Chapter 2

FREIGHT HAULAGE WINCH

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

LEADING PARTICULARS

Freight haulage winch	**Ref. No. 26DF/2662**
Maximum cable load	5900 *lbs.*
Weight	302 *lbs.*
Supply voltage	24*V d.c.*
Maximum current	250*A*
*Lubricating oil O.E.P.*70, *N.A.T.O. No.* 0.155	*Ref. No.* 34B/9100539

Introduction

1. The electrically operated loading winch (*fig.* 1) is provided for general freight-handling operations, and was designed originally for the Beverley aircraft. Specific functions of the winch are as follows:—

(1) To haul up the ramps and into the freight compartment any wheeled or tracked vehicle weighing up to 25,000 lb. which is not self-propelled, or which is not capable of climbing the ramps under its own power, or which is unserviceable.

(2) To haul heavy items of freight, such as crates or machinery into the freight compartment, possibly in conjunction with the roller conveyor.

(3) To haul supply-dropping platforms from a lorry or trailer on to the roller conveyor on the freight compartment floor.

(4) Unloading the foregoing in conjunction with a snatch-block.

DESCRIPTION

Winch assembly

2. The winch is a self-contained assembly with its electrical control gear and requires attachment to the freight floor at two of the standard 10,000 lb. lashing points which may be disposed fore and aft or athwartships. The body is a zinc zirconium magnesium casting which completely encloses the mechanism and carries a removable superstructure

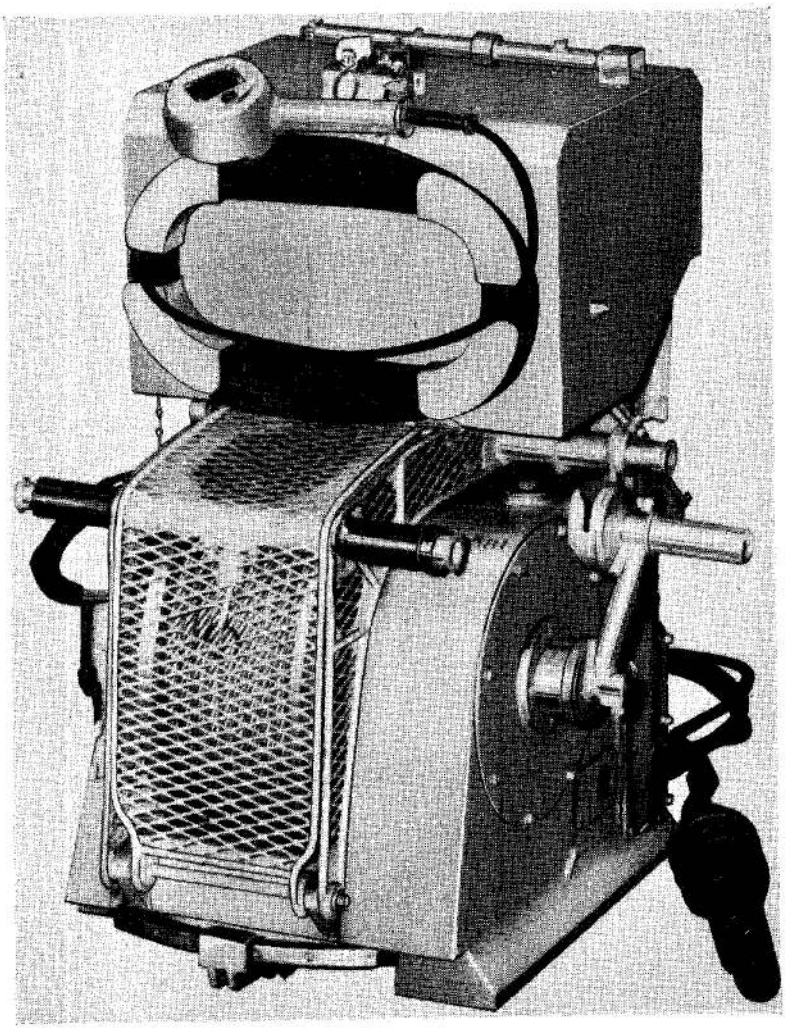

Fig. 1. General view of winch

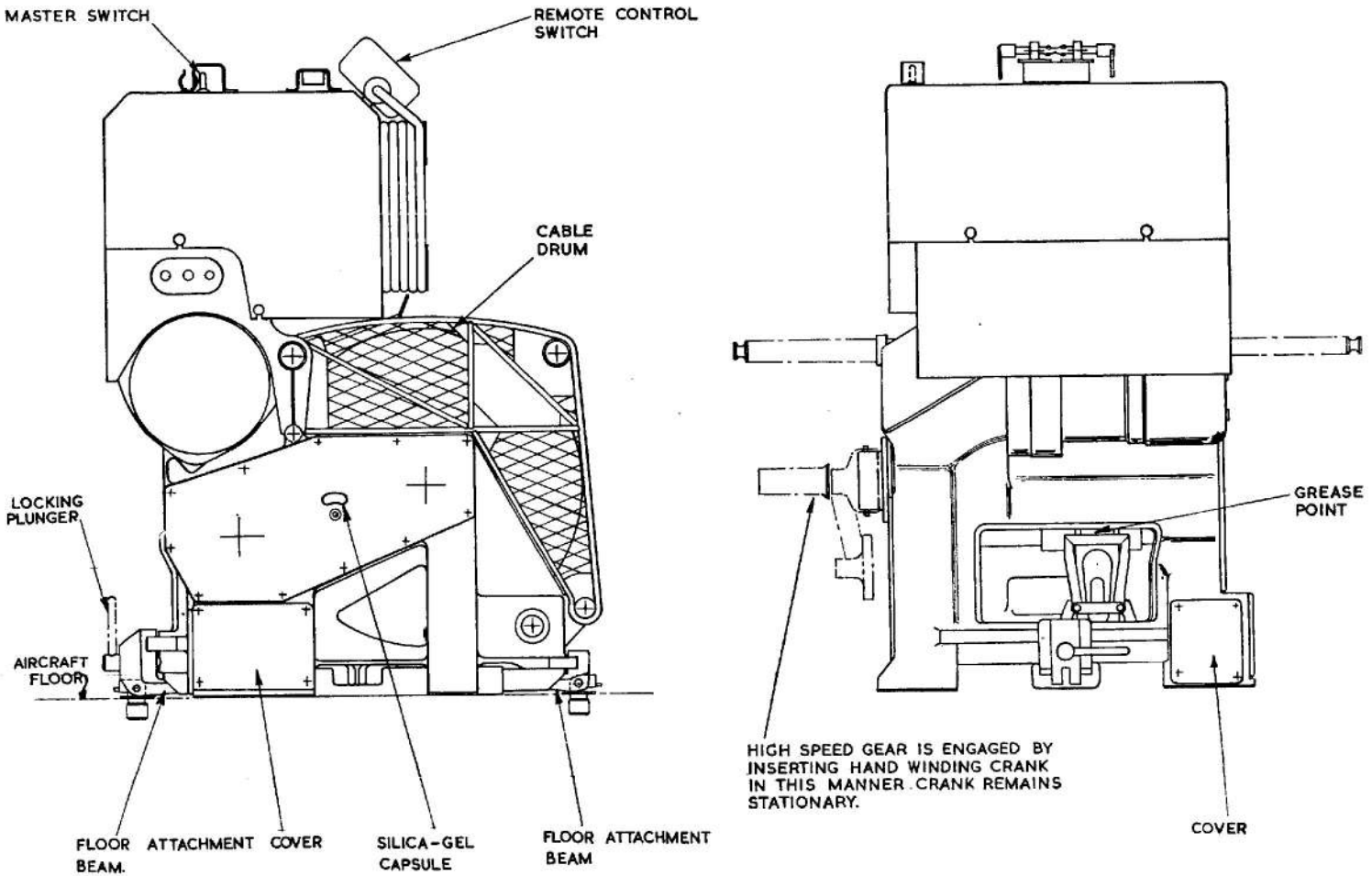

Fig. 2. Front and side view

consisting of an expanded metal guard, a sheet metal casing containing the electrical control gear, and the lifting and slinging handles. The body has a base of ample size for stability and is rotatable through 22½ deg. either side of its mean position with provision for locking at every 7½ deg. by means of the plunger (*fig.* 2). The maximum cable angle relative to the body centre line in the horizontal plane is 22½ deg. either way, and this in conjunction with the variable body angle and choice of floor connections permits the cable to operate in any required direction; the maximum cable elevation is 20 deg. Complete instructions for installing and operating the winch are contained in A.P.4213D, Sect. 1, Chap. 2.

Cable

3. The cable is B.S.-W9 (160 cwt. preformed), 115 ft. in length with a cylindrical swaged slug at each end for attachment, either to the winch accessories, or to the drum. A slot in the drum flange connecting the outer periphery to an internal recess allows the cable to be attached directly to the drum without dismantling.

Main drive

4. The mechanical portion of the power system is illustrated in fig. 3, the reversible motor A drives (via bevel gearing B & C) a wormshaft D meshing with a wormwheel E, the latter is normally connected to the pinion F of an epicyclic system with a stationary gear H and planetary gears G housed in the drum J. For assembly purposes the drum is detachable from one of its flanges K; the whole drum assembly is carried in spherical roller bearings L. The arrangement described above is the drive for normal power hauling; if the handle is applied as in fig. 1 the shaft M is drawn out of engagement with the wormwheel E, permitting the cable to be hauled out manually, or rewound by means of the handle (the cable cannot be payed out by the handle, which is designed to slip off the shaft, if operated in the wrong direction). Attaching the handle as in fig. 2 disconnects the epicyclic gear and provides a straight-through drive from the wormwheel to the drum with a greatly increased speed suitable for rewinding under power.

Lubrication system (*fig.* 3)

5. Incorporated in the wormshaft lower bearing assembly is a low pressure reversible gear pump P delivering oil from the sump Q through the centre of the wormshaft D to the bevel gear C from whence it is centrifuged out, some of the oil descends on to the wormwheel and the wormshaft upper bearing and some drains to the interior of the drum. The oil used is O.E.P.70 (Ref. No. 34B/9100539).

Corrosion inhibition

6. The lubricant is of a type which can maintain a thin film on a metallic surface for a considerable time, but this may not be sufficient protection against corrosion for parts which, by reason of their function, cannot be plated, particularly when stored for long periods in a humid atmosphere. For this reason certain metallic parts are phosphate coated and an air drier has been included in the breather system, the arrangement being such that the only inward air passage is through a silica-gel capsule (*fig.* 2).

Traverse gear

7. Cable winding is controlled by a traverse gear, this consists of chain and sprockets driving a shaft from the drum with a reduction ratio of 3 : 1. Sliding on the shaft is a carriage which acts as a travelling guide for the cable and is actuated by a follower engaging in a double helical groove. A reasonable cable tension is maintained between the traverse guide and the drum even though the cable outside the winch is slack. This is achieved by trapping the cable between two surfaces, one of which is in the form of a free wheeling pulley mounted on a spring-loaded arm on the traverse guide, and the other being the upper surface of the cable eye. The pulley free wheels with the cable emerging from the winch, but during winding the cable has to slide over the pulley.

Stop gear

8. Limit switches are provided to stop the motor under certain critical conditions. Fig. 4 shows the arrangement of the stop gear; when the maximum allowable length of cable has been payed out in a lowering operation a block B on the traverse gear chain occupies a position on the traverse shaft sprocket such that the cam D is caused to swing outward from the shaft centre and depress the tappet F, thus tripping the limit switch in the motor reverse circuit but permitting the motor to be switched on in the winding direction. A similar combination, A, C and E stops the winding drive when the drum is full. These mechanisms, being driven from the drum, are unaffected by changed settings of the intermediate gearing and therefore cannot get out of phase. It is

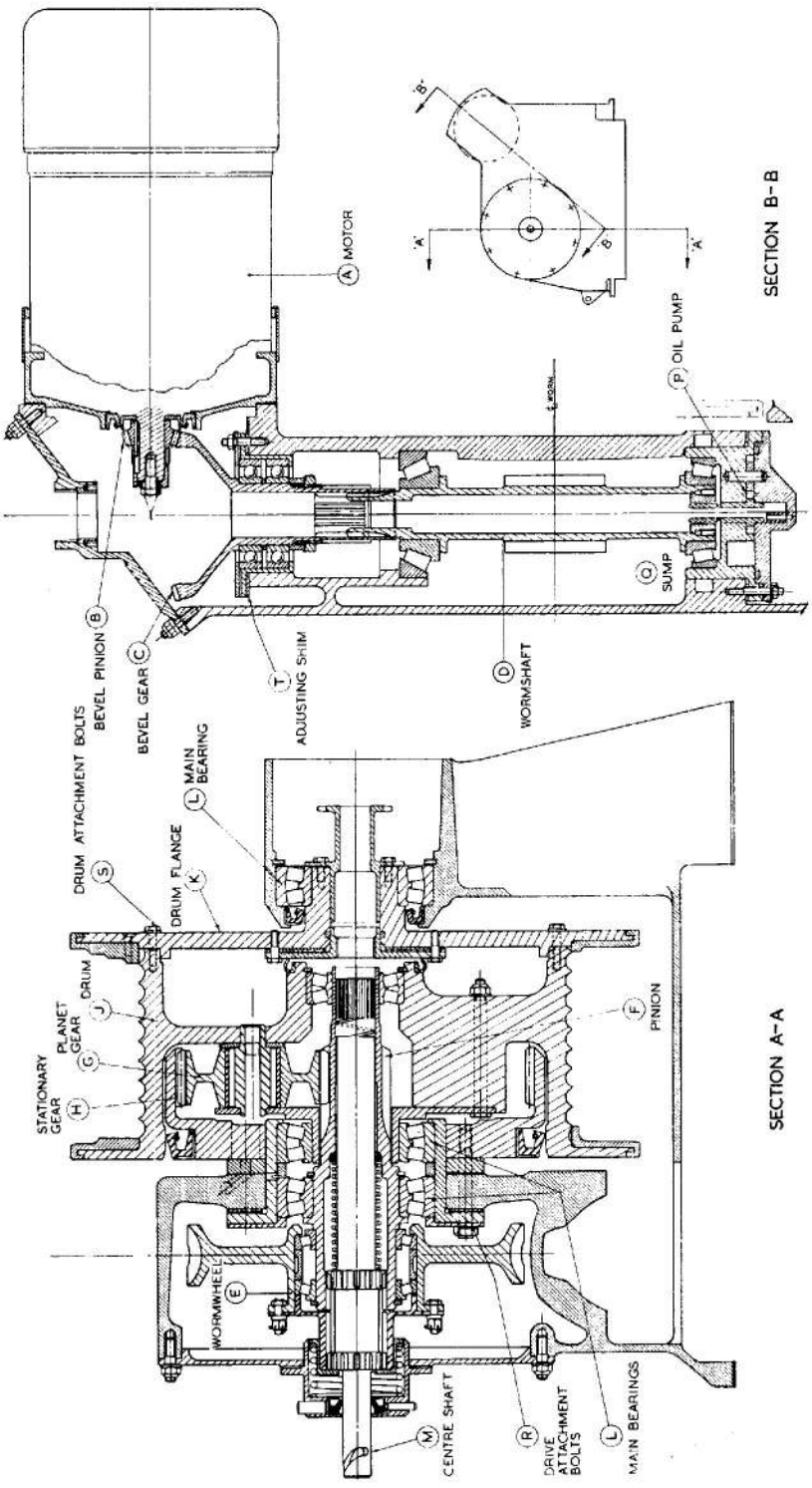

Fig. 3. Sectional view

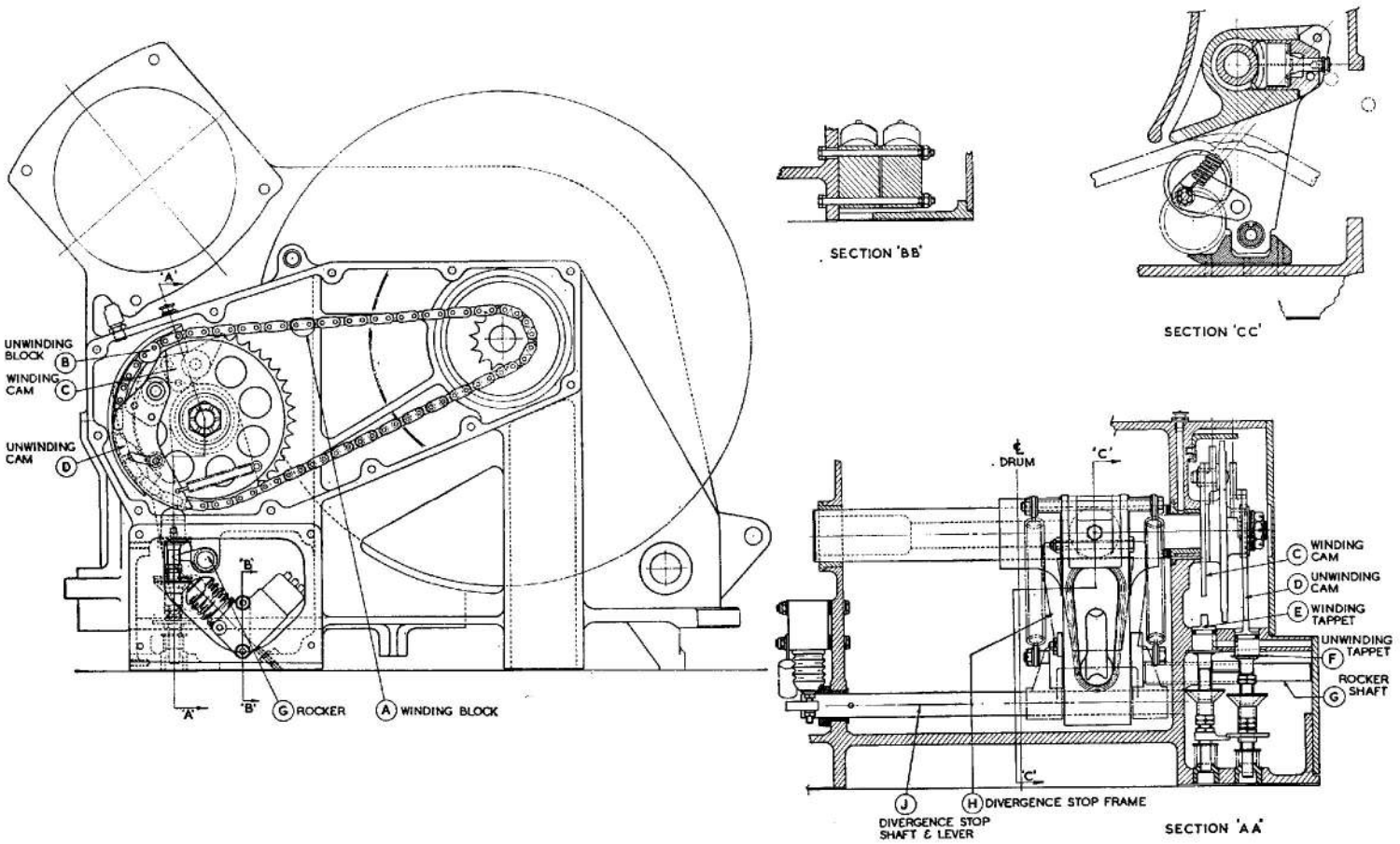

Fig. 4. Timing and stop gear

possible however for the limit switch positions to be overrun manually, but only with cable removed from the drum. This can only occur during servicing when a routine check of the timing would be customary before putting the equipment back into use.

9. The unwinding stop cam D has two phases of operation, the initial phase stops the unwinding action of the minimum cable-wrap for load sustaining leaving the winding operative, further unwinding (as could occur during manual haul-out or when it is necessary to bring the drum to a datum position for timing) brings an enlarged profile of the cam D into contact with tappet F, giving F an increased travel which is transmitted to the other tappet E, thereby tripping the limit switches for winding and unwinding. Since it is not then possible to haul in under power it will be necessary to wind the drum back to a starting position by hand.

10. If the cable could be unwound electrically with no load, unravelling of the cable would occur inside the drum housing; to guard against this the friction pulley is connected by a shaft and rocket G to the tappet F. Slackening of the cable outside the winch allows the friction roller to rise to its upper position, thereby operating the unwinding limit switch.

11. The cable entering the traverse guide has to pass through the divergence stop frame H; an excessive cable angle (vertically due to a load with high cable attachment approaching too closely to the winch, or horizontally due to wrong direction setting) operates a limit switch through a shaft and lever J, (*fig.* 4) and this stops the winding motion.

Floor attachment

12. The floor attachment member (*fig.* 2) is a telescopic beam having a central spigot fitting into the winch body; the ends of the beam attach to the standard 10,000 lb. tie-down points, and the design of the attachment beam allows for small variations in the centre distance of attachment points, and ensures that a horizontal load applied to the winch in any direction is shared equally between the two attachments.

Electrical system

13. The winch is driven by a 24V 5 H.P. reversible motor (*fig.* 3), compound wound with a speed range of 5,300 to 10,000 rev/min. Power is supplied from a ground starter trolley, or from the aircraft batteries supplemented by the A.P.U. Fig. 6 shows the control and power circuit, a master switch J controls the opening and closing of a type D2 circuit breaker C, which acts both as an isolator and an overload protection, current to the motor is via one of two 150A one-way contactors A or B and the starting resistance D, which is connected across the back e.m.f. relay.

14. Two electrically interlocked contactors are used to give forward and reverse operation. Manual control is by a two-way switch M at the end of a wander lead. The power lead is designed to detach at the power source.

15. The remote control switch has a guarded thumb-wheel so designed that the switch can only be operated in one direction for a particular travel position of the wheel; in order to reverse rotation it is necessary to rotate the wheel to its opposite position during which the switch returns to its OFF, position and dwells there long enough for the motor to slow down before being reversed.

16. Modification 460 provides for the fitting of a brake relay unit. The effect of this unit is to provide regenerative braking for the winch motor, so preventing over-run on the completion of a hauling or lowering operation.

OPERATION

Note . . .

Instructions on the installation of the winch are contained in A.P.4213D, Sect. 1, *Chap.* 2

Unwinding cable

17. The winding crank is applied as in fig. 1 and the drum is thereby freed for the cable to be hauled out manually. This requires a pull of approximately 30 lb. When handling vehicles over 14,000 lb. the cable has to be threaded through the guard on the pulley attached to the vehicle and then taken forward to the bridle attachment.

Hauling

18. The remote control switch is the only control required, and the operator can be in

the position best suited for observation. The master switch on the winch, can, if necessary be used as an emergency stop. A difficult loading (as for instance an unserviceable vehicle with defective steering) may require several stops, reversals and restarts with the load on the ramp. The electrical system is rated for four starts during the loading of a vehicle of maximum height. No safeguard is provided on the winch against abuse by repeated inching and caution is necessary. It may be found that the high gear, obtained by applying the crank as in fig. 2 and intended for rewinding, is also suited for hauling small loads; the cable tension however must be limited to 500 lb. The power reverse will only operate when the cable friction pulley on the traverse guide is sufficiently far below its uppermost position to allow the limit switch to close, this requires a minimum cable tension normally of 150 lb. approximately, but increasing without limit as the load approaches close to the winch. A condition may arise on a load with high point of cable attachment hauled well forward, whereby the motor will not reverse to slacken the cable for uncoupling. Should this occur the reverse circuit can be closed by downward pressure on the cable close to the winch. Sufficient force (about 60 lb.) can be applied with the foot. In the event of a power failure with, for instance, a load on the ramp, an emergency shaft is provided which plugs into the splined end of the wormshaft and can be turned by hand with the winding crank. This is adequate for operating the winch under full load.

Re-winding cable

19. This can be done by hand, using the winding crank as applied in fig. 1, or electrically with the crank applied as in fig. 2 (in the latter case the crank remains stationary). The hand motion is provided mainly for use during servicing, when it may not be convenient to connect to the power system.

Electrical system

20. A simplified theoretical circuit diagram may be seen in fig. 5. The complete wiring diagram is shown in fig. 6. Hauling and lowering, or reverse, operations are controlled from the remote control switch. Operating in conjunction with the 150A contactors are a back e.m.f. relay unit and a brake relay unit.

21. A 28V d.c. supply for the winch can be provided either by a ground supply or by the auxiliary power plant. With the supply appropriately connected, current will pass via the winch socket and supply plug which is situated on the starboard side of the freight compartment.

Reversing or lowering operation

22. (1) Place the master switch, situated on the main body of the winch, to the ON position. The Type D2 circuit breaker will now become energized and complete a supply to fuses F2 and F3.

(2) Selecting REVERSE on the control switch will complete a supply to energize the reverse contactor via fuse F2, the control switch, the reverse limit switch (contacts closed with load on hauling cable) and 3-4 contacts of the haul contactor.

(3) With the reverse contactor energized contacts B1-B, A1-A and 1-2 will close, contacts 7-8, 3-4 and the economy contacts will open.

(4) A supply to the motor shunt field winding is completed via fuse F3 and contacts 2-1 of the reverse contactor.

(5) The motor armature and series field winding supply is completed via the main contacts of the D2 circuit breaker, the armature current limiting resistance (D), the motor series field and contacts A-A1 of the reverse contactor. The circuit is completed to negative via contacts B1-B of the reverse contactor.

23. The motor and winch will now commence to turn and the haul limit switch will close. As the motor back e.m.f. increases with speed the armature current will be reduced. The volt drop across resistor D will now decrease to a point where the coil of the back e.m.f. relay unit will be sufficiently energized to close contacts 1-2 and 5-6. Contacts 1-2 short circuit resistor D and allow the motor speed to rise to its self regulated value. Contacts 5-6 complete a secondary supply to the motor shunt field; this will enable back e.m.f. to be generated by the motor to facilitate regenerative braking so preventing overrun at the conclusion of the operation.

24. When the reverse contactor is de-energized, either due to the operation of the reverse limit switch or the control switch, the contacts will be reset to their positions as shown in the diagram. Supply to the motor armature and series field will now be cut off, but the coil of the back e.m.f. relay,

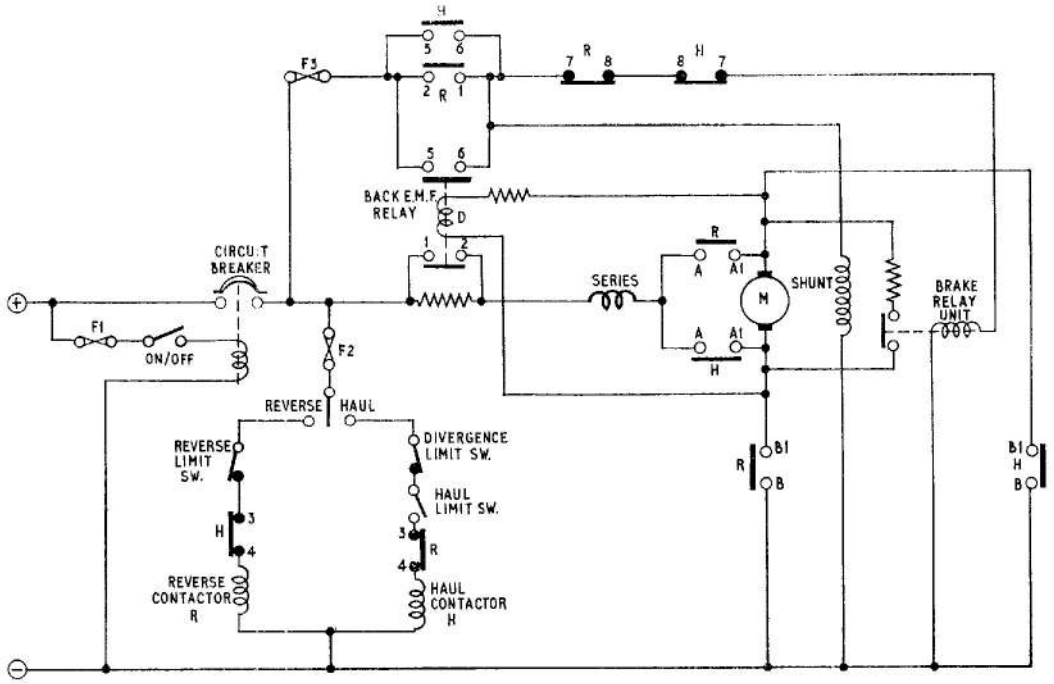

Fig. 5. Simplified circuit diagram

being connected across the motor armature, will remain energized due to the motor back e.m.f., and the motor shunt field will remain energized via contacts 5-6 of the back e.m.f. relay.

25. Contacts 7-8 of the reverse contactor, having now closed, will permit the coil of the brake relay unit to energize, being supplied via fuse F3, contacts 5-6 of the back e.m.f. relay unit, contacts 7-8 of the reverse contactor and 7-8 contacts of the haul contactor. The brake relay unit contacts having now closed will connect a 0·06 ohm resistor across the motor armature. The reverse current flowing through the motor armature, due to the back e.m.f., will interact with the shunt field flux to rapidly decelerate the speed of the motor. As the back e.m.f. decreases the back e.m.f. relay unit and brake relay unit will become de-energized, so disconnecting the 0·06 ohm resistor from the motor armature.

Hauling operation

26. The operation of the electrical system during hauling operations is similar to that during reverse operations but the direction of rotation of the motor is opposite. This is brought about by reversing the armature current, but leaving the direction of the series and shunt field currents unaltered; this will be apparent from the diagrams fig. 5 and 6.

Handling

27. Four telescopic tubular handles are built into the drum guard. These are self locking when extended, and retract automatically when unlocked. When hoisting the winch the sling should be arranged to lift at all four handles.

Capacity

28. The winch and its ancillary equipment (with the exception of the snatch block) are designed for a maximum working cable tension of 7,000 lb. with an ultimate factor of 2·5, giving a fully factored load of 17,500 lb. This applies to the normal gear ratio only, for the high gear the tension must be limited to 500 lb. as previously stated. The permissible snatch block loading varies with the angle of cable wrap on the pulley, and is limited by the strength of the floor attachments. For a wrap of 90 deg. the maximum tension is 5,500 lb. while for 180 deg. it must not exceed 4,400 lb. The angle of wrap is estimated from ridges cast on the pulley rim.

SERVICING

General

29. The winch should be examined for signs of oil leaks, particular attention should be paid to the base of the magnesium casting and the centre shaft plate. The winch should also be inspected for indications of fractures and other structural damage.

Lubrication

30. The level of the oil OEP.70, as seen through the oil level inspection window, should be replenished if it is more than $\frac{1}{4}$ in. below the top of the window. Lubricate the traverse shaft, rocker arm shaft and divergence stop shaft with Grease XG-275 (Ref. No. 34B/9100513), and the timing chain and sprocket with Oil OX14 (Ref. No. 34B/9100590).

Motor

31. The commutator should be free from signs of burning and pitting; it may be cleaned with lead free gasolene, applied on a rag of non-fluffy material, if grease or dirt has to be removed. To remove carbon dust deposit from the commutator and brush housing a forced jet of clean dry air should be used. The brushes should be free from contamination with oil or grease, their length should not be less than 60 per cent of the original length when new, and they should be properly bedded to the commutator surface. The brush springs should be inspected for signs of rust and deterioration. All electrical connections should be secure and insulation free from signs of damage or deterioration.

Insulation resistance test (250V)

32. The minimum insulation resistances with the motor leads disconnected are:—

(1) Between field, armature and frame 50,000 ohms.

(2) Between poles and frame 1·5 megohms.

Limit switches

33. Examine the limit switches for damage, ensure that the rubber gaiters are free from cracks and oil contamination, and that the micro switch actuating adjustment bolts are secure and locked.

Circuit breaker and contactors

34. The contacts of the circuit breaker and the reverse and haul contactors should be inspected for indications of burning or pitting. Contact cleaners (Ref. No. 1/H139-141) may be used to burnish the contacts if required.

Cables (electrical)

35. All cable insulation, particularly that of the remote control switch cable should be carefully examined for damage and deterioration.

Remote control switch

36. The remote control switch, although of robust construction, is particularly liable to rough usage and should be carefully inspected for damage and for security of the cable connections.

Hauling cable

37. Examine the hauling cable for damage due to kinks and chafing. Reference should be made to A.P.2817A, Vol. 1 & 6, Part 1 for further information on cables.

Silica-gel crystals

38. Check the crystals for discolouration in the sighting glass; the crystals must be changed if they become pink, this requires removal of the timing chain cover plate.

Winch external finish

39. Ensure that the external finish of the winch is maintained in good condition; any damage to the finish which penetrates the paint film will cause corrosion of the magnesium alloy body. Repairs to the finish must be in accordance with A.P.2662B, Sect. 9, Chap. 9.

OPERATIONAL TESTING

Reverse operation

40. Carry out reverse operation with a load of 50 lbs. attached to the cable. Run the cable off the drum and ensure that the reverse limit switch operates to stop the motor when approximately two turns of cable remain on the drum. During this operation inspect the bevel gear through the upper observation window and ensure that it is being lubricated.

Haul operation

41. Carry out hauling operation with a load of 50 lbs. attached to the cable. Ensure that the haul limit switch operates and motor stops with the load approximately 5 ft. from the winch.

High speed haul operation

42. After running out the cable until the reverse switch has operated, fit the handle

for high speed power winding. Repeat the operation as in para. 39 and ensure that the motor stops with the load approximately 5 ft. from the winch.

Divergence limit switch testing

43. After unwinding approximately 15 ft. of cable re-wind using the motor, during this operation lift the cable approximately 30 deg., the divergence limit switch should now operate causing the motor to stop.

Note . . .

Unless artificial cooling is provided, the winch runs should be limited to one minute each, followed by a five minute cooling period; this is to prevent damage to the motor armature.

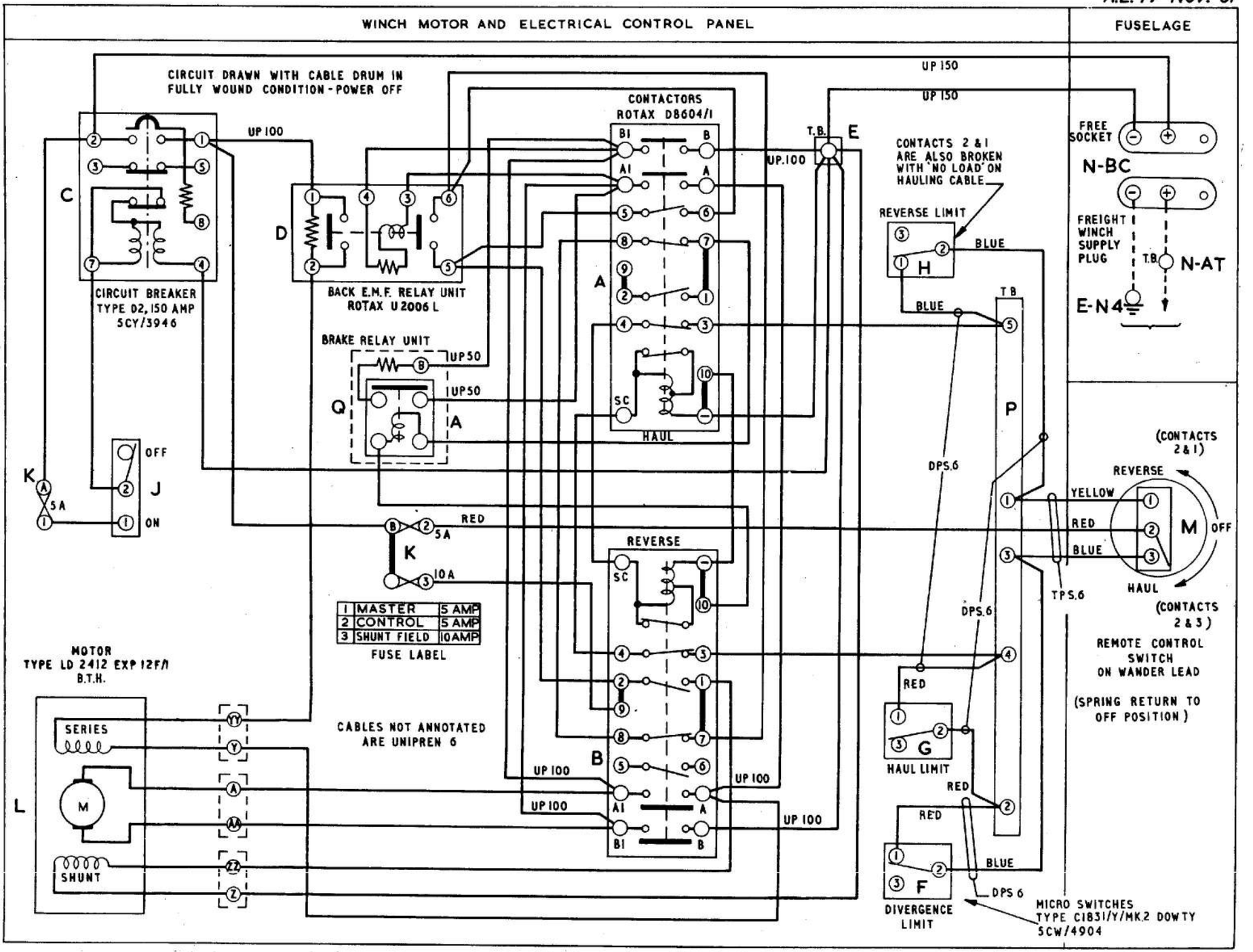

Fig. 6 Electrical system circuit diagram Fig. 6

RESTRICTED