

HYDROLOGICAL PROCEDURE NO. 23

OPERATION AND MAINTENANCE OF CABLEWAY INSTALLATIONS



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Operation and Maintenance of Cableway Installations

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**OPERATION AND MAINTENANCE
OF
CABLEWAY INSTALLATIONS**

**DRAINAGE & IRRIGATION DIVISION
MINISTRY OF AGRICULTURE
MALAYSIA**

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FOREWORD

This manual deals with the standard cableway for river discharge measurement used by the Drainage and Irrigation Department (D.I.D.), Malaysia. It contains all information needed to operate and maintain the cableway in the best possible way. Before operating the cableway, please read through this manual carefully and be familiar with the procedures described.

This is an operation and maintenance manual. It is not intended to be a comprehensive technical manual. However, it will show the operators how to look after the cableway so that trouble or breakdown can be avoided.

For major repair and overhaul operations, work should be performed by specially trained personnel. Trained personnel are available at the Instrumentation Section, Hydrology Branch, Drainage and Irrigation Department, Ampang.

1. INTRODUCTION

One method for the measurement of discharge at a cross-section of of a river is to carry out such measurement with a current meter suspended from a cableway installation. This method offers several advantages:—

- (i) Discharge measurements are performed from the river bank, operators are not exposed to high water or other hazards.
- (ii) Two persons only are required to carry out the measuring operations.
- (iii) Measurements can be performed at all time. The cableways are usually installed above the highest river water level.

There are many different designs of cableways used for river discharge measurements. The design adopted by the Drainage and Irrigation Department is as shown in Fig. 1. Cableways of such design can satisfactorily be used for span of up to 400 metres. The cableways are hand-operated if the spans are less than 120 metres. Otherwise, they are driven by hydraulic drives.

2. DESCRIPTION OF CABLEWAY

2.1 General

The cableway consists of a steel wire rope stretched across the river as the main cable supported by two steel towers or A-frame structures, one on each bank. The current meter and the sinker weight are suspended from the traveller carriage which can be moved along the main cable. A double-drum winch is mounted on the steel tower at the bank from where the discharge measurements are to be taken. A galvanised wire rope as tow cable runs from the traversing drum of the winch to the pulley at the top of the opposite tower and back to the traversing drum to form an endless loop. The traveller carriage is attached to the cable. By the double-drum winch, the current meter and its sinker weight are hauled with the cable from one measuring vertical to the next.

The conductor—suspension cable used to suspend the current meter runs from the gauging drum of the winch. It can be loaded safely with sinker weight of up to 100kg. It is also used to transmit electrical signals from the current meter to the impulse counter.

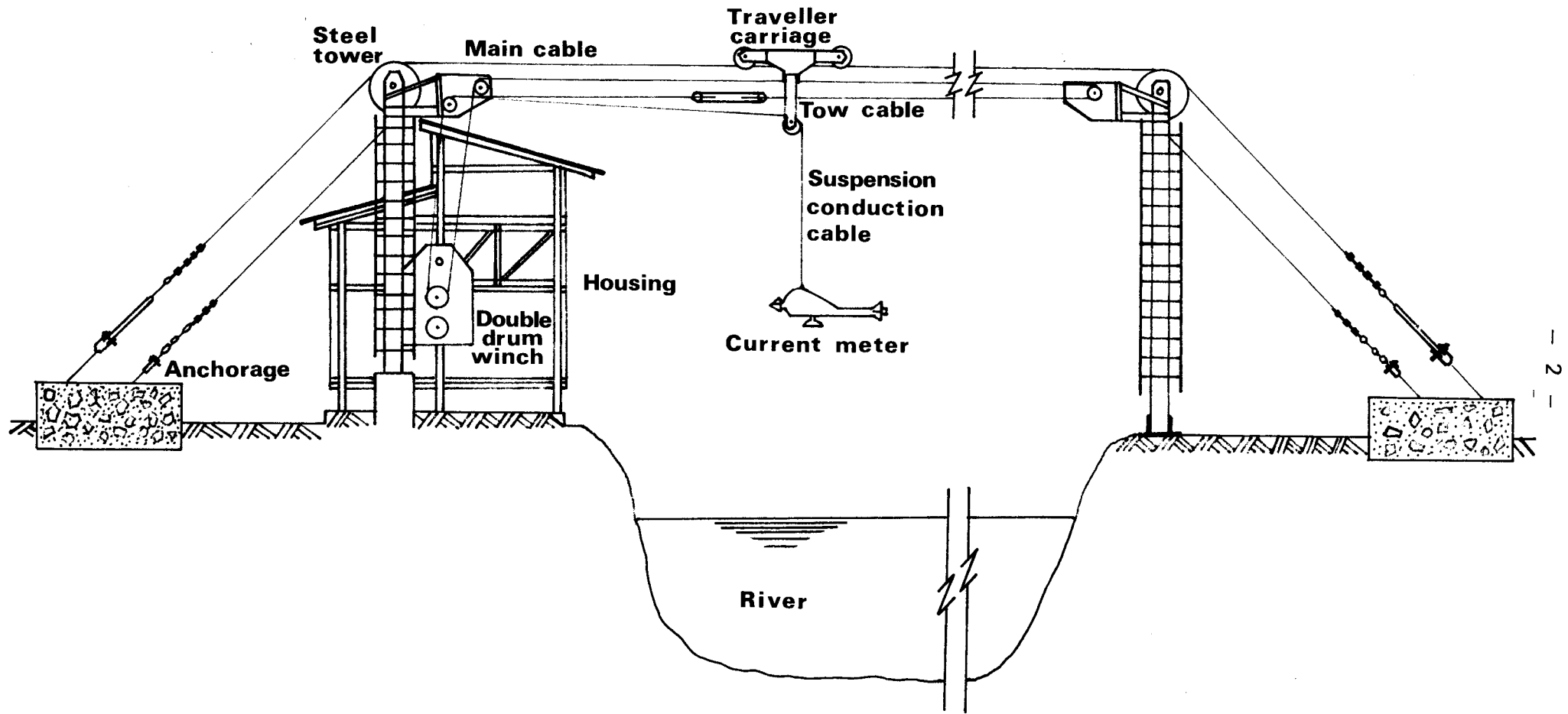


FIG.1— TYPICAL CABLEWAY STATION

2.2 Double—Drum Winch

The main feature of the cableway is the combined traversing and gauging winch unit which is normally known as the double-drum winch. It comprises a gauging drum with conductor—suspension cable and a distance counter and a traversing drum also with a distance counter. Each of the two drums can be operated independently and facility is provided for coupling the two drums when traversing is required. The arrangement has an important advantage that it may be operated easily and quickly by one operator using one winch's crank only.

For details of double-drum winch, please refer to *Appendix 3B, Hydrological Procedure No. 15, "River Discharge Measurement by Current Meter"*.

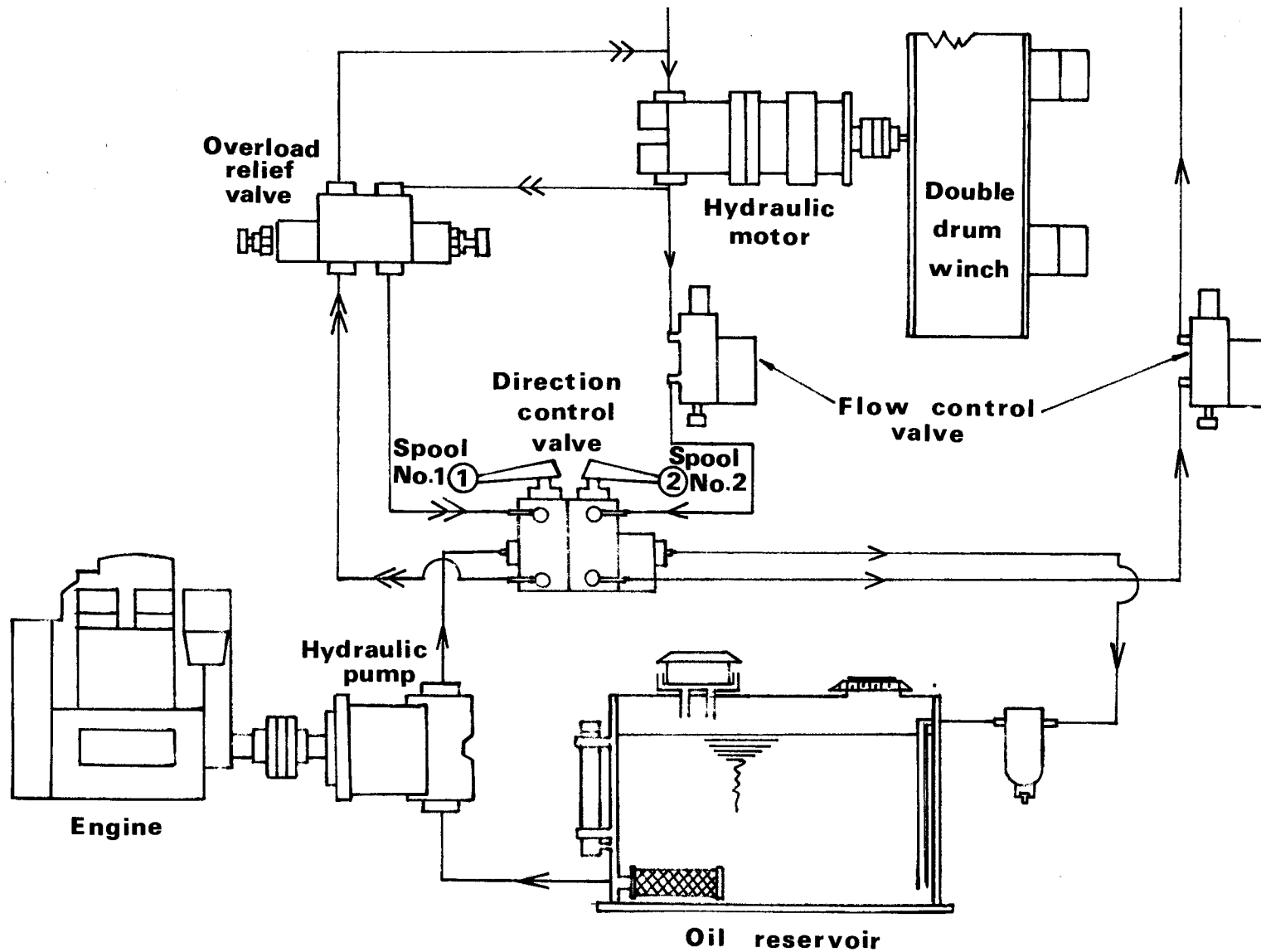
2.3 Hydraulic Drive

For larger rivers, usually with spans longer than 120 metres, where speed of operation is critical and also where heavier sinker weights are needed to prevent drifting of the current meter, the cableways are power-operated. The Drainage and Irrigation Department has designed a hydraulic system to drive the standard double—drum winch.

2.3.1. Operating principles

The basic configuration of the drive is illustrated in Fig. 2. It is an open hydraulic system with reservoir type of arrangement. It consists basically of a reservoir, a pump, a double-acting two spool directional control valve, two flow control valves and a hydraulic motor (Plates 1, 2 and 3). The pump is driven by a 5 hp. petrol engine at the speed of 3000 rpm. With both spools of the directional control valve in neutral or non-operating position, the oil flows through the valve and back to the reservoir.

When Spool No. 1 of the valve is moved in one position, oil is forced into one end of the motor, turning the output shaft in one certain direction, and comes out from the other end and back to the reservoir. In the neutral position, the oil is held under pressure in the two pressure lines to the motor, thus holding it in the position it was in at the time the valve moved into the neutral position. When the spool is moved into the opposite position the oil is forced into the other end of the motor, turning the shaft in the opposite direction.



**FIG. 2 – HYDRAULIC DRIVE SYSTEM FOR
DOUBLE – DRUM WINCH**

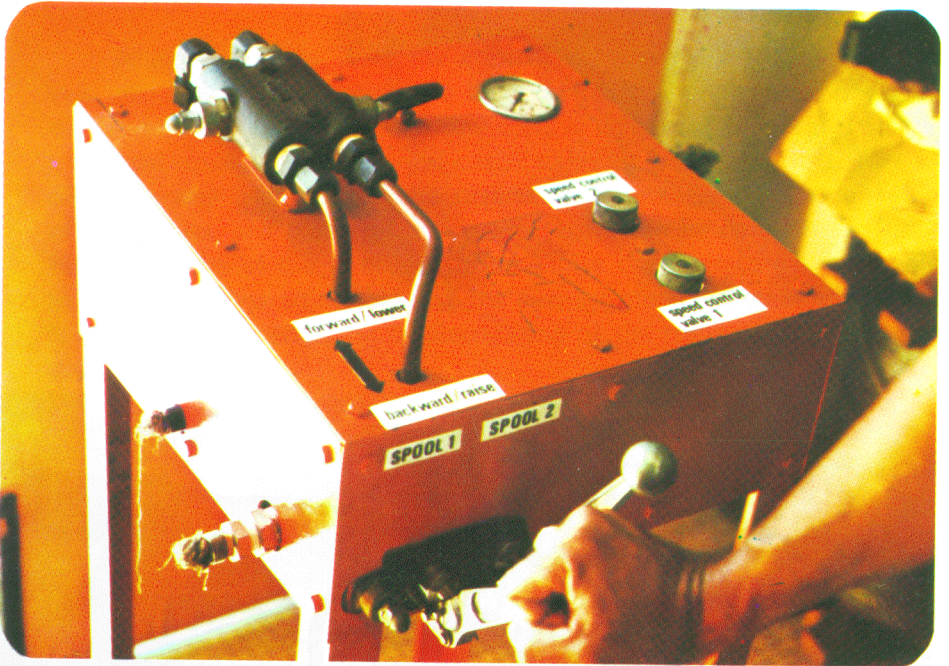


PLATE 1 — CONTROL PANEL OF HYDRAULIC DRIVE SYSTEM

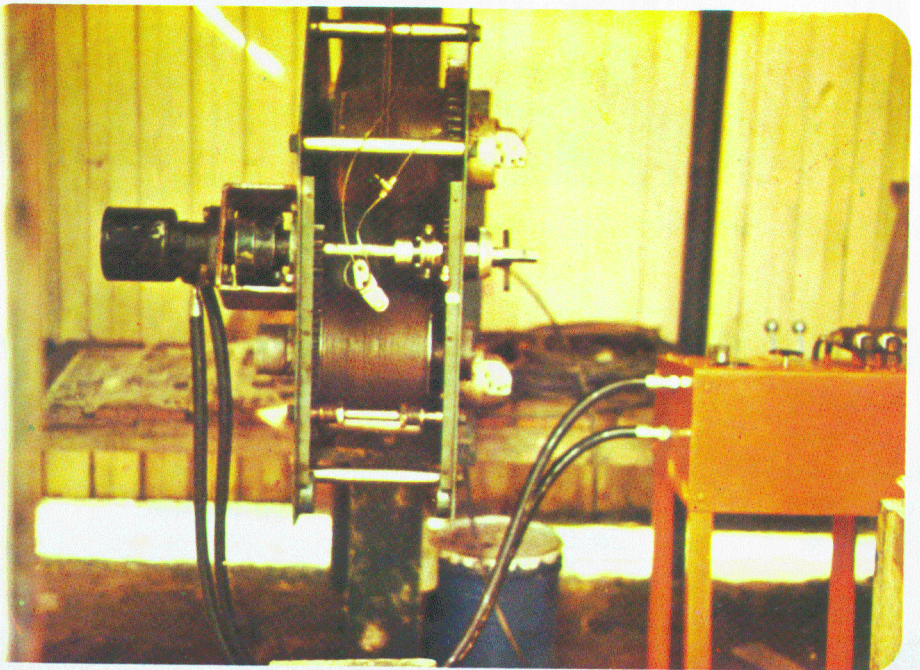


PLATE 2 — DOUBLE-DRUM WINCH DRIVEN BY HYDRAULIC MOTOR

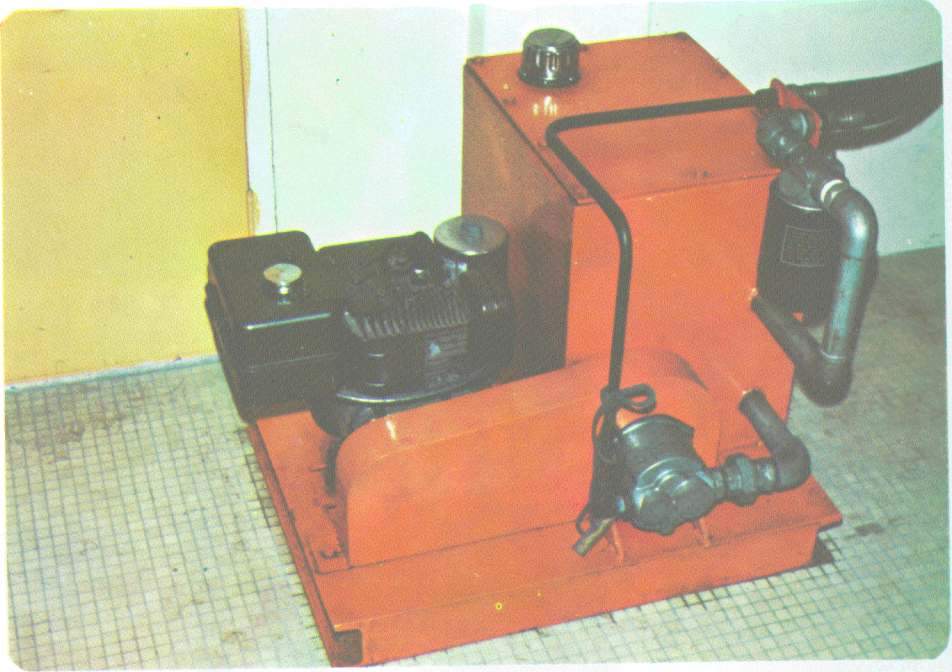


PLATE 3 — POWER PACK CONSISTING OF PETROL ENGINE, PUMP
AND OIL RESERVOIR

When Spool No. 2 of the control valve is operated, oil is forced to flow into the motor through the second circuit where the two pressure lines to the motor are fixed with a flow control valve each. The valve consists of a control knob and an integral check valve to give controlled flow in one direction and free flow in the reverse direction. By regulating the knobs of the valves, the speed of the motor shaft can be controlled. This additional features of the hydraulic drive allows the operators of the cableway to carry out fine adjustment of the current meter position while gauging. It also facilitates engaging or disengaging of the transversing clutch of the double-drum winch.

2.3.2 Specifications

(i) Engine

Type::	4—stroke air cool petrol engine.
Made:	Briggs and Stratton.
Model No.	131431
Capacity:	5 hp. at 3600 rpm.

(ii) Hydraulic pump

Type:	Positive displacement gear pump.
Made:	Cross
Model:	40p005
Max. Speed:	3000 rpm.
Max. pressure:	3000 psi.
Max. torque:	2/5 lb. in.
Displacement:	0.5 cu. in./rev.
Output discharge:	5 gal./min. at 1000 psi. & 2400 rpm.

(iii) Hydraulic motor

Type:	High torque low speed gear motor.	
Made:	TRW CROSS	OR CHAR-LYNN
Model:	MAB 08010	S100CC4
Max. Speed:	550 rpm.	540 rpm.
Displacement:	5.9 cu. in./rev.	60 cu. in./rev.
Max. torque:	1880 lb. in. @ 2000 psi.	1920 lb. in. @ 2400 psi.
Max. working pressure:	2000 psi.	2400 psi.

(iv) Directional control valve

Type:	Level operated enbloc type with spring centre, double acting sliding spool (two), integral check valve and pressure relief valve.
Made:	Cross
Model:	SBA.22.
Max.pressure:	2500 psi.
Max. flow:	30 gpm.

(v) Relief valve

Type:	External adjustable differential poppet relief 1500—3000 psi.
Made:	Cross
Model:	SRC—A
Max.pressure:	3000 psi.
Max. flow:	30 gpm.

(vi) Speed control valve

Type:	Non-pressure compensated with control knob and integral check valve to give controlled flow in one direction and free flow in the reverse direction.
Made:	Parker Hannifin
Model:	F—800—S—10
Max. pressure:	2000 psi
Max. flow:	100 gpm.

(viii) Return line filter

Type:	Spin—on/throw away cartridge filter.
Made:	Cross
Model:	SAF 28G16P.
Element:	33 micron filter element.

3. OPERATING INSTRUCTIONS FOR CABLEWAYS

The technician in charge of the gauging operation should assume the responsibility of care and upkeep of the cableway installation. There are several rules which must be observed while the cableway is being used. Failure to adhere to these rules can have harmful effect on the parts and service life of the cableway.

The technician should also be familiar with the operating instructions of all associated gauging instruments such as current meter and revolution counter etc. as well as the method of river discharge measurement making use of the cableway. *Please refer to Hydrological Procedure No. 15 — ‘River Discharge Measurement by Current Meter’ which gives details of both.*

3.1 Hand—Operated Cableway

The following procedures should be followed when operating a hand—operated cableway:—

- (i) Before each gauging operation, lubricate all bearings of the double—drum winch. Oil lubricating points are provided on all bearings of drum shafts of the winch. For the bearings of the pulleys, grease nipples are provided.
- (ii) Check automatic load—pressure brake of the winch’s crank. Adjust brake releasing screw clearance if necessary. It should be approx. 10 mm.
- (iii) Check brake linings. Replace them if they are badly worn.
- (iv) Connect revolution counter to the slip-ring housing of the winch.
- (v) Assemble current meter and sinker weight on the hanger bar. Roll out some cable from the gauging winch and over the lower pulley of the traveller, secure the cable to the hanger bar. Connect the angle plug to the current meter.
- (vi) Check transmission of electrical impulses from the current meter by giving its propeller a slight spin. Electrical impulses generated by the current meter should operate the counter. If it does not, carry out test as described in Section 4.1(iv).
- (vii) Carry out gauging operation as described in Hydrological Procedure No. 15 — “River Discharge Measurement by Current Meter”.

3.2 Power--Operated Cableway

The following procedures should be followed when operating a power--operated cableway:—

3.2.1 Before starting engine

- (i) Lubricate all bearings of the double--drum winch.
- (ii) Assemble revolution counter, current meter and sinker weight to cableway.
- (iii) Check transmission of electrical impulses from current meter to the revolution counter.
- (iv) Check crankcase oil level. Top up if necessary.
- (v) Fill fuel tank. Use only "regular low--lead" grade petrol.
Do not mix oil with petrol.
- (vi) Check hydraulic oil reservoir level.

3.2.2 To start engine

- (i) Open fuel valve on tank.
- (ii) Move choke level as indicated.
- (iii) Move STOP switch away from spark plug.
- (iv) Move throttle level to $\frac{1}{4}$ mark.
- (v) Wind the starter rope around the pulley and pull the rope with a quick full arm stroke to overcome compression and prevent kickback. Repeat if necessary with choke opened slightly. When engine starts, open choke gradually.
- (vi) Move throttle level to $\frac{3}{4}$ mark, allow the engine to run for a few minutes before operating the hydraulic drive.

3.2.3 To operate hydraulic drive

CAUTION: ALWAYS KEEP HANDS AND FEET CLEAR OF ROTATING MACHINERY.

- (i) Set control speed of the winch by carrying out the following steps:—
 - (a) Close speed control valves No. 1 and No. 2 completely by turning their knobs clockwise.
 - (b) Move spool No. 2 of the directional control valve forward.
 - (c) Open speed control valve No. 1 gradually by turning its knob anticlockwise until the drum is just beginning to turn. Open the valve further a little at a time and set the speed approx. 15 to 20 rpm.
 - (d) To set the speed of the winch in the opposite direction, repeat the steps by moving the spool lever downward and adjust speed control valve No. 2.
 - (e) Once the speed control valves are set, they should be remained set permanently. Readjustment should only be carried out if it is absolutely necessary.
- (ii) To raise the current meter, move spool No. 1 of the directional control valve forward as indicated.
- (iii) To lower, move the spool downward.
- (iv) For tranversing, carry out the following steps:—
 - (a) Move spool No. 2 of the directional control valve either forward or downward gradually until the drum of the winch is just beginning to turn.
 - (b) Maintain the speed until the red line on the bearing block coincides with any one of the red line of the alluminium marking block on the drive shaft.

- (c) Lock the shaft in this position by moving the spool back to its neutral position.
- (d) Engage gear for traversing drum by pulling gear lever outward as indicated. Do not use excessive force. Engage gear smoothly.
- (e) To move current meter away from the winch, pull spool No. 1 downward. To return, push the spool lever in the opposite direction.
- (f) To disengage the gear, lock the current meter in position by keeping the spool lever in neutral position. Push the gear lever inward as indicated.
- (v) For fine positioning, move the current meter as close as possible quickly using spool lever No. 1. Then use spool lever No. 2 to move and lock the current meter at the desired position.
- (vi) To stop engine, push stop lever until it is in contact with the spark plug terminal.

NOTE: *The conductor—suspension cable can easily be damaged. Please ensure that it is evenly wound on to the drum while rewinding.*

4. MAINTENANCE INSTRUCTIONS FOR CABLEWAYS

A cableway, like any other mechanical plant, requires regular maintenance to keep it working efficiently. The easiest as well as the least expensive type of maintenance is preventive maintenance.

4.1 Double—Drum Winch

The following instructions should be carried out for the maintenance of double—drum winch:—

- (i) Lubricate all bearings before each gauging operation. All lubricating points are in the form of spring-loaded steel balls on the bearings of various shafts, or nipples on the pulleys.

✕

(ii) For manual—operated winch, check brake lining before each gauging operation. Change lining if it is badly worn. To change lining, carry out the following steps:—

- (a) Remove wing nut and cover.
- (b) Remove clutch lever and the hexagon lock nut.
- (c) Turn clockwise to unscrew the clutch assembly.
- (d) Clean clutch assembly with commercial solvent.
- (e) Replace clutch linings and reapply grease.
- (f) Re-assemble clutch assembly.

(iii) One of the most common fault encountered by the operator of cableway is faulty pulse transmission system. It could be due to any of the following causes:—

- (a) Exhausted batteries of counter.
- (b) Faulty counter.
- (c) Faulty connections.
- (d) Faulty conductor—suspension cable.
- (e) Faulty pulse generating device of current meter.

(iv) Test systematically as follows, until the fault is located:—

- (a) Switch on the counter and short circuit the two-pin plug at the end of the counter connecting lead. If the short circuit is interrupted, the counter should be operated. If it does not, the fault lies in the batteries or the connecting lead or the counter itself. Change the batteries. If it still does not work, return it to the Instrumentation Section, Hydrology Branch, D.I.D. Ampang for repair.
- (b) Connect the counter to the slip-ring housing of the winch and short circuit the contact pin and the body of the angle plug at the end of the conductor-suspension cable. The counter should operate if the short-circuit is interrupted. If it does not, it may be due to (1) bad connection at angle plug, (2) bad connection at

slip—ring housing or (3) faulty conductor—suspension cable. Conductor—suspension cable is normally damaged by crushing while rewinding. Care therefore must be taken to ensure that the cable is wound evenly onto the drum. If the cable is found to be faulty dismantle the cable drum and return it together with the cable to the Instrumentation Section, Hydrology Branch, D.I.D. Ampang for replacement.

- (c) If the fault lies with the current meter, change the reed-switch of current meter if possible, otherwise, return the current meter to the Instrumentation Section, Hydrology Branch, D.I.D. Ampang for repair.

4.2 Steel Towers and Cables

The following instructions should be carried out for the maintenance of steel towers and cables:—

- (i) Grease all bearings of pulleys once every 6 months.
- (ii) For the steel towers, anchorages, traveller carriage etc., fresh coat of paint has to be applied *once every three years* to prevent corrosion.
- (iii) The stay wires and the main cable should be greased *once every two years*. To facilitate greasing of the main cable, a greasing tank which can be attached to the traveller carriage had been designed. The tank and the cable grease are available at the Instrumentation Section, Hydrology Branch, D.I.D. Ampang or the nearest Mechanical Workshop in the State.

NOTE: *Do not grease the traveller cable. It should be changed once every three years.*

4.3 Engine

For power—operated cableway, its successful operation depends very much on the reliability of the engine. To ensure satisfactory performance of the engine, carry out the following maintenance procedures:—

- (i) Use a high quality engine oil. The recommended viscosity grade shall be SAE 30. No additives should be used. *Oil should be changed after every 25 hours of engine operation.*

- (ii) Service air cleaner every 25 hours of operation or at three months intervals, whichever is earlier, as follows:—
 - (a) Remove knob and cover.
 - (b) Remove from air-cleaner by sliding it off of the paper cartridge.
 - (c) Wash foam air-cleaner in liquid detergent and water.
 - (d) Wrap foam air-cleaner in cloth and squeeze dry.
 - (e) *Saturate foam air-cleaner in engine oil.* Squeeze to remove excess oil.
 - (f) Install foam air-cleaner over paper cartridge. Re-assemble cover and screw down tight.
- (iii) Clean cooling system regularly. Continued operation with a clogged cooling system may cause severe over-heating and possible engine damage.
- (iv) For every 100 hours of operation, clean spark plug and reset gap at 0.03". Spark plug should be cleaned by scraping or wire brushing and washing in commercial solvent.
- (v) For every 100 hours of operation, remove cylinder head and cylinder head shield. Scrape and wire brush the combustion deposits from cylinder, cylinder head, top of piston and around valves. Use a soft brush to remove deposits. Reassemble gasket, cylinder head and cylinder head shield.

NOTE: *Major repairs should be carried out only by trained mechanics. Contact the nearest Mechanical Workshop in the State. Otherwise, return it to the Instrumentation Section, Hydrology Branch, D.I.D. Ampang for replacement.*

4.4 Hydraulic Drive

The hydraulic drive is almost maintenance free except the followings:—

- (i) Use only medium hydraulic oil with viscosity grade SAE 20

- (ii) Check for any oil leakage. If oil leaks from pipe fitting, tighten the fitting. But if leakage still persists, change rigs. For leakage at connections of hydraulic components, unscrew and apply fresh sealant. Tighten back properly.
- (iii) Change return—line filter and suction filter *once every year*.

4.5 Failure of Hydraulic Drive

In case the hydraulic drive fails to operate, gauging operation can still be carried out manually. Please carry out the following procedures:—

- (I) Remove hydraulic motor together with the bracket. (Only 4 bolts holding the bracket to the winch needed to be unscrewed).
- (ii) Fix the winch handle and carry out manual operation.
- (iii) Contact Instrumentation Section, Hydrology Branch, D.I.D. Ampang for the repair of the hydraulic drive.

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