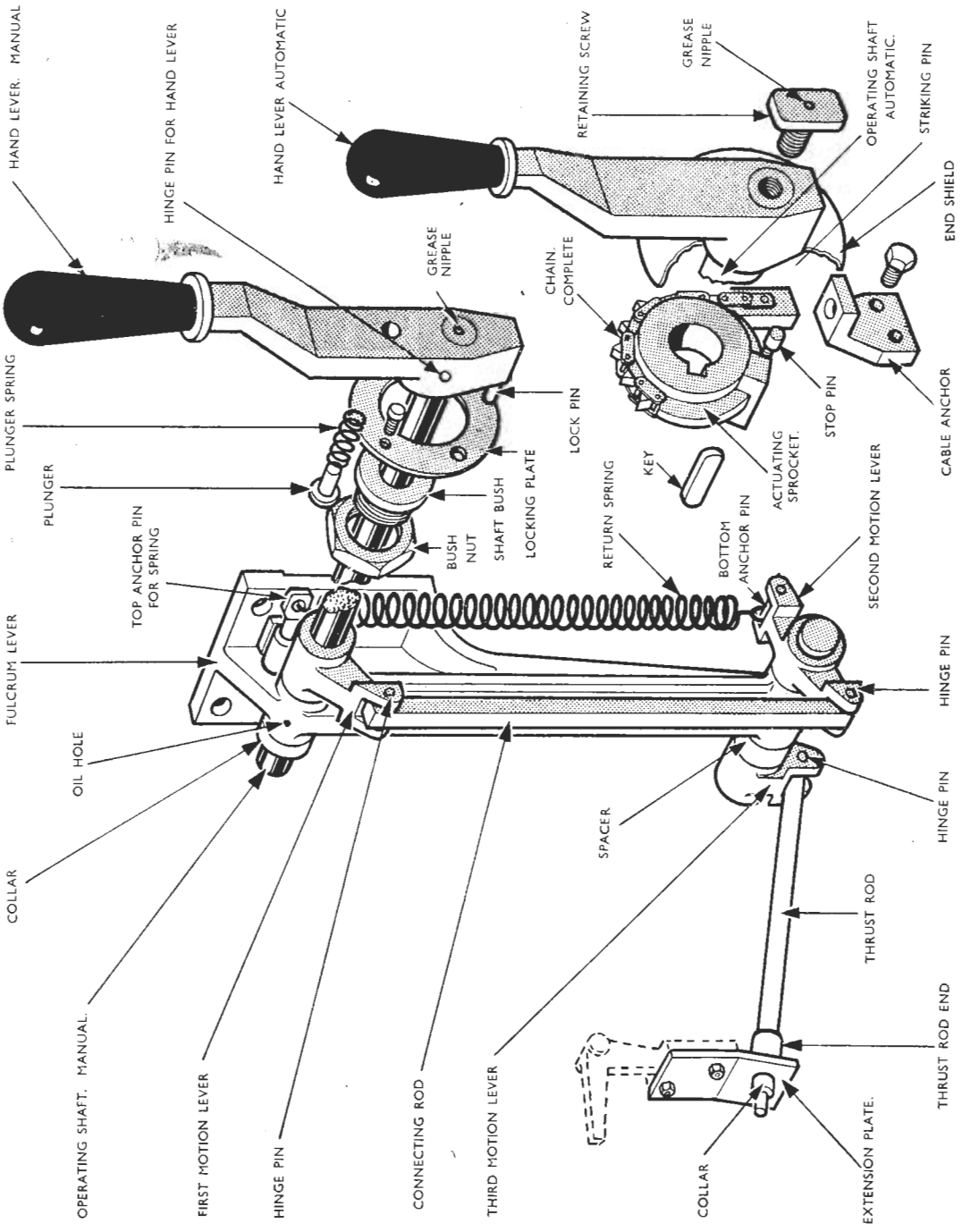

Fig. 19.—Outlet valve operating mechanism.

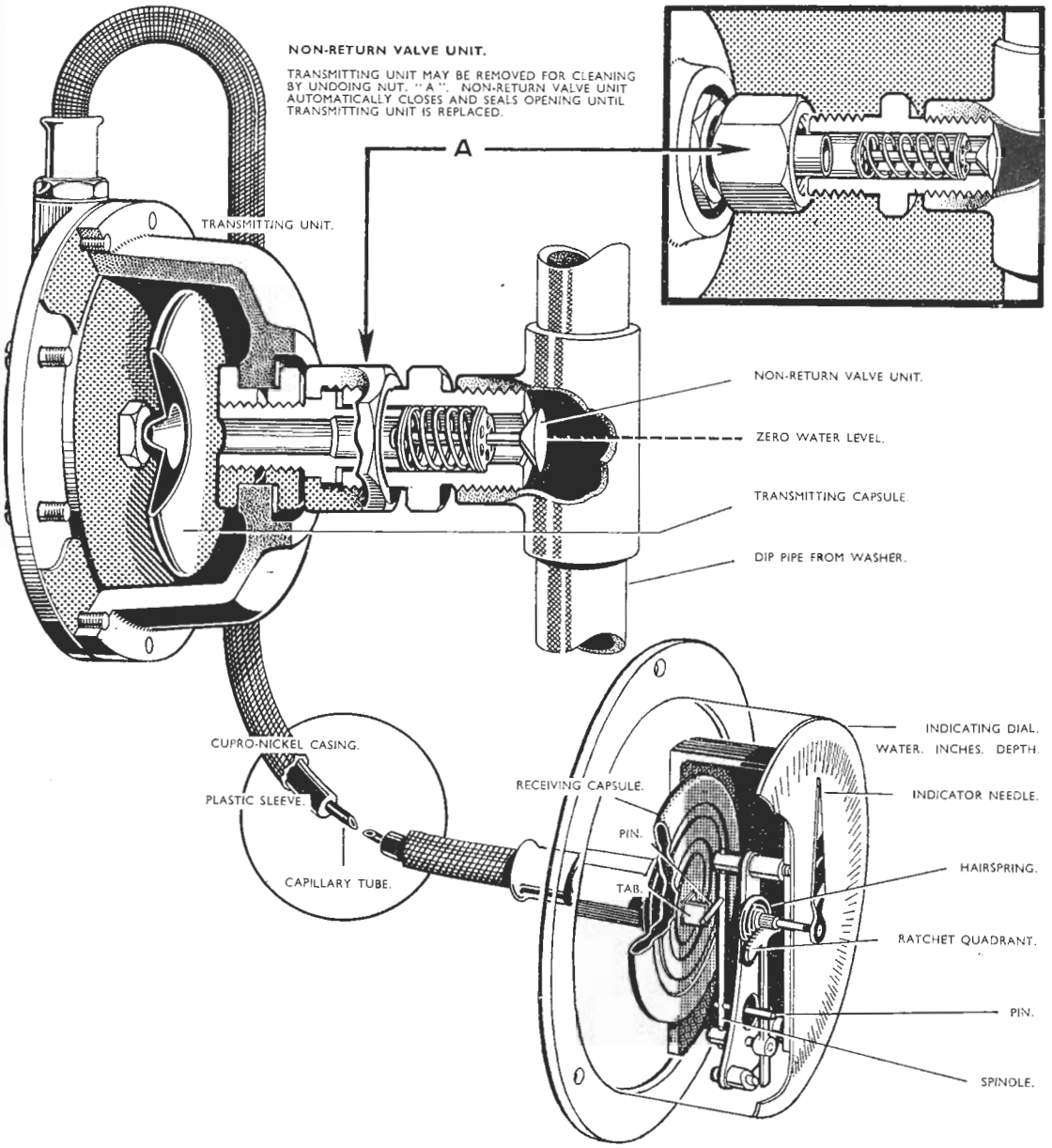

Fig. 20.—K.G.D. hydrostatic depth gauge.

period between each reversal to allow the cage to come to rest before starting away in the opposite direction. Movement of the cage is therefore eight seconds clockwise motion, two seconds dwell, eight seconds anti-clockwise motion, two seconds dwell and so on.

The timing of the cycle of operations is controlled by an automatic electrically-operated switchgear known as a reversing panel. The correct sequence of the cycle of operations 8-2-8-2 is obtained by a motor-driven timing relay consisting of an arrangement of cam-operated switches.

The requirements for woollen washing are met by the provision of a second timing relay in the reversing panel to give an over-riding cycle of one minute running and two minutes dwell (or any other cycle which may be originally specified). This over-riding cycle is only used when the machine is engaged on woollen washing and can be switched out from the control system when the machine is engaged on the washing of cottons and linens.

METHOD II.—With this arrangement of drive an additional two speed gearbox of the Croft type No. 3A

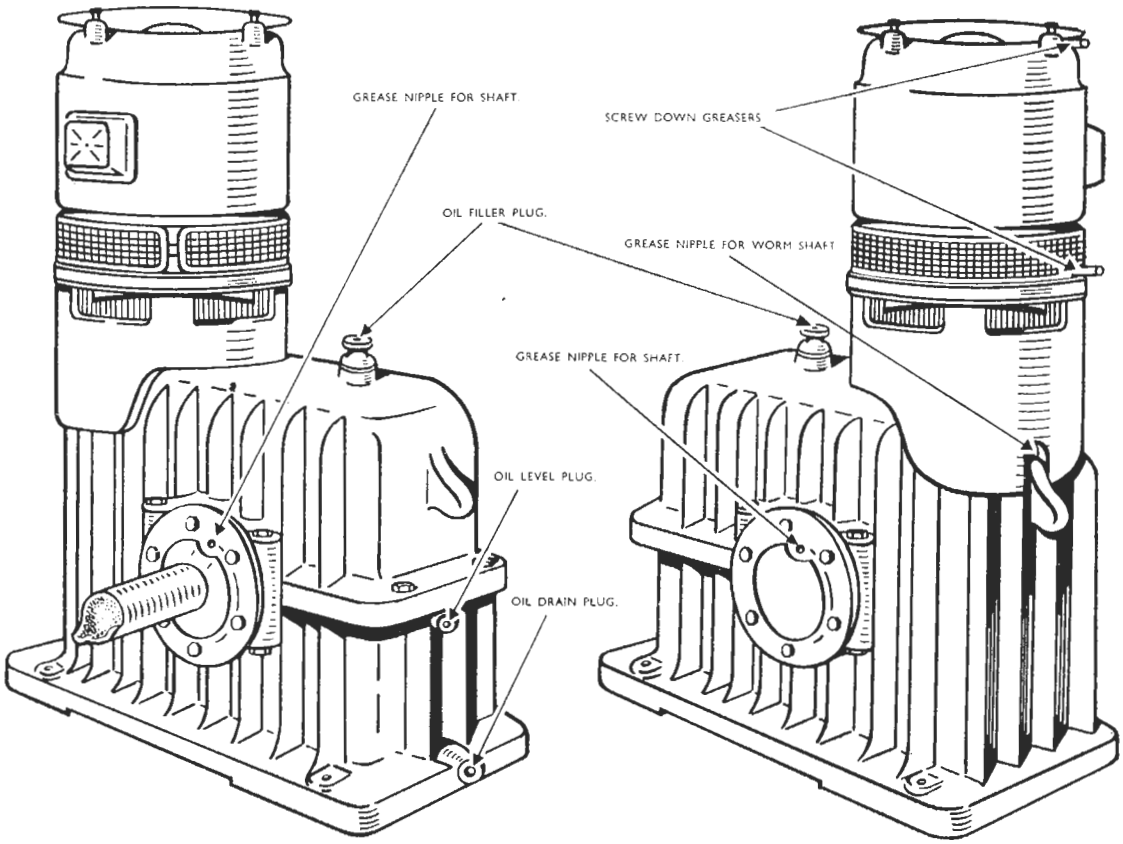

Fig. 21.—Gear box lubricating diagram.

giving a 1:1 or a 2:1 reduction is fitted between the motor pinion and the standard type 15:1 worm reduction gearbox. The purpose of this gearbox is to reduce the rubbing speed of the machine by 50 per cent., namely to 119 ft. per minute when the machine is engaged in washing woollen goods. The low speed enables the washing operation to be continuous and the alternative " short washing " and " long dwell " periods normally associated with interrupter gear when used for washing woollens with single speed machines is unnecessary. When washing woollens therefore in a machine fitted with this type of drive, the reduced speed permits the normal timing cycle to be used, namely 8-2-8-2 seconds, as for cottons and linens. Engagement of the two speed gear from the 1:1 ratio for cottons and linens to the 2:1 reduction when washing woollens is effected by a gear change lever operated from the front of the machine.

17. General Maintenance

TRUNNION BEARINGS.—A grease nipple is supplied on the trunnion for greasing the trunnion bearings—this should be turned occasionally and recharged at intervals of approximately three months.

MAIN DRIVING WHEEL is lubricated by means of a grease cup mounted on the bearing bridge. This should be given a turn each day and the cup replenished as necessary.

GEAR BOX (Fig. 21) is fully charged by the makers on assembly. After installation and when the machine has been running for approximately 500 hours, the gearbox should be drained and re-filled with new oil to the correct level. Thereafter the gearbox should be drained, cleaned and re-filled after each 12 months running. Always fill and check the gearbox when the machine is idle. Filling above the correct level results in excessive heat generation and in loss of power due to the drag of the surplus oil. The remaining grease nipples on the gearbox assembly should be turned occasionally and replenished at three-monthly intervals.

MOTOR.—Two screwdown type greasing connections are provided for the motor bearings (Fig. 21). These should be turned occasionally and replenished at three-monthly intervals.

HOPPER.—The strainer in the hopper should be maintained constantly in a fully clear condition.

INJECTOR.—Should normally require very little maintenance but should be inspected at three-monthly intervals to ascertain the condition of the steam valve discs.

DIP CHAMBER.—Should be inspected at three monthly intervals and all silt removed. Clearing plugs are also provided in the connecting pipe work for similar removal of silt and lint accumulations.

DOOR.—The seal between the door frame and the door is effected by a length of ½ in. diameter rubber tube let into a recess. Should replacement be necessary, the new tubing should be fitted with the joint at the top of the door.

18. Replacement and adjustments

In all cases the detailed instructions contained in maker's handbooks are to be observed but the following details are included in this manual primarily because the description of the operations involved and the associated sketches illustrate the construction of the machine.

TRUNNION BEARING

To remove the trunnion bearing (Fig. 22), first remove the gear guards thus exposing the spur wheel. Place hardwood wedges between the bottom of the spur wheel and the bearing bridge. These wedges should not be driven in with unnecessary force but should be only tight enough to prevent the trunnion housing from dropping when the trunnion and bearing is removed. Under no circumstances should an attempt be made to remove the trunnion without first supporting the gear wheel. Having supported the wheel, both clamping bolts should then be removed from the spur wheel. If not free, the wheel should be eased on the trunnion housing by lightly driving a steel wedge into the split hub.

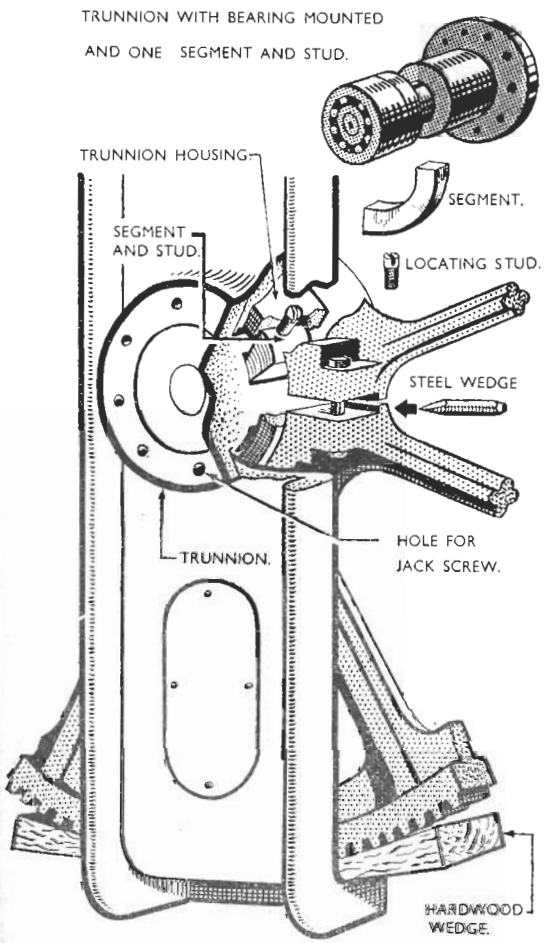

Fig. 22.—Trunnion and bearing assembly.

The trunnion bearing is located by three internal segments which in turn are maintained in position by three slotted studs (grub screws) which pass through the trunnion housing. To expose these, the inner cylinder should be gently turned by hand until the head of the grub screw can be seen through the split hub of the spur wheel. This grub screw should be removed and the procedure repeated for the removal of the remaining two.

The nuts holding the trunnion to the bracket should then be removed and set bolts inserted in the holes provided for this purpose to "start" the trunnion from the bracket face. When the trunnion is completely withdrawn from the housing, the roller bearing should be removed in the normal manner for examination.

Important.—The locating segment studs must be removed before attempting to withdraw the trunnion, as bursting of the trunnion flange will otherwise occur.

To replace the trunnion, reverse the procedure.

After running for a few hours, the nuts on the spur wheel should be tested and further tightened if necessary.

FRONT BEARING (*Fig.* 23)

(*a*) *To inspect.*—Unscrew the door switch from the outer door frame and remove the door switch unit. The hexagonal set screws on the outer door frame should next be removed. The whole door assembly can then be withdrawn, leaving the front bearing exposed.

(*b*) *To remove.*—First remove the rectangular cover plate on the front end frame in order to gain access to two in number hexagon head brass plugs fitted on the bottom rim of the outer drum. The two brass plugs should be removed and replaced by hexagonally headed steel set screws (½-in. Whitworth, 3 in. long). Screw up gently on the set screws until they are just in contact with the underside of the inner cylinder. When contact is established, no further tightening should take place as the purpose of these bolts is merely to hold the inner cylinder in position when the front bearing is removed. Undue tightening will cause distortion.

Important.—The cylinder must be supported in the manner described before attempting to withdraw the bearing as otherwise sagging of the cage with consequent damage to the trunnion assembly will result.

(*c*) *To remove outer track.*—The outer track is attached to the front end plate. The front angle

beading (if necessary) and the hopper should first be removed. The hexagonal screws holding the front end plate should then be taken out. The front end plate can then be withdrawn. The outer track can be dismantled independently.

(*d*) Reverse the procedure for re-erection taking care to make good all joints.

Note.—The brass filling plugs for the jacking screw holes must be re-inserted when the steel jacking screws are removed.

(*e*) If wear is detected on the bearing face of the outer rack (normally at the lowest position), this can be countered each time by turning the track round on its fixing screws in steps of 15° through a full circle of 180°—thus preventing twelve fresh contacting surfaces to minimise wear.

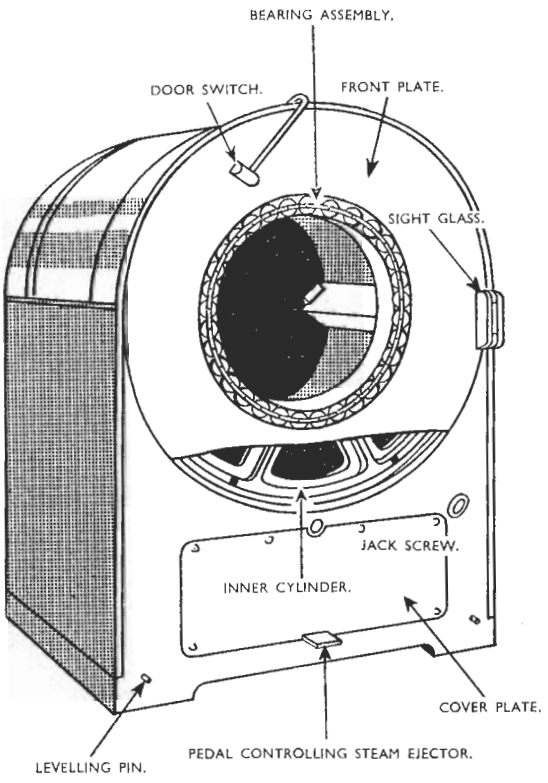

Fig. 23.—Front bearing assembly.

SEALS

Sealing is effected by an external seal of the split type which is automatically compensated for wear. The seals are located behind the main driving wheel (Fig. 24), and form contact with the trunnion housing.

To remove the seal, first ease back the spur wheel. Remove the nuts holding the seal in position and pull forward until clear of the studs. Remove the two cheese-headed screws thus allowing the seal to be disconnected in two halves.

To replace, reverse the procedure.

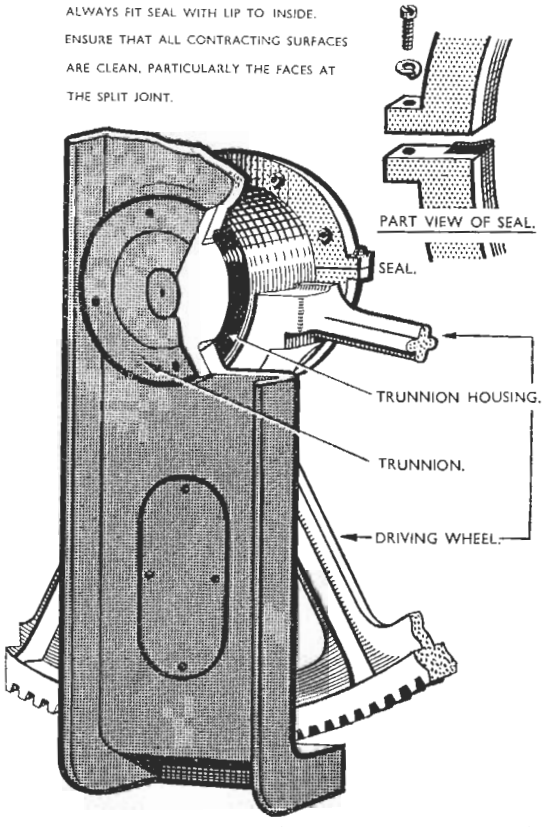

Fig. 24.—Arrangement of seal on the trunnion housing.

OTHER TYPES

19. Dual electric and steam-heated type

One of the main difficulties associated with the installation of laundry facilities in destroyers, frigates, etc. is the provision of equipment which will cater for harbour conditions when no steam is available. With the maker's co-operation the Admiralty has developed a dual-purpose 40 lb. capacity end-opening type machine for

(*a*) Steam heating of water at sea
(*b*) Electric heating of water in harbour.

The machines are similar to the end-opening type washing machine previously described. The main drive, method of reversing and provision for woollen washing by the electrical interruption of the timing cycle is as detailed in paragraph 19(*a*).(*b*).

Steam heating of the water is arranged in the normal way by means of a boiling nozzle. Electric

heating of the water is arranged by means of heating elements having a total loading of 12 kW. and contained in a tank fitted to the underside of the outer cage of the machine. A magnetic type float switch is fitted in this tank to protect the heating elements. When the water is discharged from the machine, the float lowers and the switch automatically breaks the electric power circuit to the elements. Similarly, on refilling the machine, the float is raised and the switch contacts in and completes the power circuit to the heater. The electrical supply to the heating elements can also be hand controlled by a direct on-and-off switch mounted on the front of the washing machine. This hand control should be used in all circumstances thus leaving the float switch to act in the capacity of a safety device only. A pilot lamp fitted to the front of the machine indicates the heater "on" or heater "off" condition.

20. The washing process using electric heating is slower than with steam heating. The effective use of the machine depends upon the availability of an adequate supply of hot water from external sources. An electrically heated calorifier 16 kW. loading and capable of an output of 50 galls. per hour at 160° F. is provided. Care must be taken to draw off only such quantities of hot water into the washing machine as are actually required throughout the various stages of the cycle in order to preserve a continuous supply of hot water. Because of the time factor and in view of the need for balanced draw off from the calorifier detailed instructions in the use of the unit have been compiled for separate issue to the "users."

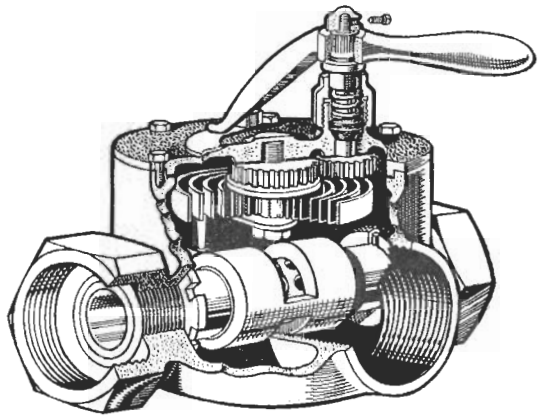

Fig. 25.—Sectional arrangement of thermostatic steam and water mixing valve.

21. Domestic washing machines

Domestic washing machines of the fully automatic type are at present installed in certain destroyers and minor vessels. Full details of the method of operation and of the maintenance of these machines are contained in the maker's comprehensive servicing manual copies of which are issued to all vessels in which such machines are installed.

STEAM AND WATER MIXING VALVES

22. Increased use is being made in H.M. ships' laundry installations of steam and water mixing valves, the valve in general use being the Leonard Type T.S. thermostatic steam and water mixer. The T.S.50 is used in small vessels equipped with domestic washing machines and the T.S.200 in major vessels in

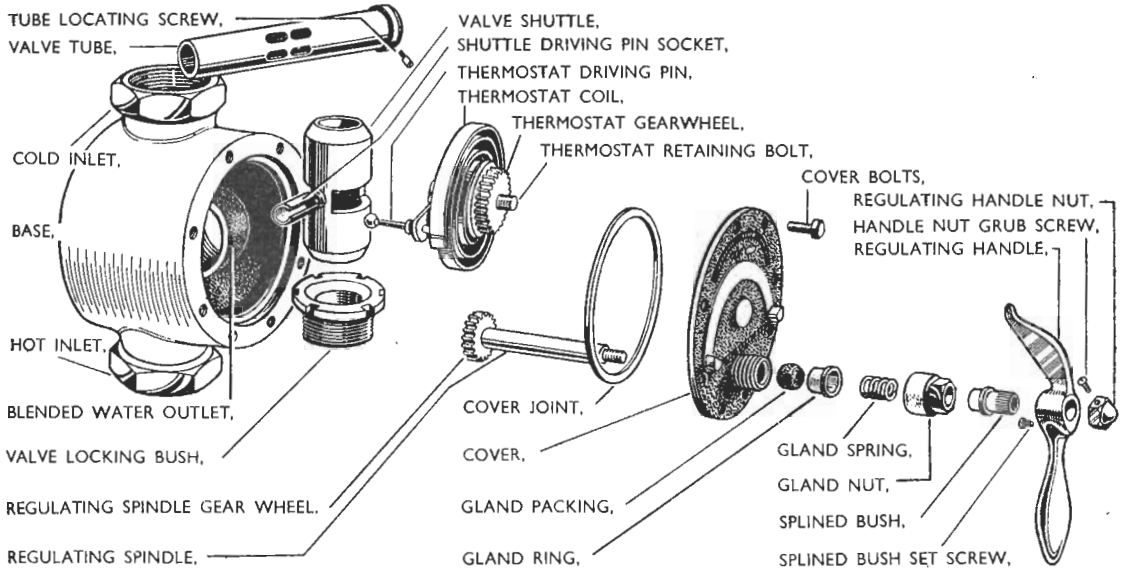

Fig. 26.—Exploded view of thermostatic steam and water mixing valve.

association with the " fresh and salt water washing equipment " fitted to washing machines of 12½ cu. ft. capacity and above.

The mixing valve is capable of providing an instantaneous flow of water at temperatures ranging from cold to a maximum of 180°F. thus ensuring the means to conduct each washing or rinsing process at the temperature prescribed in the washing formula.

23. Action

Variation in temperature is controlled by movement of the regulating handle between the cold and hot positions. Within the mixer a bimetallic coil winds or unwinds according to the temperature of the water in the mixing chamber and in so doing, opens or closes the ports admitting the steam and cold water. If the outlet temperature tends to rise, the thermostat cuts down the steam supply and thus increases the admission flow for the cold water; alternatively, if the outlet temperature tends to decrease, the thermostat control cuts down the cold water supply, thus increasing the area for steam admission.

24. Maintenance

Scale deposit on the moving parts of the mixer may occur through various factors. Should the valve shuttle become sealed up, it will be necessary to remove the cover, tube, and shuttle, and clean the bearing surfaces with a suitable scale removing fluid.

When re-assembling it is extremely important that the thermostat driving-pin is correctly meshed in the shuttle driving-pin socket. The closing up of the cover and thermostat should be carried out separately by fitting the thermostat before replacing the cover and not both together as one unit.

25. Regulation of temperature

It should be noted that the regulating handle controls the temperature only and cannot be used to control the outflow of hot water. If it is found that the maximum temperature (of 180° F. or lower as required) cannot be obtained with the regulating handle against the HOT stop, proceed as follows:—

Slacken the grub screw, remove the regulating handle nut and draw the handle off the thermostat spindle. Remove the small set screw which holds the splined bush in the handle. Remove the splined bush and slide it back on to the thermostat spindle. Replace the handle and move this splined bush around until the required maximum temperature is being delivered by the mixer. Slide the regulating handle back on to the splined bush without altering this setting so that the handle comes up against the HOT stop screw. Remove the handle and splined bush simultaneously. Tighten down the set screw. Replace the handle and splined bush in the spindle and tighten down the regulating handle nut and grub screw.

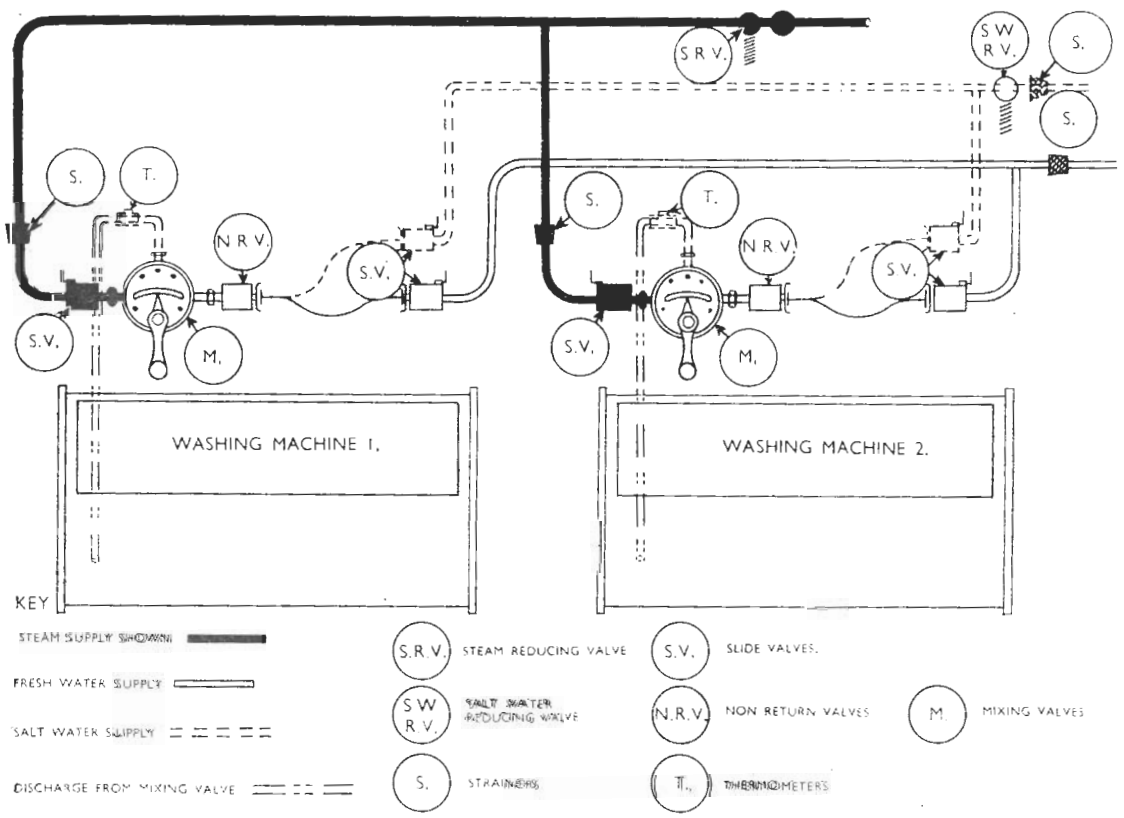

Fig. 27.—Piping arrangement of steam and water mixing valve with fresh and salt water washing connections.

The mixer will then deliver the required maximum setting of blended water.

26. Operation (*in connection with the salt and fresh water washing equipment* (*Fig.* 27)).

(*a*) To supply hot salt water:

(1) Couple the flexible hose from the slide valve on the salt water line to the N.R.V. on the inlet side of the mixer.

(2) Open the slide valve and allow salt water to flow into the mixer BEFORE

(3) Opening the slide valve on the steam supply to the mixer.

(4) Adjust to the required temperature by means of the regulating handle on the mixer. The temperature reading can be obtained from the thermometer on the outlet pipe.

(*b*) To change from salt to fresh water supply:

(1) Close the steam slide valve BEFORE

(2) Closing the slide valve on the salt water supply pipe.

(3) Disconnect the flexible hose from the salt water supply valve, and

(4) Reconnect the hose to the fresh water supply line.

(5) Open the steam supply valve.

(6) Adjust to the required temperature by means of the regulating handle on the mixer.

Note.—The details contained in this para. are for possible future information only as it is not intended to introduce sea water washing formulae in the immediate future—see also Chapter IV, para. 6 (*b*) (iii).

27. Scheme of piping (*for mixing valves working in conjunction with a battery of Bendix domestic washing machines*).

The diagrammatic arrangement of piping, Fig. 28, permits:

The operation of all four machines with hot water from the mixing valves.

The operation of any individual machine with hot water from either mixing valve.

The operation of all four machines or any individual machine with hot water from the ship's domestic system or from the separate hot water supply for laundry purposes when working under harbour conditions, *i.e.*, with no steam available.

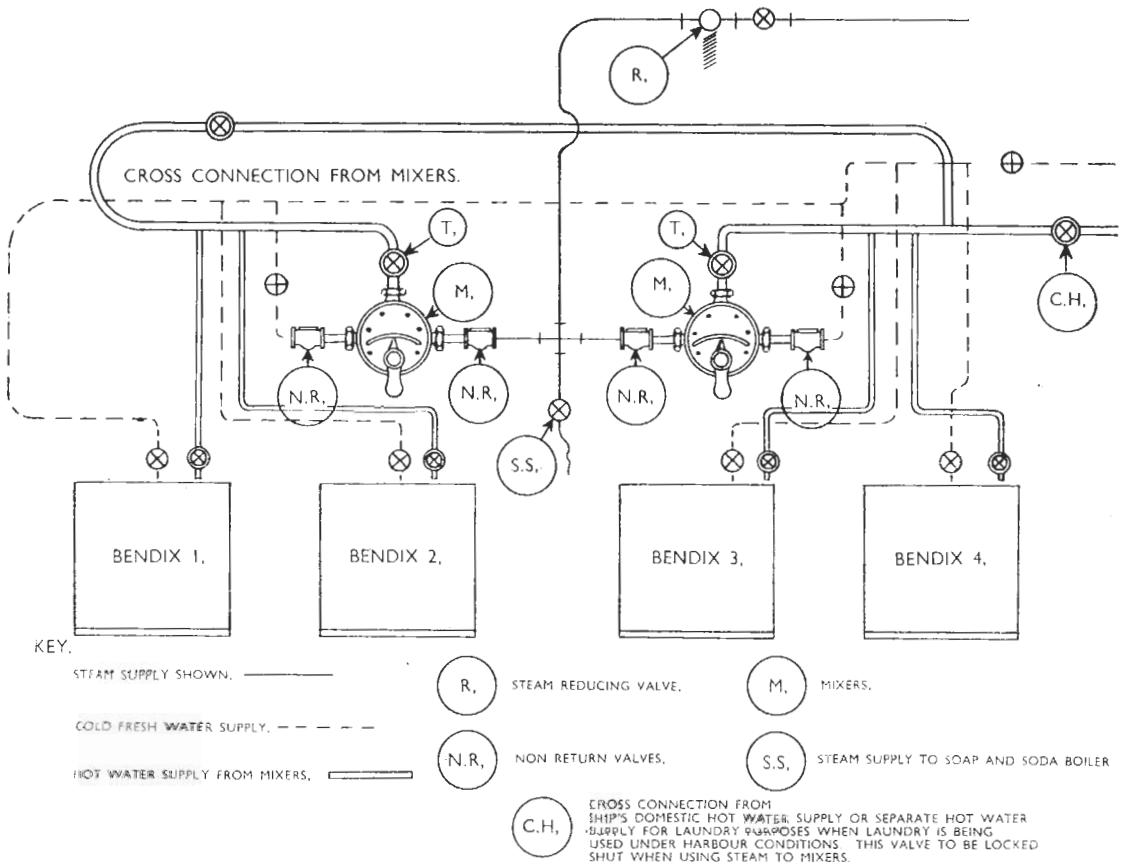

Fig. 28.—Piping arrangement for 2 in No. mixing valves working with Bendix domestic washing machines.