CHAPTER 5

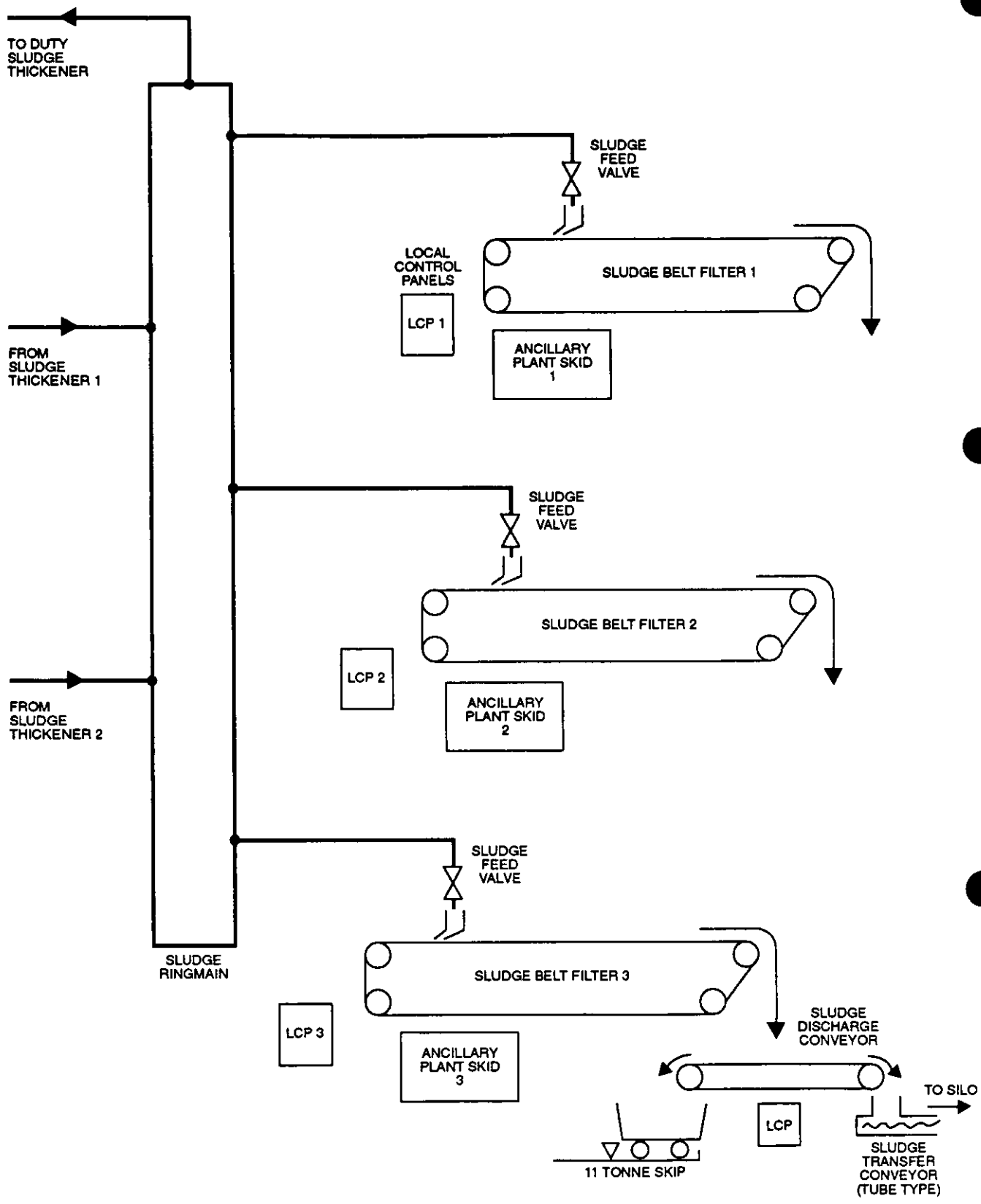
SLUDGE DEWATERING SYSTEM

LIST OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES



DXF 2621

FIG. 1 SLUDGE DEWATERING SYSTEM - BLOCK DIAGRAM

1. INTRODUCTION (fig. 1)

The sludge dewatering system is that part of the Waste Water Treatment Plant (WWTP) where sludge from the sludge thickeners is delivered to sludge belt filters for final dewatering which results in a solids content of approximately 60%. The sludge thickeners and associated transfer pumps form part of the sludge handling system. The treatment is designed to be continuous in operation, but normally will be operating over 15 hours in any one day allowing the plant to be shut down overnight.

Sludge from the sludge thickeners is pumped into a ring main where it is distributed to three sludge belt filters which are installed in the sludge dewatering plant house. Excess sludge in the ring main is recycled back to the thickener from which it has been discharged.

Sludge is deposited on to the slowly moving cloth belt of each filter. The loaded belt runs across a shallow tray which spans the width of the belt and is almost as long as the upper length of belt. The belt when loaded is then stopped and a vacuum is applied to the tray. Water is drawn off through the cloth and into the tray below, so dewatering the sludge. The water drawn from the sludge is known as 'sludge filtrate' and is retained for belt washing purposes.

The dewatered sludge is then transferred from the sludge belt filters in a phased discharge to a sludge discharge conveyor which serves all three. The discharge conveyor normally operates in one direction and transfers the sludge to a sludge transfer conveyor which, in turn, delivers it to a sludge fixation and disposal system. When necessary the discharge conveyor can be reversed to load the sludge into a skip at the other end. The transfer conveyor forms part of the sludge fixation and disposal system.

A skid (machinery raft) is located underneath each sludge belt filter. Items of ancillary plant associated with that filter are mounted on the skid. The plant consists of a sludge filtrate pump, a sludge filtrate receiver, a sludge vacuum pump, a sludge vacuum seal water air separator, a sludge filtrate break tank, a sludge vacuum seal water cooler and a sludge filtrate belt wash pump.

The various other systems forming the WWTP are described in the following chapters:

(1) Volume 2, Part 6, Chapter 1 - Introduction

(2) Volume 2, Part 6, Chapter 2 - Reception and Clarification

(3) Volume 2, Part 6, Chapter 3 - Filtration and Discharge System

(4) Volume 2, Part 6, Chapter 4 - Sludge Handling System

(5) Volume 2, Part 6, Chapter 6 - Chemical Storage and Dosing System

(6) Volume 2, Part 6, Chapter 7 - Sludge Fixation and Disposal System

(7) Volume 2, Part 6, Chapter 8 - WWTP Trace Heating

Distribution of control and instrument air supplies within the WWTP is described along with other Flue Gas Desulphurisation (FGD) air systems in Volume 2, Part 8, Chapter 5 - Compressed Air Systems. Similarly, distribution of industrial towns water is described in Volume 2, Part 8, Chapter 9 - Towns Water.

2. TECHNICAL DATA

Design data for the system only is given in this section. Design data for each item of plant forming the system is given in the respective Plant Description Module (PDM) in Appendix 1.

Sludge feed per stream	
Solids content	
Normal	2372.1 kg/h
Maximum	3558.2 kg/h
Liquid content	
Normal	9910.1 kg/h
Maximum	14 865.1 kg/h
Total	
Normal	12 282.2 kg/h
Maximum	18 423.3 kg/h
Solids concentration	19.3% w/w
Specific gravity	1.1
Chlorides	40 000 ppm
Sludge discharge (dry solids basis) per stream	
Normal	4303 kg/h
Maximum	6454 kg/h
Cake solids concentration	55% w/w
Vacuum capacity	3540 m^3/h of saturated air at 35 °C 2946 m^3/h of dry air
Filter belt cloth wash supply	
Flow rate	7 m^3/h
Pressure	2 bar g
Vacuum pump seal water supply	
Flow rate	12 m^3/h
Temperature	22 °C

Instrument air supply

Flow rate	5 m^3/h
Pressure	5.5 bar

3. SYSTEM DESCRIPTION

The WWTP sludge dewatering system is considered from three aspects for the purpose of the following description. These are as follows:

(1) Sludge belt filter - principal features.

(2) Process flow.

(3) Pipework and instrumentation.

A site layout showing the locations of the three sludge belt filters and the discharge conveyor which form the sludge dewatering system is given in fig. 2. Each sludge belt filter ancillary plant is located on a skid below the filter.

The plant is normally operated from local control panels (LCP's). However a facility does exist where, provided that all ancillary plant is started from the LCP's and control switches are set for remote operation, the actual starting and stopping of the main plant can be carried by an operator at the WWTP Control Room (WWTPCR). Each sludge belt filter is sequence controlled by an individual programmable Logic Controller (PLC) which is housed in the LCP. A safety interlock system is incorporated in the control arrangements to protect plant and personnel. Indications and alarms necessary to ensure safe operation of the plant are displayed at the LCP's together with system fault alarms at the WWTP control room panel.

3.1 Sludge Belt Filters - Principal Features

The general arrangement of a sludge belt filter is shown in the Plant Description Module (PDM) in Appendix 1.

A mild steel framework supports and guides the polypropylene cloth belt on which sludge is deposited intermittently as the belt moves. The sludge feed valve is mounted on the framework and connected by a flexible hose to the distributor which spreads the sludge along the belt and across its width. The feed is by batches and after a preset time the feed valve closes. When the spread of sludge coincides with the position of a vacuum tray underneath the belt it is stopped. The vacuum tray comprises two rows of flat panels flanking a centre-line trough. The trough is connected to a manifold pipe by eleven flexible hoses. The manifold pipe, not shown on the illustration, runs alongside the framework on the drive motor side. The vacuum is applied to the manifold pipe by the opening of a valve and water is drawn through the belt fabric into the trough via grooves in the vacuum tray panels. The extracted water (sludge filtrate) flows from the trough via the manifold pipe to a sludge filtrate receiver, a vessel on the ancillary plant skid, where it is stored for later use.

After the vacuum has been released by closure of the vacuum valve the belt restarts and deposits the sludge via a chute on to the sludge discharge conveyor for disposal. Another valve, also connected to the manifold pipe, opens to drain any remaining filtrate into the recycle sumps. The belt runs at the lower level over a set of return rollers. Prior to returning to the upper level the belt passes through

two sets of water sprays where it is washed before receiving more feed. Any water dripping off the belt and the spent water from the sprays is collected in drip trays and drained to the recycle sumps.

The sludge belt filter has a number of specialised rollers as follows:

(1) A drive roller, rubber covered, which is driven by a motor/gear unit mounted on the outside of the framework.

(2) A steering roller which corrects any tendency for the belt to wander off track.

(3) A tension roller which is weighted to maintain belt tension.

(4) A feed dam roller which prevents sludge from the distributor spreading upstream.

(5) An encoder roller which provides electrical pulses of belt travel and position to a controller incorporated into a local control panel.

Instrumentation includes belt tension and tracking monitoring switches on the sludge belt filter and level, pressure and temperature sensors on the ancillary plant.

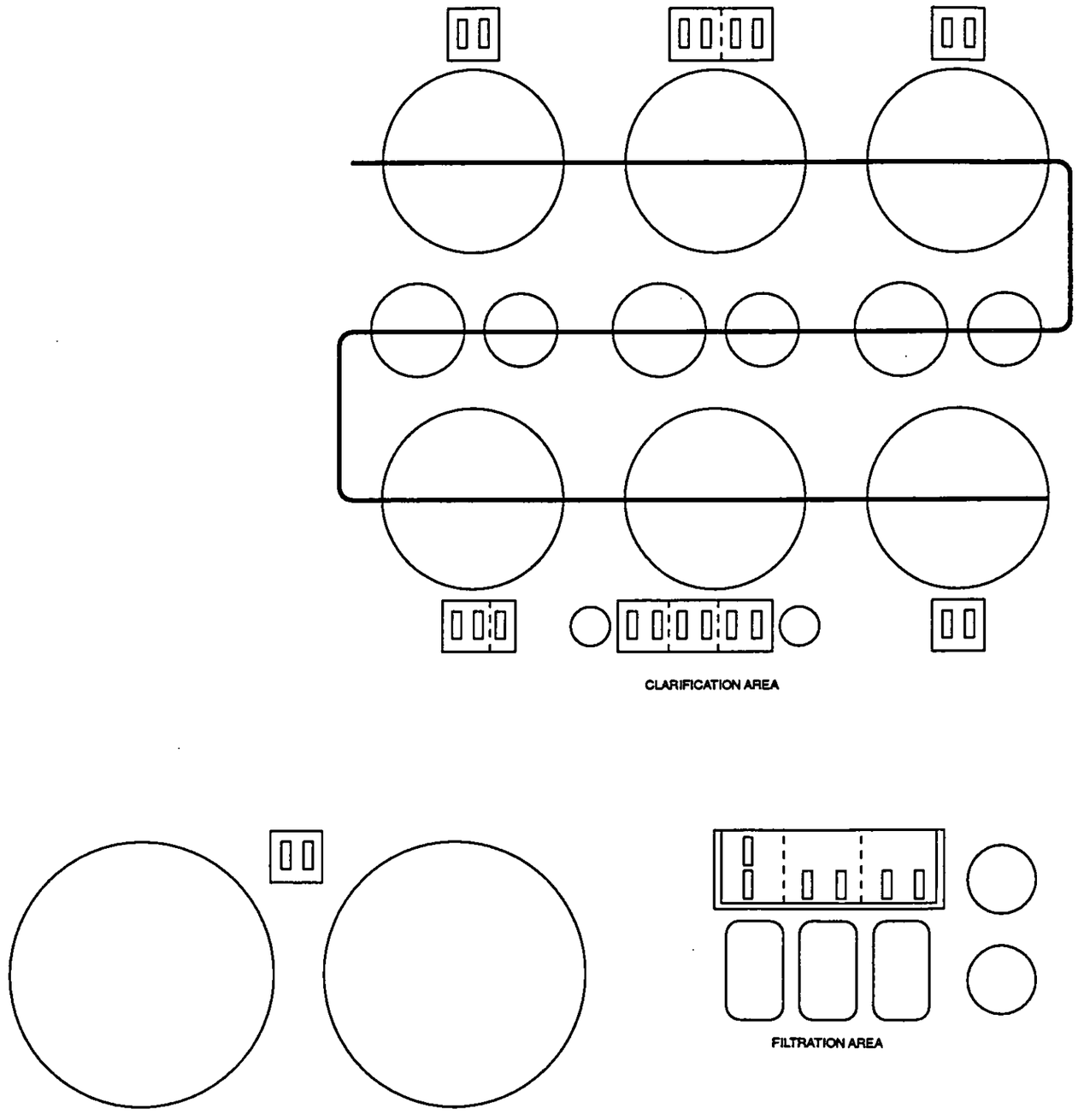
3.2 **Process Flow** (fig. 3)

Sludge is pumped from either of the sludge thickeners into the ring main at constant pressure. The ring main provides a supply to each of the three sludge belt filters which are mounted alongside each other in the sludge dewatering plant house. Excess sludge in the ring main is returned to the thickener from which it was drawn. The admission of sludge to each filter is controlled by an associated sludge feed valve which is connected to a sludge distributor by a flexible pipe. Normally two filters operate in the duty mode with the third on standby. Sludge is spread evenly across and along the upper length of the slowly moving belt.

The cloth belt runs over a long vacuum tray. Once the loaded part of the belt is positioned over the vacuum tray, the belt drive is halted while water is removed from the sludge by vacuum and drained to a sludge filtrate receiver. The vacuum is then released and the belt travels forward again to discharge the dewatered sludge and to take on a fresh load of wet sludge.

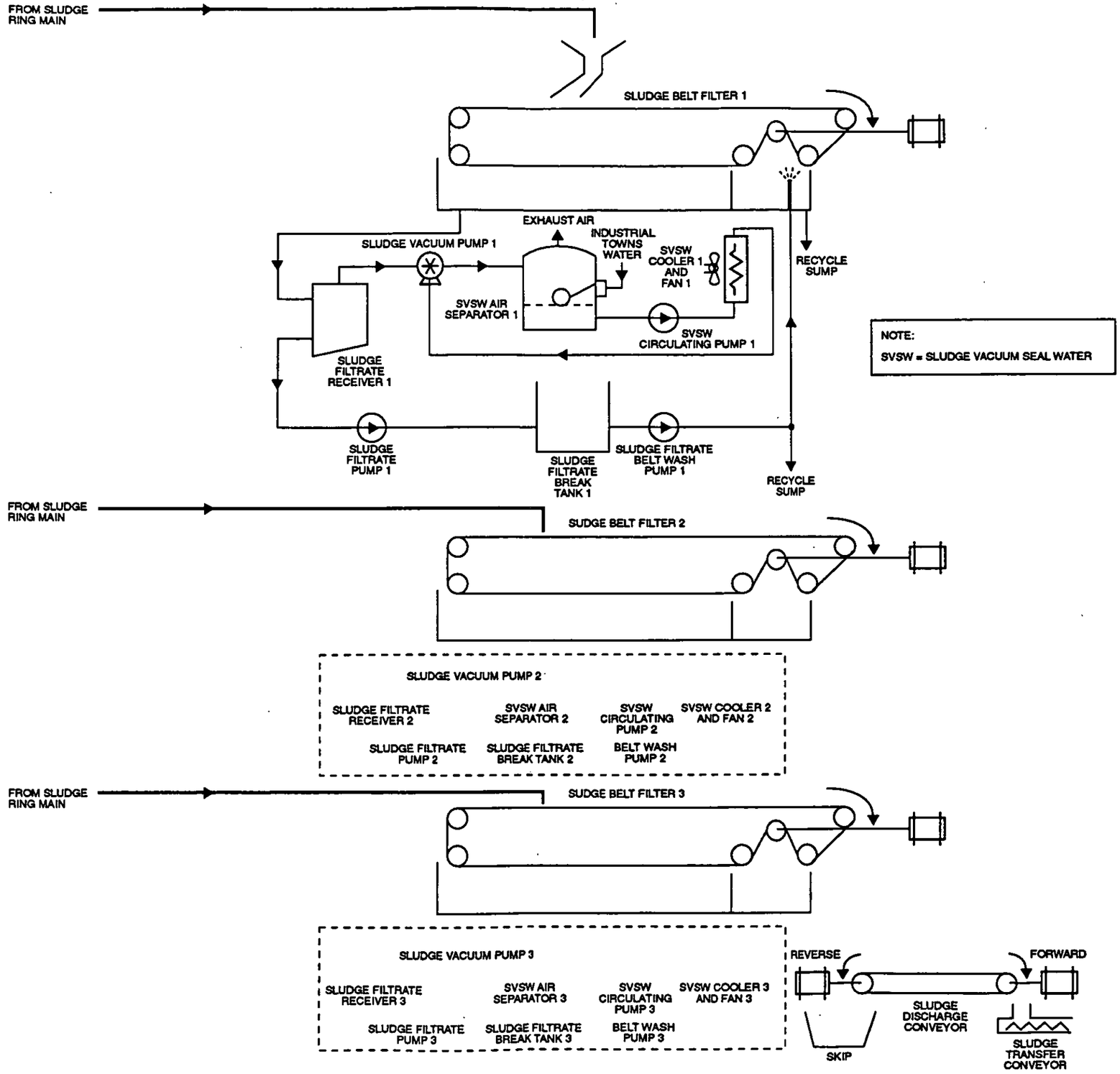
The water is drawn into the sludge filtrate receiver by a sludge vacuum pump. The filtrate which accumulates in the receiver is then discharged to a sludge filtrate break tank by a sludge filtrate pump. The filtrate is pumped continuously from the break tank by a sludge filtrate belt wash pump to the belt wash spray nozzles. The spent spray water and any water dripping off the belt as it runs along the return rollers is collected in drip trays and drained to the recycle sumps.

The vacuum pump employs water sealing. The discharge of the vacuum pump is a mixture of saturated air from the filtrate receiver and seal water. Air and water are separated in the vacuum seal water air separator. The air is discharged to atmosphere and the water is accumulated in the separator. The water, heated by the action of the vacuum pump, is passed through a water cooler by a sludge vacuum seal water circulating pump and then re-used for vacuum pump water sealing.



DXF 2940

FIG. 2 SLUDGE DEWATERING SYSTEM - PLANT LAYOUT



DXF 2622

FIG. 3 SLUDGE DEWATERING SYSTEM - PROCESS FLOW DIAGRAM

The dewatered sludge from each filter is deposited down a chute onto a single sludge discharge conveyor which normally delivers it in one direction to a sludge transfer conveyor, but can deliver it in the opposite direction to a skip for removal by lorry. The sludge transfer conveyor deposits the sludge in a silo where it is stored awaiting fixation and disposal.

3.3 Pipework and Instrumentation

3.3.1 Sludge Dewatering System (fig. 4)

The following description is based on sludge belt filter 1 but applies equally to sludge belt filters 2 and 3. The tag numbers are similar, differing in the second digit only, ie the sludge feed valves of sludge belt filters 1, 2 and 3 are 0DW-XV61031A, 0DW-XV62031A and 0DW-XV63031A respectively.

Sludge is delivered at constant pressure from a 50 mm tapping on the sludge ring main and is evenly deposited onto the slowly moving belt via pneumatically-operated sludge feed valve 0DW-XV61031A and a sludge distributor. When the layer of sludge on the belt corresponds in length to that of the vacuum tray, the feed valve is shut and the belt drive motor is stopped. Pneumatically-operated filtrate manifold isolating valve 0DW-XV61032A then opens and sludge vacuum pump 1 pulls a vacuum at the tray via sludge filtrate receiver 1 and associated pipework. Water (sludge filtrate) is drawn off from the sludge into the thirteen sections of the vacuum tray where it drains into a central longitudinal trough. The water is then drawn into the sludge filtrate receiver via a 350 mm manifold which is connected to the vacuum tray by 11 flexible pipes. After a preset time the filtrate manifold isolating valve closes and the filtrate manifold drain valve 0DW-XV61033A opens allowing any water which remains in the manifold to drain to the recycle sumps via a 40 mm drain line.

The belt drive starts up again and the belt travels forward. The dewatered sludge is deposited on to the sludge discharge conveyor, via a discharge chute at the end of the sludge belt filter. The belt returns along the lower level where it is washed prior to being fed again when the sludge feed valve re-opens after a preset interval. The timing of the feeds is determined by the PLC and is governed by the current plant throughput.

The filtrate from the dewatered sludge is collected in sludge filtrate receiver 1. Saturated air is drawn from the receiver through 250 mm pipework by sludge vacuum pump 1 and is discharged into sludge vacuum seal water air separator 1 via 150 mm pipework, together with the seal water expended by the vacuum pump. The air and water mixture in the vessel is separated out, the air being exhausted to atmosphere and the water being retained in the separator. A 40 mm drain line is provided to allow the water air separator to be drained to the recycle sumps, when required for maintenance, via drain valve 0DW-AA61008 and a drain trench. An overflow pipe is incorporated in the separator to prevent overfilling and is connected to the drain line.

The water is recirculated to the vacuum pump from the seal water air separator by sludge vacuum seal water circulating pump 1 via 40 mm pipework and seal water inlet isolating valves 0DW-AA61006 and 0DW-AA61007, and 0DW-AA61037 and 0DW-AA61040. Seal water circulating pump inlet and outlet isolating valves 0DW-AA61011 and 0DW-AA61012 are normally open and are fitted for maintenance purposes only. An indication of seal water pressure is given locally by pressure indicator 0DW-PI61010. The water, which becomes heated by the action of the vacuum pump, is passed through sludge vacuum seal water cooler 1 to reduce its temperature prior to it being delivered back to the vacuum pump. As

the seal water flows in a recirculating system there should be no loss, however, float-operated valve 0DW-AA61009 in the air separator ensures that a constant level of water is maintained via the industrial towns water header and isolating valve 0DW-AA61052.

The sludge vacuum seal water cooler is a rectangular enclosure housing a nest of 120 tubes mounted clear of the ground. The tubes are grouped so that the circulating water makes ten passes through the cooler. A motor-driven fan at the underside of the enclosure blows air up through the tube nest.

The filtrate which accumulates in the sludge filtrate receiver is pumped to sludge filtrate break tank 1 by sludge filtrate pump 1 via 40 mm pipework and pneumatically-operated sludge filtrate discharge isolating valve 0DW-XV31038A. The valve opens when the pump is running and closes when it stops to prevent loss of vacuum in the filtrate receiver. The starting and stopping of the pump is controlled by level switches in the filtrate receiver. Sludge filtrate pump inlet and outlet isolating valves 0DW-AA61002 and 0DW-AA61003 are normally open and are fitted for maintenance purposes only. A 50 mm drain line is provided to allow the sludge filtrate receiver to be drained to the recycle sumps, when required for maintenance, via drain valve 0DW-AA61004 and a drain trench.

Filtrate stored in the filtrate break tank is pumped by sludge filtrate belt wash pump 1 to two sets of spray heads via 40 mm pipework, tank outlet isolating valve 0DW-AA61016 and belt spray isolating valve 0DW-AA61019. A duplex strainer is fitted in the line which incorporates discharge selection valve 0DW-AA61017. The discharge selection valve permits a strainer element to be taken out of service for cleaning without interrupting operation of the belt wash system. An indication of belt wash water pressure is given locally by pressure indicator 0DW-PI61039.

The spray heads are positioned on both sides of the belt; one having 24 nozzles, the other 27. The belt wash pump and the sprays run continuously. The spent spray water and that which drops off the belt as it travels along the return rollers is collected in drip trays and drained to the recycle sumps via 100 mm pipework and a drain trench. A constant level of water is maintained in the filtrate break tank by taking make-up from the WWTP filtered water header via 40 mm pipework, filtered water supply isolating valve 0DW-AA61042 and tank float valve 0DW-AA61014. A 40 mm drain line is provided to allow the filtrate break tank to be drained to the recycle sumps, when required for maintenance, via drain valve 0DW-AA61013 and a drain trench. An overflow pipe is incorporated in the tank to prevent overfilling and is connected to the drain line.

3.3.1.1 Sludge Belt Filter Local Control Panel

A local control panel is provided alongside each sludge belt filter. A front view of the panel is given in Appendix 1.

Incoming power supplies of 415 V, 3-phase, 50 Hz and neutral and 110 V, 1-phase, 50 Hz are routed via door switches. The 415 V supply powers the sludge belt filter drive motor, the 110 V supply is transformed and rectified providing 48 V dc and 24 V dc supplies for control and instrumentation. Important supplies are routed via circuit breakers which on tripping initiate alarms.

The front panel is divided into three sections, the left hand panel carries the main isolator, the centre panel carries pump controls and a keypad/ display unit and the right hand panel carries valve controls and an auto/manual/remote control selector switch.

NOTES:

1 STREAMS 2 AND 3 ARE SIMILAR, DIFFERING ONLY BY THE TAG IDENTIFICATION NUMBERS.

2 THE SLUDGE DISCHARGE CONVEYOR SERVES ALL THREE SLUDGE BELT FILTERS.

KEY:

- - - - ELECTRICAL SIGNAL

—·—· INSTRUMENT AIR SIGNAL

FIG. 4 SLUDGE DEWATERING SYSTEM (STREAM 1)

DXF 2623

Motor running and valve open indicators are green, motor stopped and valve closed indicators are red and 'system in manual' and 'system in remote' indicators are white. If a fault condition occurs on the system the appropriate indicating lamp flashes. Additionally, a beacon flashes and a klaxon (adjacent the panel) sounds a warning.

The following pumps must be running before the sludge belt filter can operate:

(1) Sludge transfer pump.

(2) Sludge vacuum pump.

(3) Sludge filtrate pump.

(4) Sludge filtrate belt wash pump.

(5) Sludge vacuum seal water circulating pump.

All except the sludge transfer pump are started and stopped from the LCP. The sludge transfer pump is controlled from the WWTP control room panel. In addition, the sludge discharge conveyor must be running. The vacuum seal water cooler fan should be started; it is not an essential prerequisite for starting the sludge belt filter, but without it the vacuum seal water temperature will rise with eventual shutdown initiated.

The sludge belt filter can be selected to run in one of three modes, auto, remote and manual; auto is the normal operational mode.

In auto the control of pumps and valves is exercised by the PLC in the LCP in defined start and stop sequences initiated by the 'process start' and 'process stop' pushbuttons. In remote the sequences are initiated by 'start' and 'stop' pushbuttons at the WWTP control room panel. In manual the individual pumps and valves are controlled by pushbuttons at the LCP. Generally, manual is only used if the PLC fails, or for maintenance purposes.

A process start sequence comprises six steps, after which steps 3, 4, 5 and 6 are repeated continuously to feed the belt with sludge, dewater the sludge, discharge the sludge and take on another feed of sludge until a process stop or emergency stop is initiated. The process start sequence is given in table 1.

Note: The sludge filtrate pump starts and stops under the control of level switches in the sludge filtrate receiver. The sludge filtrate discharge valve opens when the filtrate pump runs and shuts when it stops.

A process stop sequence closes the sludge feed valve, dewaters the sludge on the belt, deposits the sludge on to the sludge discharge conveyor and then drives the empty belt through the sprayers for a preset time. The belt and associated pumps are then stopped and the valves are shut.

The following controls and indications are provided on the LCP:

(1) Main power isolating switch. Isolates 415 V ac and 110 V ac supplies to the panel and the plant items.

(2) Auto/manual/remote keyswitch (0DW-ES61018C). Selects mode control. In auto mode programmed starts and stops of pumps and sludge belt filter are initiated by the 'process start' and 'process stop' pushbuttons at the local control panel. In remote mode programmed starts and stops are initiated by start and stop pushbuttons at the WWTP control room panel, and in manual mode individual items are controlled by pushbuttons at the LCP.

(3) Process start/process stop pushbuttons (0DW-ES61018A and 0DW-ES61018B). The start pushbutton initiates a sequenced start of ancillary plant and the sludge belt filter. The stop pushbutton initiates a sequenced stop of the filter and plant.

Plant Item	Step 1 Select 'Auto'	Step 2 Start Sequence	Step 3 Filter Drive	Step 4 Sludge Feed	Step 5 Vacuum Applied	Step 6 Vacuum Released
Sludge Vacuum Pump	Stopped	Starts	Running	Running	Running	Running
Sludge Vacuum Seal Water Circ. Pump	Stopped	Starts	Running	Running	Running	Running
Sludge Filtrate Pump	Stopped	Enabled	Enabled	Enabled	Enabled	Enabled
Sludge Filtrate Belt Wash Pump	Stopped	Starts	Running	Running	Running	Running
Filtrate Discharge Valve	Shut	Open	Open	Open	Open	Open
Sludge Belt Filter	Stopped	Stopped	Starts	Running	Stopped	Stopped
Sludge Belt Filter Feed Valve	Shut	Shut	Shut	Open	Shut	Shut
Sludge Belt Filter Discharge Valve	Shut	Shut	Shut	Shut	Open	Shut
Sludge Belt Filter Manifold Drain Valve	Shut	Shut	Shut	Shut	Shut	Open
Encoder	Off	Off	On	On	Off	Off

TABLE 1 PROCESS START SEQUENCE

(4) Sludge belt filter drive start/stop pushbuttons (0DW-ES61012A and 0DW-ES61012B). The pushbuttons provide for starting and stopping of the sludge belt filter. Mainly used if PLC fails or for maintenance purposes (eg a belt change).

(5) Belt speed indicator and speed adjuster (0DW-ES61007). The speed of the belt can be controlled in manual mode only for maintenance purposes, eg testing a new belt. The speed of the belt is preset (100% on the scale) on commissioning by a speed adjust control at the rear of the panel and once set should not be altered.

(6) Emergency stop pushbutton (0DW-ES61020A). A red pushbutton which when operated trips circuit breakers in the LCP which immediately stop the belt and all plant motors and shuts the automatic valves.

(7) Emergency stop reset pushbutton (0DW-ES61020B). Restores all power supplies to enable a restart. The pushbutton has a lockable guard cover.

(8) Alarm acknowledge pushbutton (0DW-ES61018E). The pushbutton extinguishes the alarm beacon, silences the klaxon and steadies the flashing fault indicator lamp.

(9) System reset pushbutton (0DW-ES61018F). Resets all alarm circuits. Any parameter still in an alarm condition immediately raises the alarm again.

(10) Valve status indications. Limit switches at each of the four automatic valves provide status indications at the panel. In the event of a failure the status lamps flash.

(11) A keypad/display unit displays plant fault conditions, timer settings and data register contents. The keyboard is used to set all adjustable parameters, eg belt stroke length and timer settings. Pressing function keys F1-F6 causes the display to show a parameter identity and current set point as follows:

(a) F1 - Duration of vacuum applied time.

(b) F2 - Duration of vacuum released time.

(c) F3 - Filter stroke stop set point.

(d) F4 - Filter slow speed set point.

(e) F5 - Feed process timer.

(f) F6 - Process stop belt wash time.

The values set on the keypad/display unit are easily changed.

When a fault occurs the display shows an appropriate message. Most messages use two lines of text which are rolled over every five seconds. Typical message are:

(1) AT 61253 BELT TENSION FAULT.

(2) TRIP WIRE/E STOP CIRCUIT OPERATED.

Pressing a function key causes the function title and its current set point to be displayed. Pressing the same key again accepts this set point. To change a set point proceed as follows:

(1) Press relevant function key (say F1).

(2) Message 'VAC TIME 30' is displayed.

(3) Enter desired change, 40.

(4) Press ENTER key.

(5) Message 'VAC TIME 40' is displayed.

(6) Press F1.

When a fault has been accepted, cleared and reset by the panel controls the last message at the display panel must be cleared by pressing the ENTER key.

3.3.1.2 Control Switches

A number of control switches are incorporated into the design of the sludge belt filter. Others are incorporated into the various items of ancillary plant or into the system pipework.

The following control switches are associated with sludge belt filter 1:

(1) Belt tension limit switches. The belt is tensioned by a weighted roller which is free to move in vertical guide rails. If limit switch 0DW-WS61005A detects a lowering of the roller, indicating a reduction in tension, it initiates an alarm at the LCP display unit. If the belt tension is allowed to reduce even further, limit switch 0DW-WS61005B operates and initiates a shutdown.

(2) Belt tracking switches. Belt tracking is monitored by a vertical arm pivoted at its lower end and resting against the edge of the belt at its upper end. Any sideways movement of the belt tilts the arm one way or the other. Movement at the pivot directs pneumatic pressure into one of two bellows which act horizontally against one end shaft of a steering roller. The roller adjusts the belt tracking to recentre it. Two limit switches 0DW-GS61003A and 0DW-GS61003B, at opposite sides of the belt, initiate an alarm operated by the belt tending to move off-track. If tracking deteriorates further two more limit switches 0DW-GS61004A and 0DW-GS61004B initiate an emergency shutdown.

(3) Trip-wire switches. Two trip-wire switches 0DW-ES61003B and 0DW-ES61003C are separately operated by trip-wires running the length of the sludge belt filter on opposite sides. Operation of either switch initiates a plant shutdown.

The following control switches are associated with the ancillary plant:

(1) Sludge filtrate receiver 1. Four level elements, which are non-adjustable, and associated controllers are provided; the purposes of these are as follows:

(a) If the filtrate in the receiver exceeds a set level, level element 0DW-LE61022A and associated level controller 0DW-LC61022 initiate starting of sludge filtrate pump 1 and opening of filtrate discharge isolating valve 0DW-XV61038A.

(b) If the filtrate in the receiver exceeds a further set level, level element 0DW-LE61021 and associated level controller 0DW-LC61021 raise filtrate receiver level 'emergency high' alarm 0DW-LA61021 at the LCP and initiate shut down of sludge belt filter 1 and associated ancillary plant.

(c) If the filtrate in the receiver falls below a set level, level element 0DW-LE61022B and associated level controller 0DW-LC61022 initiate stopping of sludge filtrate pump 1 and shutting of filtrate discharge isolating valve 0DW-XV61038A. Shutting the valve prevents the vacuum being lost when the pump is shut down.

(d) If the filtrate in the receiver falls below a further set level, emergency low level element 0DW-LE61023 and associated level controller 0DW-LC61023 raise filtrate receiver level 'emergency low' alarm 0DW-LA61023 at the LCP and initiate shut down of sludge belt filter 1 and associated ancillary plant.

(2) Sludge filtrate break tank 1. If the filtrate in the tank falls below a fixed level, level element 0DW-LE61024 and associated level controller 0DW-LC61024 raise filtrate break tank level 'low' alarm 0DW-LA61024 at the LCP and initiate shut down of sludge belt filter 1 and ancillary plant.

(3) Sludge vacuum seal water air separator 1. If the level of filtrate in the separator falls below a fixed level, level element 0DW-LE61025 and associated level controller 0DW-LC61025 raise seal water air separator level 'low' alarm 0DW-LA61025 at the LCP and initiate a shut down of sludge belt filter 1 and associated ancillary plant.

(4) Belt wash water system pipework. If the belt wash water system pressure falls below 4.2 bar, pressure switch 0DW-PS61039 initiates belt wash water pressure 'low' alarm 0DW-PA61039 at the LCP.

(5) Sludge vacuum pump 1 inlet header. If the sludge filtrate receiver vacuum is lost, pressure switch 0DW-PS61035 raises 'vacuum lost' alarm 0DW-PA61035 and initiates shut down of sludge belt filter 1 and associated ancillary plant.

(6) Instrument air header. If the instrument air pressure falls below 5 bar, pressure switch 0DW-PS61001 raises air pressure 'low' alarm 0DW-PA61001 at the LCP and initiates shut down of sludge belt filter 1 and associated ancillary plant. All valves fail safe.

(7) Sludge filtrate belt wash pump outlet duplex strainer. If the differential pressure across the strainer rises above 5 bar, pressure switch 0DW-PS61041 raises strainer differential pressure 'high' alarm 0DW-PA61041 at the LCP. The standby strainer can be brought on line by manipulation of hand-operated local valves without interrupting flow to the belt wash sprayers.

(8) Seal water header. If the vacuum pump seal water temperature rises above 40 °C, temperature switch 0DW-TS61042 raises seal water temperature 'high' alarm 0DW-TA61042 at the LCP and initiates a shut down of sludge belt filter 1 and associated ancillary plant.

(9) Seal water header. If the vacuum pump seal water flow falls below 10 litres/h, flow switch 0DW-FS61043 raises seal water flow 'low' alarm 0DW-FA61043 at the LCP and initiates a shut down of sludge belt filter 1 and associated ancillary plant.

(10) Valve limit switches. Limit switches at the four actuator-operated valves light indicating lamps at the LCP to show the open or closed state of the valves. These signals are relayed to the PLC. A valve failure initiates a shut down of sludge belt filter 1 and associated ancillary plant.

3.3.2 Sludge Discharge System

The sludge discharge system comprises essentially the sludge discharge conveyor, and the sludge transfer conveyor. The sludge transfer conveyor forms part of the sludge fixation and disposal system and is described in detail with that system.

3.3.2.1 Sludge Discharge Conveyor

The conveyor is mounted at right angles to the three sludge belt filters along the outside wall of the sludge dewatering plant house on an east-west axis. The conveyor travels in either direction driven by dedicated motors. The conveyor normally runs forward (eastwards) to transfer sludge to a screw-type sludge transfer conveyor which delivers the sludge to the sludge fixation and disposal system. If the transfer conveyor stops, the discharge conveyor automatically reverses to deposit sludge into a skip at the western end. An illustration showing the arrangement of the discharge conveyor is given in appendix 1.

The skip sits on an unpowered four wheel bogie. A short length of rail track allows the skip to be pushed into position under the discharge chute from the roadside take-away position. The track is in two independent sections; the longer length is bolted down directly onto concrete footings, the shorter length immediately under the chute is mounted on load cells to form a weigh bridge. The track has end stops fitted at both ends and the top surfaces of the rails adjacent the end stops are ground down to prevent unwanted movement of the skip. A levelling bar spans the rails to spread the load as the skip is withdrawn from under the conveyor.

The sludge discharge conveyor is controlled from a weatherproof local control panel which is located on an adjacent column of the sludge dewatering plant house. The panel incorporates a weigh controller unit which receives signals from the load cells and from these determines whether the skip is in position and that it is not full. The weigh controller enables reverse drive when required provided that the skip is in position and is not full.

The control panel incorporates the following controls and indications:

(1) The weigh controller with its display.

(2) Manual start and stop drive pushbuttons (for reverse drive only).

(3) Emergency stop pushbutton; when operated also stops all three sludge belt filters.

(4) Indicating lamps to confirm that the skip is in position and to warn of overheated gearboxes (both drive units), blocked chutes, weigh controller failure and belt drive fault.

(5) Fault reset pushbutton.

The two discharge conveyor drive units each comprise a 15 kW, 415 V, 3-phase, 50 Hz motor which is coupled through a fluid coupling and a disc brake to a helical worm gear unit. The gear unit incorporates an oil overtemperature heat sensor. The gear unit is coupled to the drive pulley of the conveyor via a cone ring coupling. The reverse drive unit only is provided with an operational shaft brake which is effective in both directions of travel.

The PLC exercises overall control of the sludge discharge conveyor in conjunction with the Auto/Plant Manual/Local Manual selection switch 0DW-ES60001 at the WWTP control room panel.

Normally, auto control is selected. Provided that the sludge transfer conveyor is running, the discharge conveyor starts and runs in the forward direction after a 10 second delay. During this delay period prestart sequence lamp 0DW-ES60005D is lit and a klaxon sounds local to the conveyor. When the conveyor starts the prestart sequence lamp is extinguished and start pushbutton/running lamp 0DW-EI60005A is lit.

If the transfer conveyor stops, the PLC automatically initiates a reversal of the discharge conveyor. This is indicated by the extinguishing of the running lamp and the illumination of stopped pushbutton lamp 0DW-EI60005B. The conveyor restarts in the reverse direction after the prestart sequence time delay during which the klaxon sounds and prestart sequence lamp 0DW-ES60002C is lit. When the conveyor starts the prestart sequence lamp is extinguished and start pushbutton/running lamp 0DW-EI60002A is lit.

When plant manual control is selected the discharge conveyor can be started and stopped from the WWTP control room panel using pushbuttons 0DW-ES60005A and 0DW-ES60005B respectively. The PLC ensures that the conveyor cannot be started unless the transfer conveyor is running. The start is delayed for 10 seconds by the prestart sequence. Similarly, the discharge conveyor can also be started and stopped in the reverse direction using pushbuttons 0DW-ES60002C and 0DW-ES60002B respectively. The reverse drive is only enabled if the PLC receives a signal from the local control panel that a skip is in position and that it is not full. Indicating lamps 0DW-EI60003 and 0DW-EI60004 at the WWTP control room panel indicate skip in position and skip full respectively. On receiving a signal that the skip is full the reverse drive is stopped by the PLC irrespective of the control mode selected.

When local manual control is selected, which is essentially a maintenance facility, the discharge conveyor can be started and stopped in the reverse direction only from the LCP. Again the drive is preceded by a 10 second prestart sequence delay. Indicating lamps at the WWTP control room panel provide indication of conveyor running.

Sensors at the conveyor provide signals to the LCP if the chutes become blocked, if either of the gearbox temperatures rise above 70 °C, or if the belt is not moving at the correct speed due to breakage or slippage. These conditions will trip the conveyor and initiate a system fault alarm at the WWTP control room panel.

Belt clearing indicating lamp 0DW-EI60005C illuminates after a stop (other than an emergency stop) has been initiated. The conveyor runs on for a very brief period to clear any sludge which remains on the belt. In the case of an emergency stop the belt is stopped immediately.

3.3.2.2 Sludge Transfer Conveyor

This tube-type conveyor enables sludge from the sludge discharge conveyor to be transferred to the sludge fixation and disposal system.

Should the transfer conveyor stop or be stopped, the belt of the discharge conveyor reverses to deposit the sludge into a skip.

3.4 Electric Motor Power Supplies

Power supplies for electric motors are as follows:

415 V Waste Water Treatment Plant Services Board 1A

(1) Sludge discharge conveyor (forward).

(2) Sludge discharge conveyor (reverse).

(3) Sludge belt filter 1.

(4) Sludge vacuum pump 1.

(5) Sludge filtrate belt wash pump 1.

(6) Sludge filtrate pump 1.

(7) Sludge vacuum seal water circulating pump 1.

(8) Sludge vacuum seal water cooling fan 1.

(9) Sludge vacuum pump 2.

(10) Sludge filtrate belt wash pump 2.

(11) Sludge filtrate pump 2.

(12) Sludge vacuum seal water circulating pump 2.

415 V Waste Water Treatment Plant Services Board 2A

(1) Sludge belt filter 2.

(2) Sludge belt filter 3.

(3) Sludge vacuum pump 3.

(4) Sludge filtrate belt wash pump 3.

(5) Sludge filtrate pump 3.

(6) Sludge vacuum seal water circulating pump 3.

(7) Sludge vacuum seal water cooling fan 2.

(8) Sludge vacuum seal water cooling fan 3.

APPENDIX 1

PLANT DESCRIPTION MODULES

LIST OF CONTENTS

Note: Due to the unique reference numbering system which is applied to Plant Description Modules (PDM's.), the reference numbers given in this Appendix may not be consecutive. The reader is informed that this does not mean that any PDM's are missing.

PLANT DESCRIPTION MODULE DXFM 236

ITEM	Sludge Vacuum Seal Water Circulating Pump
MANUFACTURER	Durco
TYPE MODEL	$1\frac{1}{2}$ x 1 - 6/41

LIST OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

A sludge vacuum seal water circulating pump is situated beneath each of the three sludge belt filters in the gypsum dewatering plant house which is located at the south east corner of the Waste Water Treatment Plant (WWTP).

The sludge vacuum seal water circulating pump is provided to supply sealing water to an associated sludge vacuum pump which, in turn, is used to dewater the sludge on the filter belt cloth. The pump take its suction from a sludge vacuum seal water air separator and discharges to the sludge vacuum pump via a sludge vacuum seal water cooler.

2. TECHNICAL DATA

Pump

Manufacturer	Durco
Type	$1\frac{1}{2}$ x 1 - 6/41
Number Off	3
Capacity	12 m^3/h
Inner bearing	SKF 6206ZJ/C3 - MRC 5305G/STD
Outer bearing	SKF 5305NRH/STD - MRC 530G/STD
Impeller diameter	4.25 in
Suction pressure	1.04 bar
Discharge pressure	2.39 bar
Weight	32 kg

Mechanical Seal

Manufacturer	Borg Warner
Type	BX 1125-5A1X

Motor

Manufacturer	Brook Crompton Parkinson
Type	AD90LN
Enclosure	TEFV
Insulation	F
Mounting	Horizontal foot
Power	2.2 kW

Speed	2850 rev/min
Bearings:	
Drive end	6205ZZ
Non-drive end	6203ZZ
Supply	415 V, 3-ph, 50 Hz
Weight	22 kg
Coupling	
Manufacturer	J.H.Fenner and Co.
Type	F50/100/SM16

3. DETAILED DESCRIPTION (fig. 1)

The sludge vacuum seal water circulating pumps are centrifugal single stage pumps. Each pump is horizontally foot mounted on a common bedplate together with an electric driving motor. Drive is transmitted from the motor to the pump via a flexible coupling. The coupling is fitted with a guard.

3.1 Pump (fig. 1)

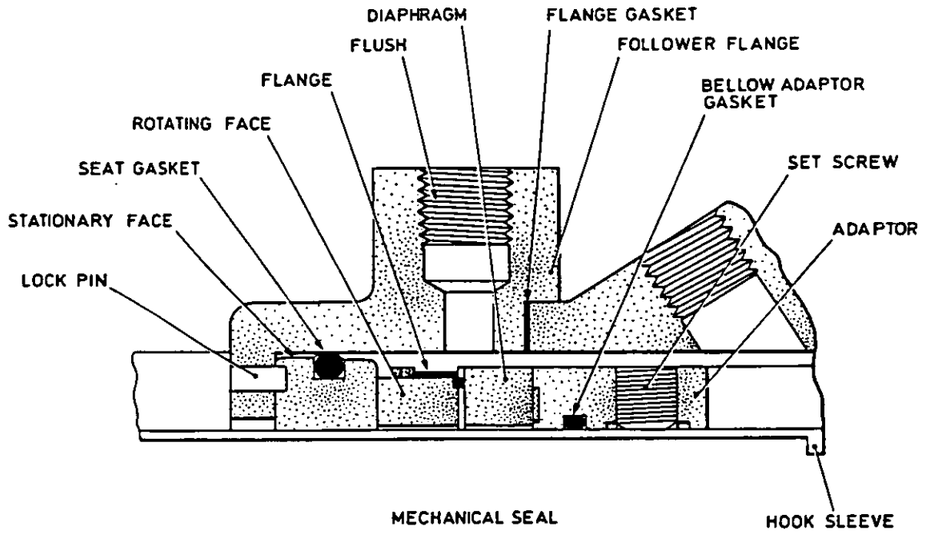
The sludge vacuum seal water circulating pump is a back pull-out, single stage unit. The pump casing and bearing housing are secured together on the vertical axis with the suction and discharge connections forming an integral part of the casing, as are the casing support feet. The bearing housing is supported centrally by a vertical support foot. This arrangement permits easy removal of the rotating assembly without disturbing the suction and discharge pipework.

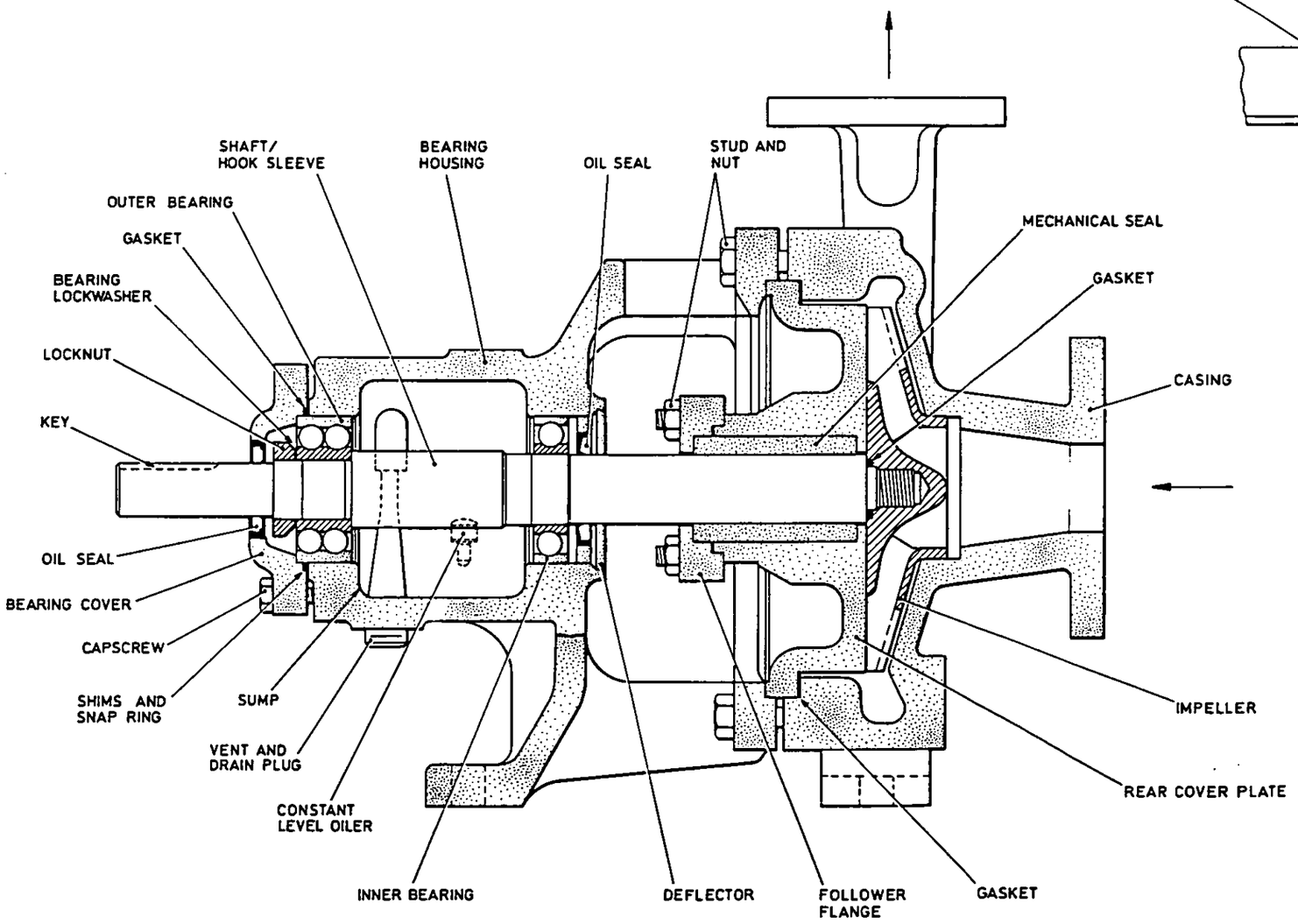
The pump casing is machined internally to provide clearances between the casing and the impeller. The casing is closed at the driven end by a rear cover plate which is sandwiched between the casing and the bearing housing. The bearing housing is secured to the casing by studs and nuts. A PTFE gasket is fitted between the rear cover plate and the pump casing.

The rotating assembly consists of a shaft and an impeller which is screwed onto a thread at the end of the shaft. A Teflon/rubber gasket is fitted between the impeller and a shoulder on the shaft. A half coupling is keyed to the drive end of the shaft. The pump shaft is supported at each end of the bearing housing by roller bearings which are an interference fit on the shaft.

The drive end bearing (outer bearing) is a double row ball bearing and abuts a shoulder on the shaft. It is held in position on the shaft by a locknut and lockwasher. The drive end bearing is closed in the bearing housing by a bearing cover which is fixed to the bearing housing by capscrews. An oil seal is fitted in the bearing cover. A cork gasket is fitted at the interface of the bearing housing and the bearing cover. The position of the impeller vanes relative to the rear cover plate is adjusted using shims and a snap ring between the bearing housing and the bearing cover gasket.

The non-drive end bearing (inner bearing) is a single row ball bearing. It is closed in the bearing housing by an oil seal and a deflector.





DXF 812

FIG. 1 PUMP - SECTIONAL ARRANGEMENT

A mechanical seal arrangement is fitted to the shaft where it passes through the rear cover plate. The seal is located in a stuffing box which is an integral part of the rear cover plate. Rubber seals (gaskets) fitted in the seal prevent the migration of water from the pump along the shaft to the bearing housing. The mechanical seal is retained in the stuffing box by a follower flange which is secured to the the rear cover plate by studs and nuts. The stationary part of the seal is located in the follower flange and is prevented from rotating by a lock pin.

Flushing/cooling water for the mechanical seal is provided by a connection from the discharge side of the pump to the the rear cover plate.

The bearings are oil lubricated. The oil in the bearing housing is maintained at the correct level by a constant level oiler (not illustrated) attached to the side of the bearing housing. The bearing housing is also fitted with a vent and drain plug.

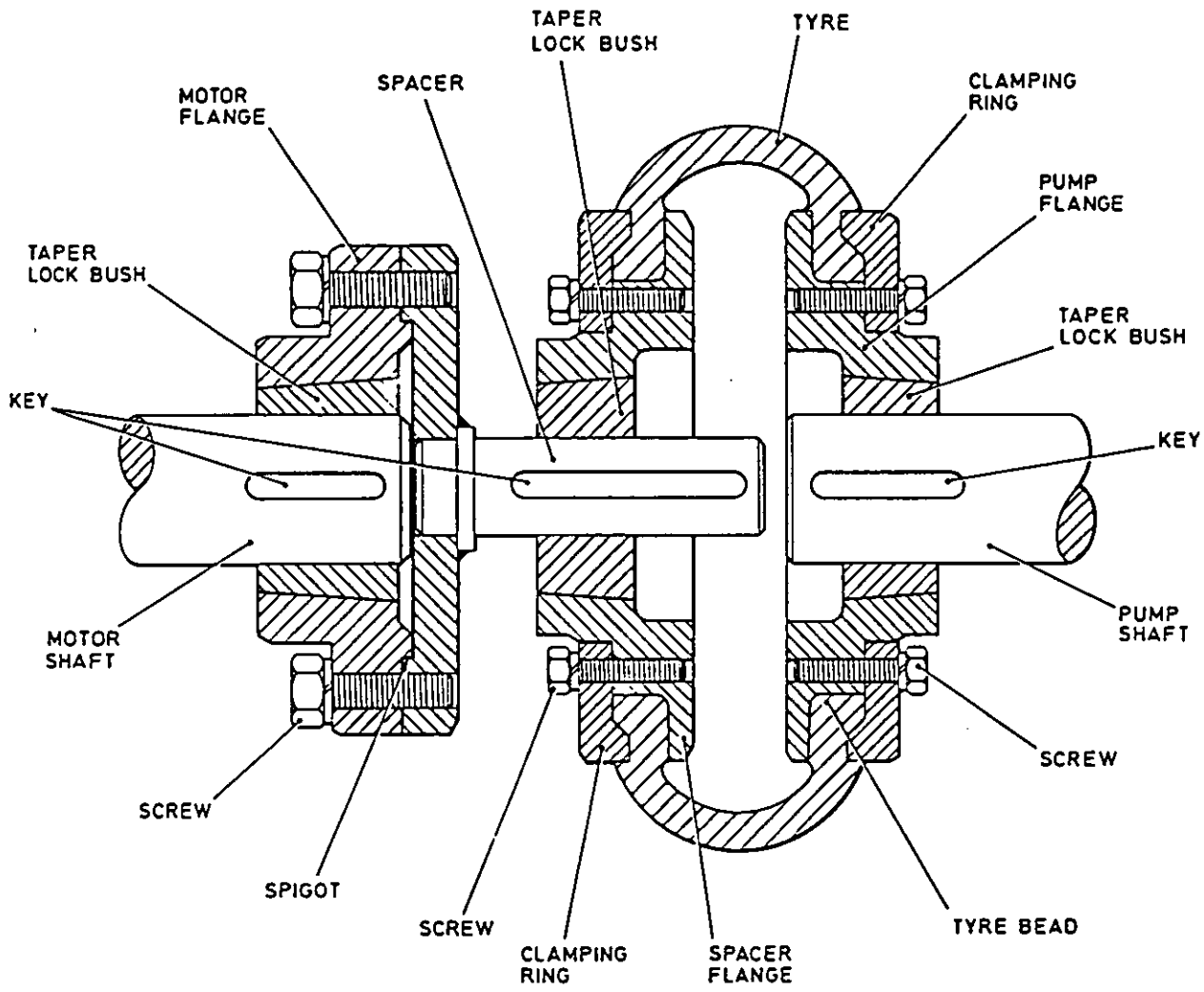
3.2 **Coupling** (fig. 2)

Drive is transmitted from the electric motor to the pump via a flexible coupling. The coupling basically comprises a motor flange, pump flange, spacer assembly and a tyre. The spacer assembly comprises a spacer flange, spacer and clamping ring.

Each flange is mounted on its respective shaft with a taper lock bush located on a key. The split taper bush has a keyway machined along its length. The keys are of such a width that the bush, when tightened, will not nip the key before gripping the shaft. The hub and the bush are drilled and tapped to take two hexagonal headed screws, 180 degrees apart, that when tightened lock the bush and hub to the shaft.

The pump flange (driven) and motor flange (driving) are keyed to and fitted flush with the end of their respective shafts. The driven flange has a spigot machined in its face for the correct location of the spacer, the spacer is connected to the driven flange by screws.

The spacer flange is positioned on the spacer shaft a fixed distance from the motor flange. A tyre, with beaded edges, is fitted over the motor and spacer flanges with the beads locating in a machined radius in the back of each flange. The beads of the tyre are held in position on their respective flanges by a clamping ring which is secured to the flange by screws.



DXF 786

FIG. 2 COUPLING

PLANT DESCRIPTION MODULE DXFM 237

ITEM Sludge Filtrate Pump

MANUFACTURER Durco

TYPE MODEL $3 \times 1\frac{1}{2}$ - 8/74

LIST OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

A sludge filtrate pump is situated beneath each of the three sludge belt filters in the gypsum dewatering plant house which is located at the south east corner of the Waste Water Treatment Plant (WWTP).

The sludge filtrate pump is provided to supply water to the associated filter belt wash system. The pump takes its suction from a sludge filtrate receiver and delivers it to a sludge filtrate break tank from which the wash water system is supplied.

2. TECHNICAL DATA

Pump

Manufacturer	Durco
Type	$3 \times 1\frac{1}{2}$ - 8/74
Number Off	3
Capacity	16 m^3/h
Inner bearing	SKF 6310 J/C3 - MRC 310S/LO
Outer bearing	SKF 5310NRH/STD - MRC 5310CG/LO
Impeller diameter	7.5 in
Suction pressure	1.81 bar
Discharge pressure	1.28 bar
Weight	89 kg

Mechanical Seal

Manufacturer	Borg Warner
Type	BX 1875-9A5X

Motor

Manufacturer	Brook Crompton Parkinson
Type	AD 100LA
Enclosure	TEFV
Insulation	F
Mounting	Horizontal foot
Power	2.2 kW

Bearings:	
Drive end	6206ZZ
Non-drive end	6205ZZ
Speed	1420 rev/min
Supply	415 V, 3-ph, 50 Hz
Weight	24 kg
Coupling	
Manufacturer	J.H.Fenner and Co.
Type	F50/100/SM16

3. DETAILED DESCRIPTION (fig. 1)

The sludge filtrate pumps are centrifugal single stage pumps. Each pump is horizontally foot mounted on a common bedplate together with an electric driving motor. Drive is transmitted directly from the motor to the pump via a flexible coupling. The coupling is fitted with a guard.

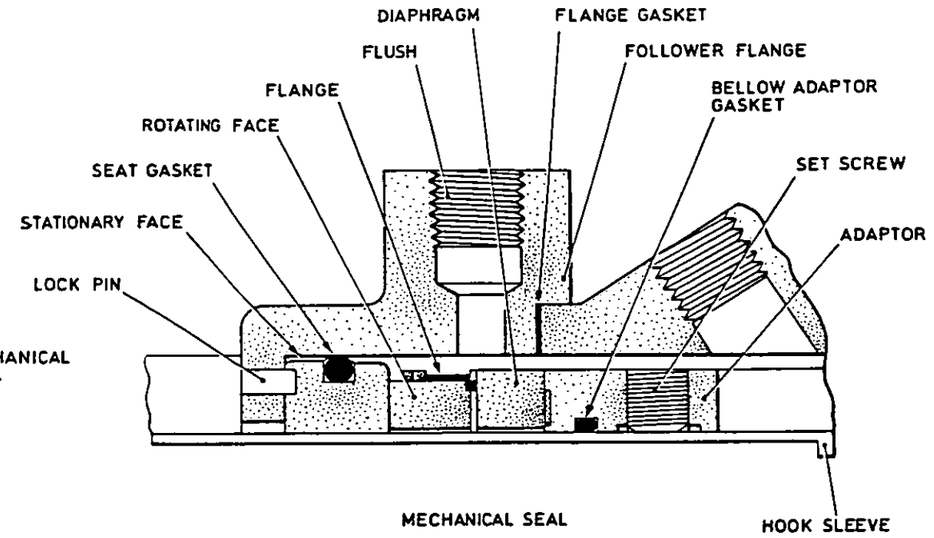
3.1 Pump (fig. 1)

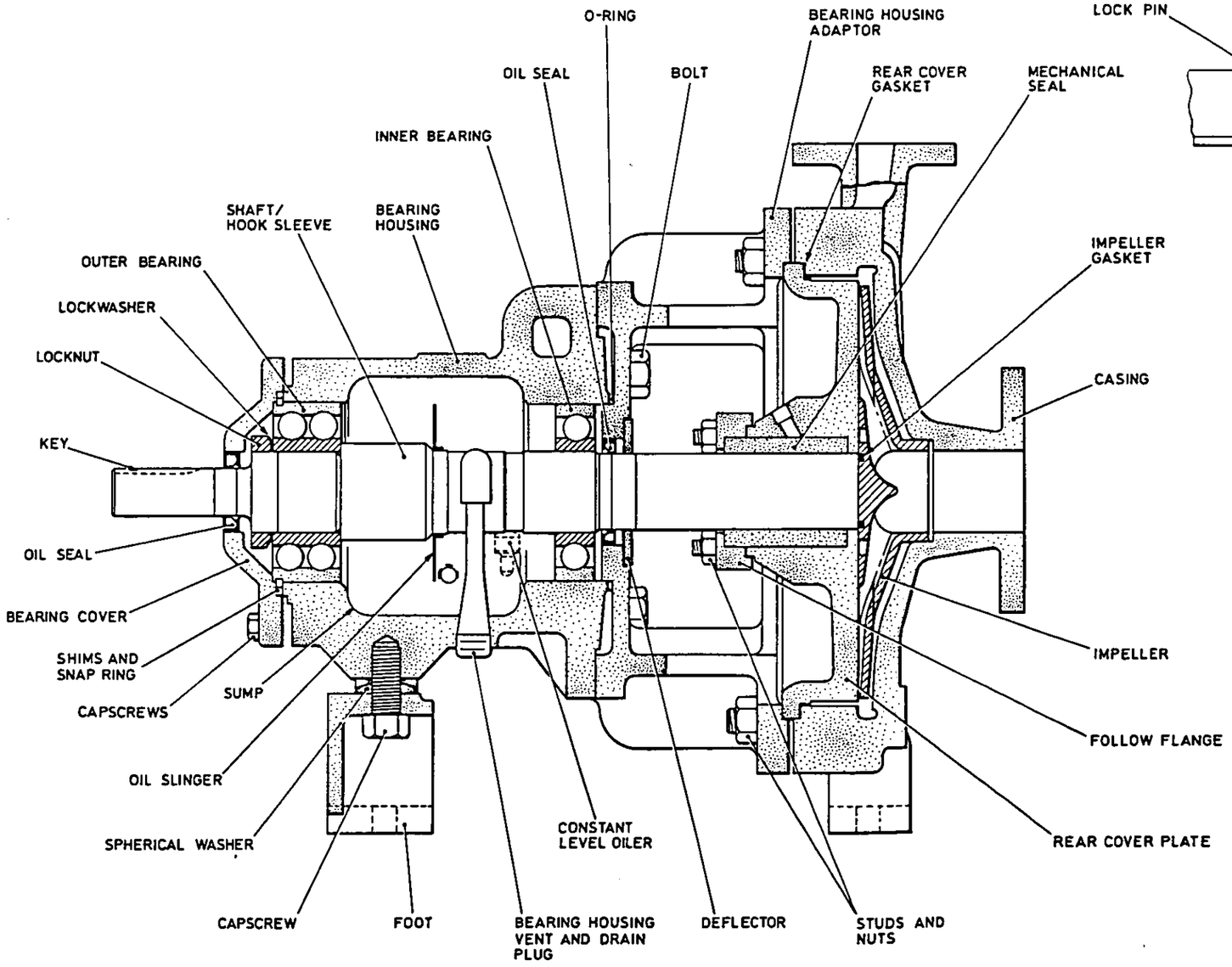
The sludge filtrate pump is a back pull-out, single stage unit. The pump casing and bearing housing are secured together on the vertical axis with the suction and discharge connections forming an integral part of the casing, as are the casing support feet. The bearing housing is supported centrally by a vertical support foot secured to the bearing housing by a capscrew. This arrangement permits easy removal of the rotating assembly without disturbing the suction and discharge pipework.

The pump casing is machined internally to provide clearances between the casing and the impeller. The casing is closed at the driven end by a rear cover plate which is sandwiched between the casing and the bearing housing adaptor. The bearing housing adaptor is secured to the casing by studs and nuts. A PTFE gasket is fitted between the rear cover plate and the pump casing. The bearing housing adaptor is secured to the bearing housing by bolts. The interface of the bearing housing adaptor and the bearing housing is sealed with an O-ring.

The rotating assembly consists of the shaft on which is mounted an impeller which screws onto a thread on the end of the shaft. A Teflon/rubber gasket is fitted between the impeller and a shoulder on the shaft. A half coupling is keyed to the drive end of the shaft. The pump shaft is supported at each end of the bearing housing by roller bearings which are an interference fit on the shaft.

The drive end bearing (outer bearing) is a double row ball bearing and abuts a shoulder on the shaft. It is held in position on the shaft by a locknut and lockwasher. The drive end bearing is closed in the bearing housing by a bearing cover which is fixed to the bearing housing by capscrews. An oil seal is fitted in the bearing cover. A cork gasket is fitted at the interface of the bearing housing and the bearing cover. The position of the impeller vanes relative to the rear cover plate is adjusted using shims and a snap ring between the bearing housing and the bearing cover gasket.





DXF 814

FIG. 1 PUMP - SECTIONAL ARRANGEMENT

The non-drive end bearing (inner bearing) is a single row ball bearing. It is closed in the bearing housing by the bearing housing adaptor. The bearing housing adaptor is fitted with an oil seal and a deflector.

A mechanical seal arrangement is fitted to the shaft where it passes through the rear cover plate. The seal is located in a stuffing box which is an integral part of the rear cover plate. Rubber seals (gaskets) fitted in the seal prevent the migration of water from the pump along the shaft to the bearing housing. The mechanical seal is retained in the stuffing box by a follower flange which is secured to the the rear cover plate by studs and nuts. The stationary part of the seal is located in the follower flange and is prevented from rotating by a lock pin.

Flushing/cooling water for the mechanical seal is provided by a connection from the discharge side of the pump to the the rear cover plate.

The bearings are oil lubricated by an oil slinger mounted on the shaft in the bearing housing. The oil in the bearing housing is maintained at a correct level by a constant level oiler (not illustrated) attached to the side of the bearing housing. The bearing housing is also fitted with a vent and drain plug.

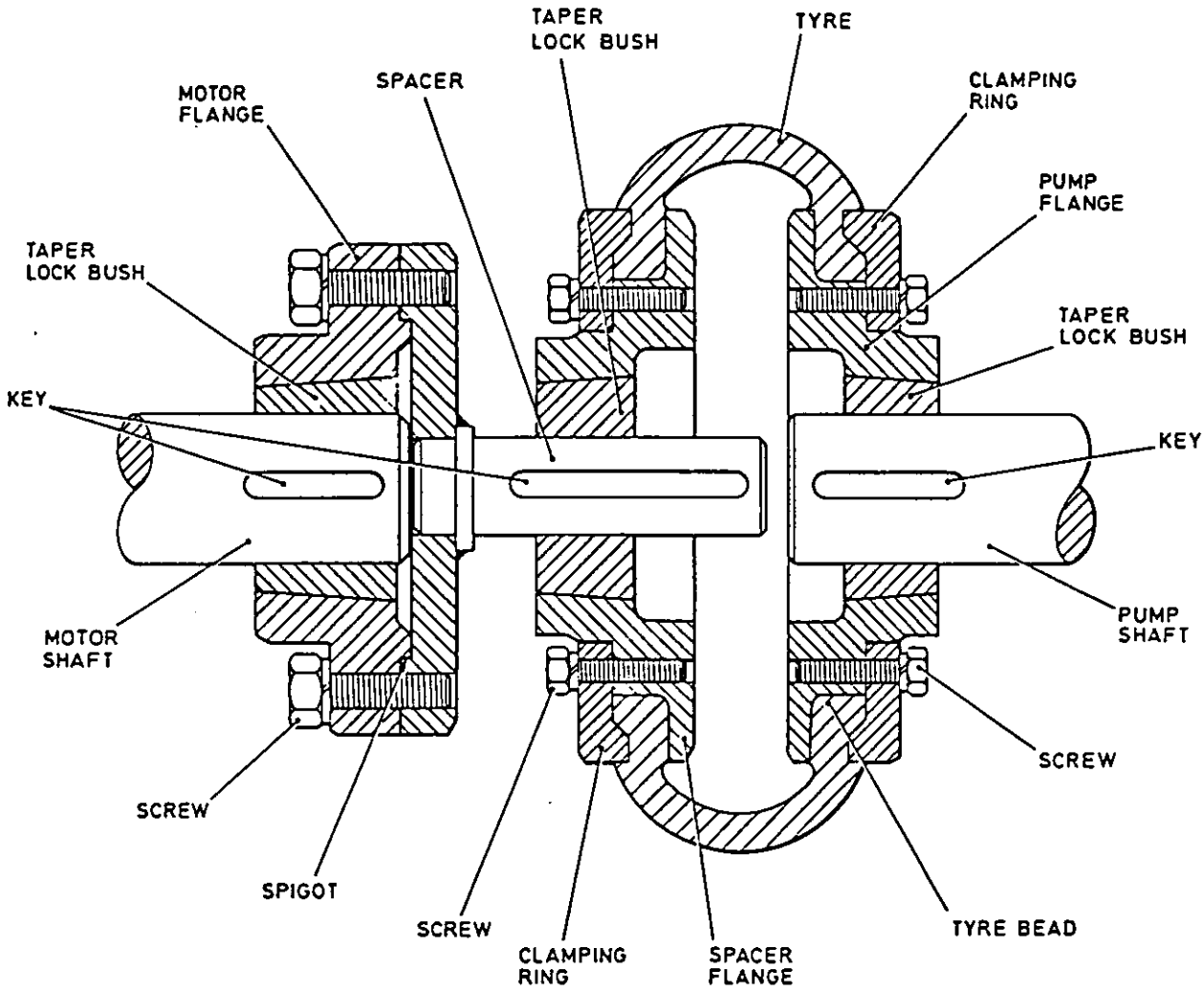
3.2 **Coupling** (fig. 2)

Drive is transmitted from the electric motor to the pump via a flexible coupling. The coupling basically comprises a motor flange, pump flange, spacer assembly and a tyre. The spacer assembly comprises a spacer flange, spacer and clamping ring.

Each flange is mounted on its respective shaft with a taper lock bush located on a key. The split taper bush has a keyway machined along its length. The keys are of such a width that the bush, when tightened, will not nip the key before gripping the shaft. The hub and the bush are drilled and tapped to take two hexagonal headed screws, 180 degrees apart, that when tightened lock the bush and hub to the shaft.

The pump flange (driven) and motor flange (driving) are keyed to and fitted flush with the end of their respective shafts. The driven flange has a spigot machined in its face for the correct location of the spacer, the spacer is connected to the driven flange by screws.

The spacer flange is positioned on the spacer shaft a fixed distance from the motor flange. A tyre, with beaded edges, is fitted over the motor and spacer flanges with the beads locating in a machined radius in the back of each flange. The beads of the tyre are held in position on their respective flanges by a clamping ring which is secured to the flange by screws.



DXF 786

FIG. 2 COUPLING

PLANT DESCRIPTION MODULE DXFM 240

ITEM Sludge Vacuum Pump

MANUFACTURER Nash

TYPE MODEL CL 2002

LIST OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

A sludge vacuum pump is situated beneath each of the three sludge belt filters in the gypsum dewatering plant house which is located at the south east corner of the Waste Water Treatment Plant (WWTP).

The sludge vacuum pump draws saturated air from the sludge belt filter via an associated sludge filtrate receiver and discharges it to a sludge vacuum seal water air separator. The separated air is exhausted to atmosphere and the liquid is cooled and returned to the pump for sealing.

2. TECHNICAL DATA

Pump

Manufacturer	Nash
Type	CL 2002
Number Off	3
Speed	550 rev/min
Belt drive:	
No. off	4
Type	SPC Wedge belt
Size	SPC 4500
Pulley diameter (motor)	300 mm PCD
Pulley diameter (pump)	800 mm PCD
Materials:	
Body	Cast iron
Rotor	Spheroidal iron
Shaft	Carbon steel
Inlet and discharge manifold	Cast iron
Connections	250 mm Flanged BS4504
Flow rate	3540 m^3/hr saturated air at 35 °C 2946 m^3/hr dry air
Suction pressure	150 mm Hg abs.
Discharge pressure	Atmospheric
Seal water temperature	22 °C

Seal water flow rate	12 m^3/hr
Weight	1293 kg
Ambient temperature:	
Maximum	30 °C
Minimum	-18 °C
Design	15 °C
Bearings	SKF - 22220C

Motor

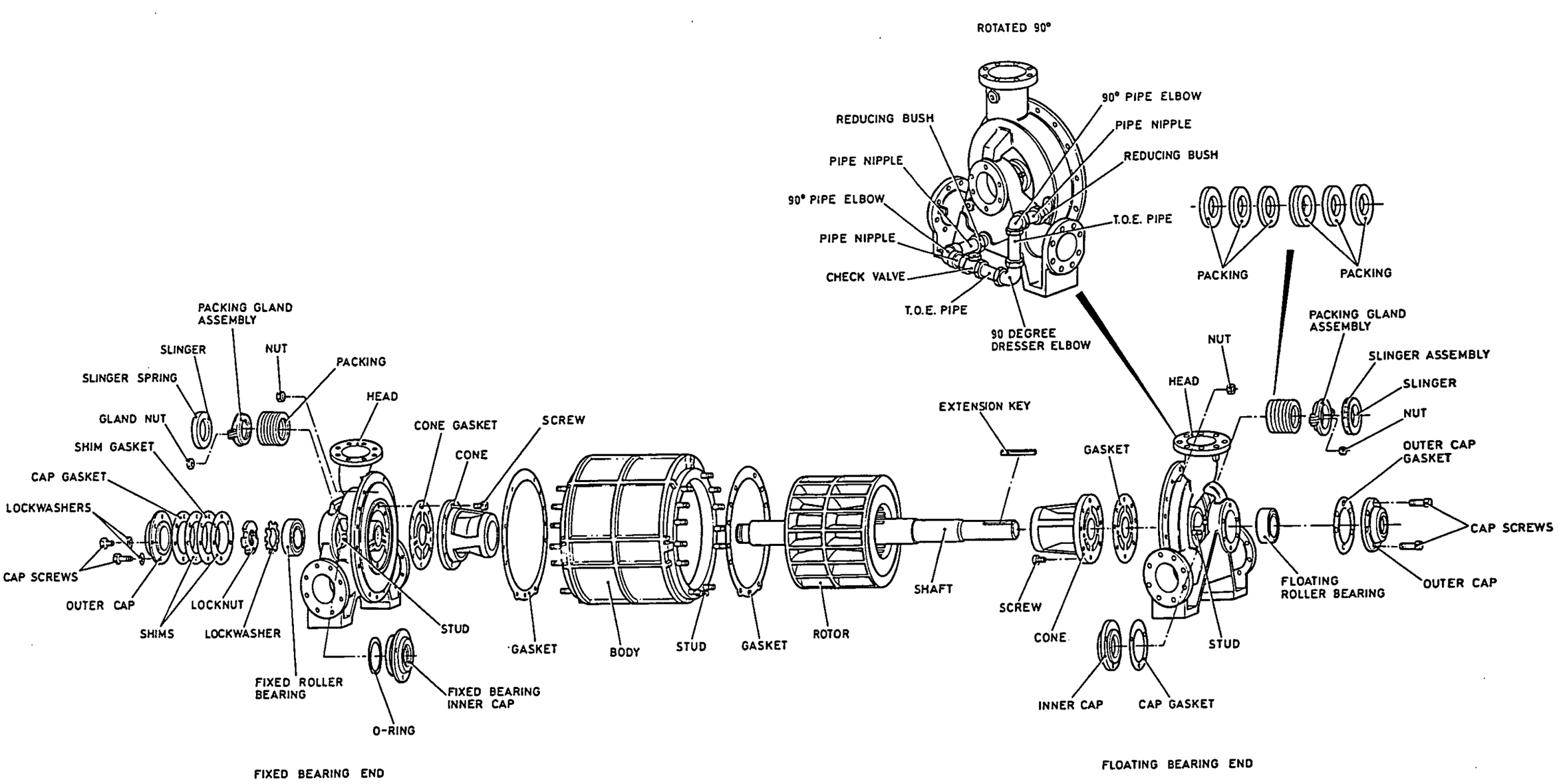
Manufacturer	Brook Crompton Parkinson
Type	7AD250M
Enclosure	TEFV
Insulation	F
Mounting	Horizontal foot
Power	75 kW
Bearings:	
Drive end	N217
Non-drive end	6217
Speed	1470 rev/min
Weight	440 kg
Supply	415 V, 3-ph, 50 Hz

3. DETAILED DESCRIPTION (fig. 1)

The sludge vacuum pumps are single stage, water ring pumps. Each pump is horizontally foot mounted on a common bedplate together with an electric driving motor. Drive is transmitted from the motor to the pump via a flexible coupling. The coupling is fitted with a guard.

3.1 Pump (fig. 1)

A rotor revolves without metallic contact in a cylindrical casing that contains a liquid compressant (water). The rotor is a casting consisting of a series of blades that project from a hollow cylindrical hub through which the shaft has been pressed. The blades are shrouded at the sides to form a series of chambers and are curved toward the direction of rotation. The shaft and rotor are mounted eccentrically within the casing.



DXF 817

FIG. 1 PUMP - EXPLODED VIEW

The shaft is a pressed fit in the rotor, the rotor hub bore is coated with 'Molykote G-n' paste (or equivalent) to prevent damage from friction or pick-up when the shaft is pressed into the rotor. It is supported between two roller bearings which are located in heads; one either end of the body. The heads are secured to the body by studs and nuts, a gasket is fitted between the body and each head.

Cones are secured to their respective heads by screws, the interface between the head and the cone is sealed by a gasket.

Where the shaft passes through the heads it is sealed by a packing gland assembly and six turns of packing. A slinger is positioned on the shaft outside of the packing gland assembly.

The roller bearings are located in housings which are an integral part of the heads. Each bearing housing is closed by an inner and outer bearing cap which are, in turn, secured to the head by capscrews.

At the fixed bearing end of the pump an O-ring seals the joint between the inner bearing cap and the head. Shims and gaskets are fitted between the head and the outer bearing cap, the number of shims can be varied to provide correct axial positioning of the rotor within the body.

The interfaces between the floating bearing end outer cap, inner cap and the head are sealed with a gasket.

The fixed bearing is held in position on the shaft by a locknut and lockwasher while the floating end bearing is free to move axially on the shaft.

3.1.1 **Operation** (fig. 2)

In operation, the chambers formed between the rotor blades at point 'A' are full of water. The water rotates with the rotor, but follows the contour of the casing due to centrifugal force. As the rotor rotates the water begins to recede from the rotor chambers at point 'B' and is replaced with air from an inlet port in the stationary conical casing which connects to the pump inlet. When the chamber reaches point 'C' the rotor chamber is full of air. As the rotor further rotates the casing converges on the rotor and water once again enters the rotor chambers forcing the air out through a discharge port in the conical casing to the pump outlet. At point 'D' the chamber is once again full of water and the cycle recommences.

During operation water is expelled with the air and and is separated from the air in the sludge vacuum seal water air separator. The water is removed from the air separator by a sludge vacuum seal water circulating pump and passed via a sludge vacuum seal water cooler back to the sludge vacuum pump.

The water used as the liquid compressant also serves to seal clearances between the rotor and the cone and is referred to as seal water.

3.2 **Coupling** (fig. 3)

The Steelflex flexible couplings are used to transmit drive between the motor and the pump and are keyed onto their respective shafts.

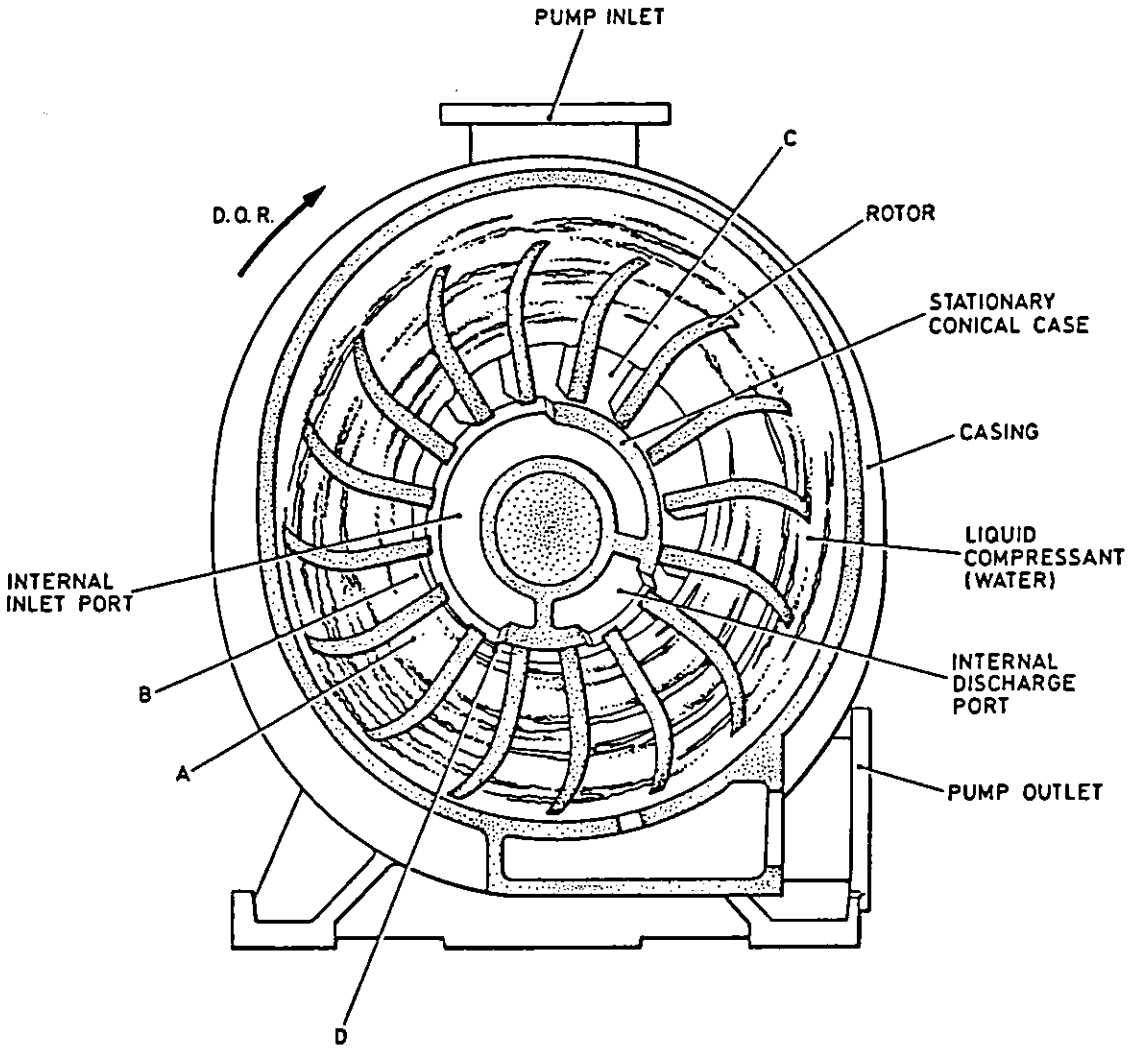
A coupling comprises two half couplings (hubs). Around the circumference of the half couplings are cut profile slots into which is fitted a continuous interleaf grid (spring), thus joining the two halves together. The unit is encased in a cover,

which is manufactured in two halves, the halves being secured by four bolts and nuts (fasteners). The two cover halves are match marked to aid assembly after maintenance.

A seal is located at each end of the coupling, fitted in annular recesses machined in the cover, which prevents the ingress of dirt, water, etc. into the coupling and retains the coupling lubricant. The coupling is lubricated by removing plugs in the cover halves and inserting a lubrication fitting.

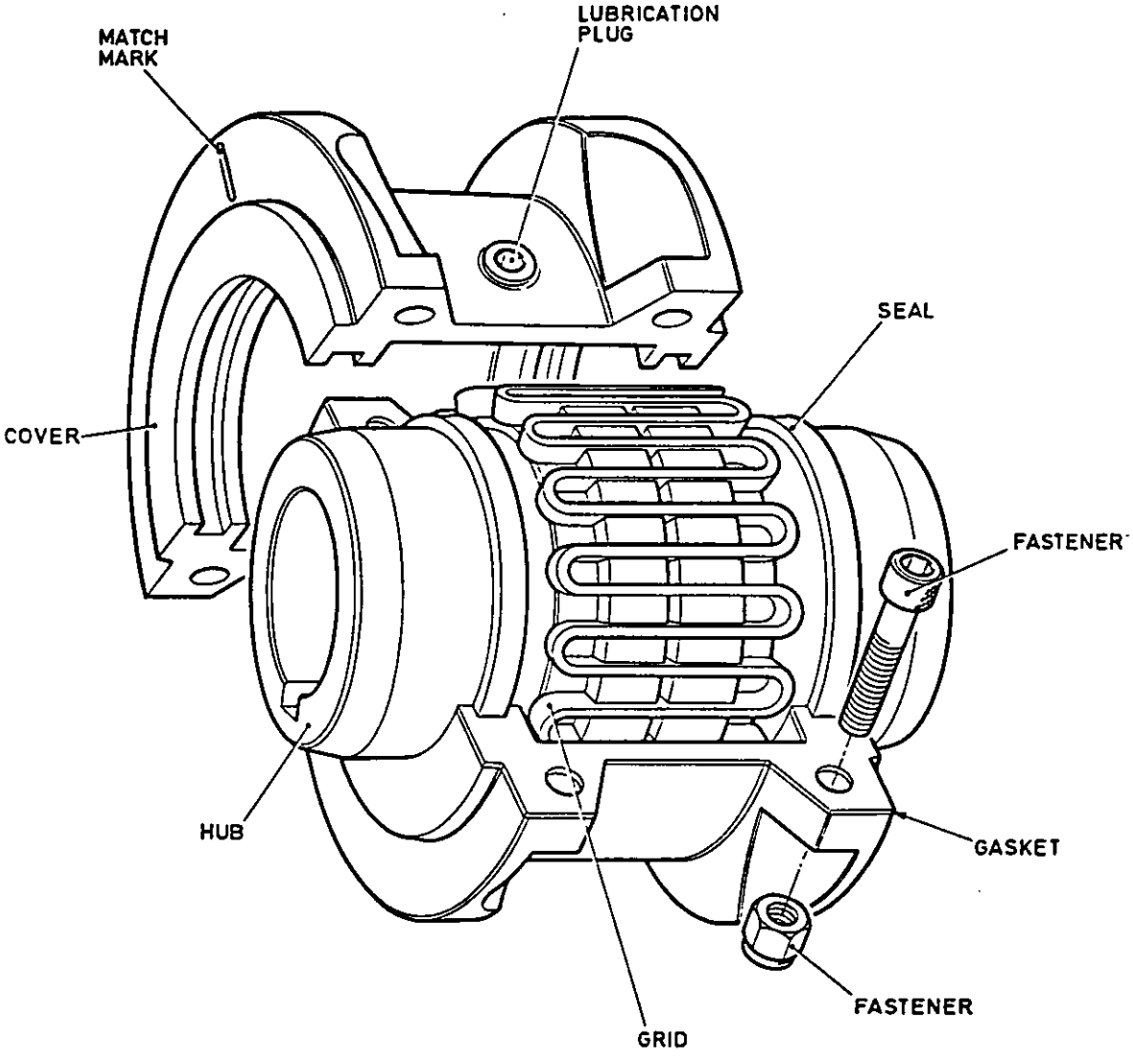
With the coupling at rest no motion is being transmitted, and no load is being subjected to the grid. With the motor rotating, motion is transmitted from one half coupling through the interleaf grid to the other half coupling.

The flexible coupling provides a damping effect for smoother transmission and because of the freedom of the grid (spring) in the slots, allows for slight misalignment between the driver and the driven unit.



DXF 819

FIG. 2 VACUUM PUMP - OPERATION



DXF 684

FIG. 3 COUPLING

PLANT DESCRIPTION MODULE DXFM 244

ITEM	Sludge Filtrate Break Tank
MANUFACTURER	Delkor Ltd
TYPE MODEL	Dwg. No. DXF/HN/25614

LIST OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

A sludge filtrate break tank is situated beneath each of the sludge belt filters in the gypsum dewatering plant house which is located at the south east corner of the Waste Water Treatment Plant (WWTP).

Mounted on a skid with other sludge belt filter ancillary equipment, it contains a head of filtered water for use by the sludge filtrate belt wash pump to spray the cloth belt of the filter each time sludge is discharged.

2. TECHNICAL DATA

Tank

Manufacturer	Delkor Ltd.
Type	Dwg. No. DXF/HN/25614
Material	Polypropylene (BS4994-88)
Number Off	3
Height	1500 mm
Diameter	1000 mm
Flanges	BS4504-16/3
Capacity	1 m^3
Weight (excluding valves, etc.)	
Empty	95 kg
Full	1145 kg

3. DETAILED DESCRIPTION (fig. 1)

The sludge filtrate break tanks are cylindrical vertically mounted units. The flanged base of the tank is 12 mm thick and is provided with four holes to take holding down bolts. The wall of the tank is 6 mm thick and is strengthened by three circumferential 6 mm stiffeners (bands); one at the top, one at the bottom and one in an intermediate position.

The top of the tank is closed by a lid complete with mild steel backing rings. The backing rings and lid are secured to the top of the tank by nuts, bolts and washers. The interface between the top of the tank and the lid is sealed by a 3 mm thick rubber gasket. Two lifting points are incorporated into the lid.

With the exception of the low level shut off which is 65 mm, all nozzles are 40 mm. At the bottom of the tank, situated in the wall 180 degrees apart, are a sludge filtrate belt pump suction line and a drain line to the sludge vacuum seal water air separator.

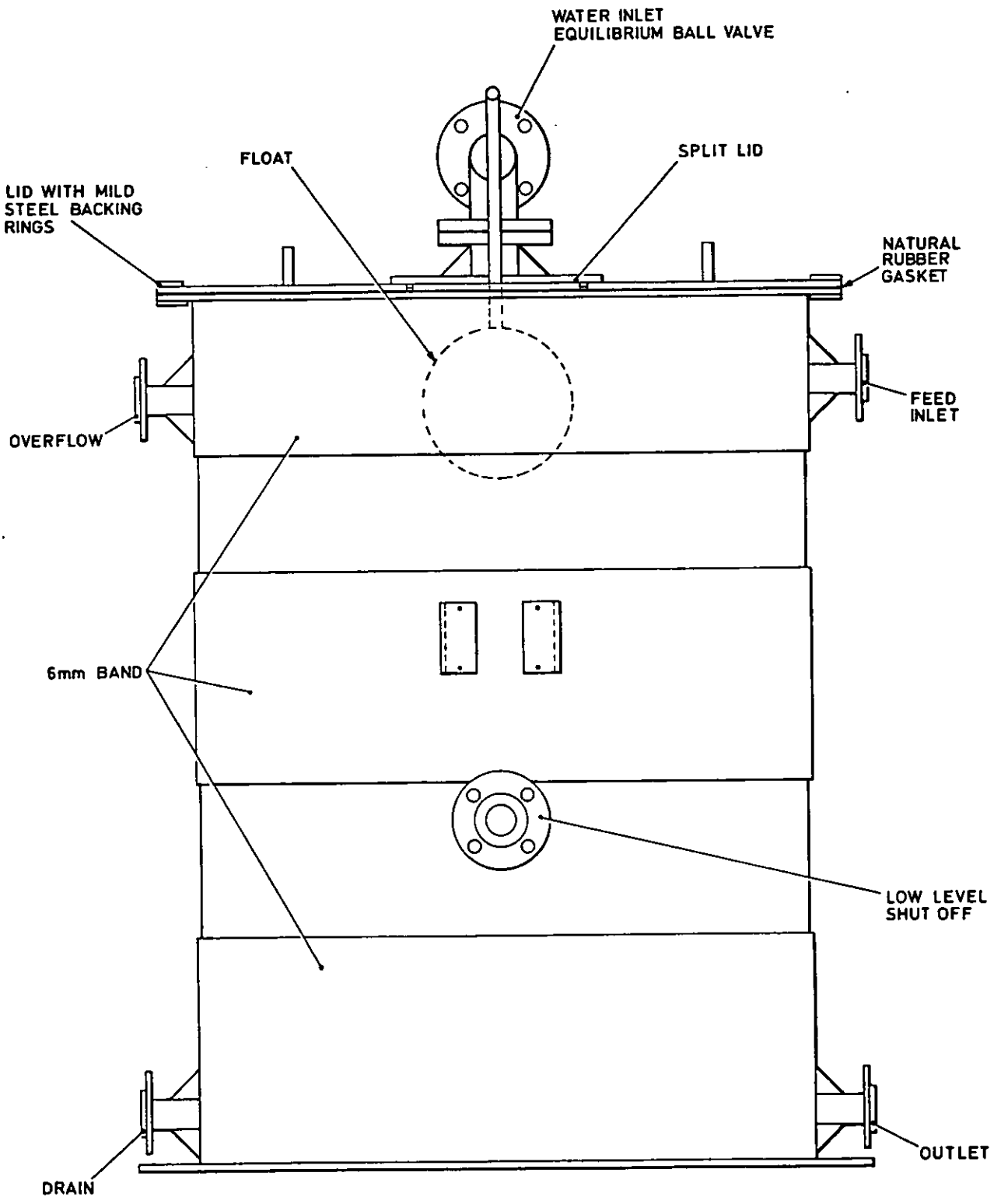
Situated in the wall at the top of the tank, directly above the sludge filtrate belt pump suction, is a feed inlet. This is supplied from the sludge filtrate receiver via the sludge filtrate pump, the flow being regulated as required.

Situated in the wall at the top of the tank, directly above the drain outlet, is an overflow. This line joins with the drain line and discharges to the sludge vacuum seal water air separator.

A float-operated ball valve is mounted on the lid of the tank. It is flanged and bolted to its nozzle on the tank, the interface between nozzle and valve is sealed with a 3 mm rubber gasket. The valve supports the supply of water from the sludge filtrate receiver in maintaining an operating level of water in the tank which is just below the feed and overflow nozzles. The ball valve float connecting arm passes down centrally through a 9 mm split lid that itself is spigot located centrally in the main lid of the tank. The split lid is of sufficient diameter, that when removed, will permit the removal of the float for maintenance purposes.

A low level shut off is fitted approximately one third of the way up the tank wall and at 90 degrees to the sludge filtrate belt pump suction. Fitted directly above the low level suction are two mounting cleats each with two 3.5 mm holes.

Around the middle of the tank is a band of 50 mm wide, adhesive marking tape - BS4800 12D45.



DXF 823

FIG. 1 TANK - GENERAL ARRANGEMENT

PLANT DESCRIPTION MODULE DXFM 245

ITEM	Sludge Filtrate Receiver
MANUFACTURER	Delkor Ltd
TYPE MODEL	Dwg No. DXF/HN/25615

LIST OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

A sludge filtrate receiver is situated beneath each of the three sludge belt filters in the gypsum dewatering plant house which is located at the south east corner of the Waste Water Treatment Plant (WWTP).

Mounted on a skid with other sludge belt filter ancillary equipment, it is used to collect sludge filtrate drawn from the filter by the operation of the sludge vacuum pump.

2. TECHNICAL DATA

Receiver

Manufacturer	Delkor Ltd.
Type	Dwg. No. DXF/HN/25615
Material	Mild steel
Number Off	3
Height	2490 mm
Diameter	1420 mm
Flanges	BS4504-16/3
Lining	Natural rubber to BS6374 PT5 1985
Internal diameter inside rubber lining	1350 mm
Internal height inside rubber lining (longest side)	2122 mm
Hydrostatic test pressure	3 bar

3. DETAILED DESCRIPTION (fig. 1)

The sludge filtrate receivers are cylindrical in shape and are vertically mounted on four steel angle supports. They are manufactured from mild steel and are of all welded construction. Each receiver is mounted on a plinth and secured to it by bolts.

The bottom of a receiver is cut off at an angle so that it is elliptical in shape and slopes down to two 80 mm nozzles, fitted in the wall of the receiver, they are the filtrate outlet and drain. The vessel is internally protected with a lining of natural rubber.

The filtrate outlet is the suction line for the sludge filtrate pump. The pump takes its suction from the sludge filtrate receiver and discharges to the sludge filtrate break tank.

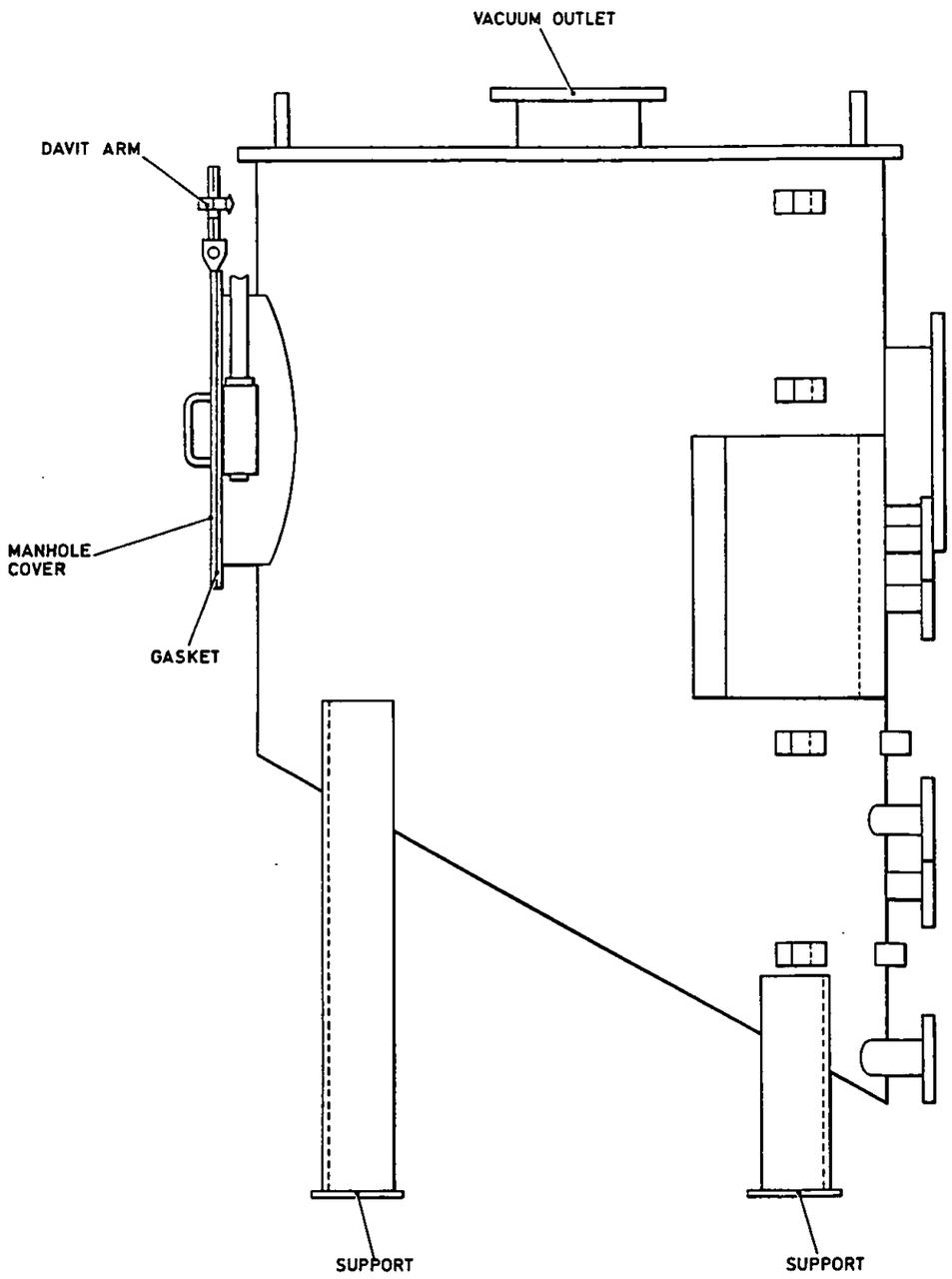
On the wall of the receiver, directly above the filtrate outlet and drain, are four 65 mm nozzles for mounting control instruments. The instruments are level probes and are secured to the receiver by bolts, the interface between each instrument and its receiver flange is sealed with a 3 mm thick neoprene gasket.

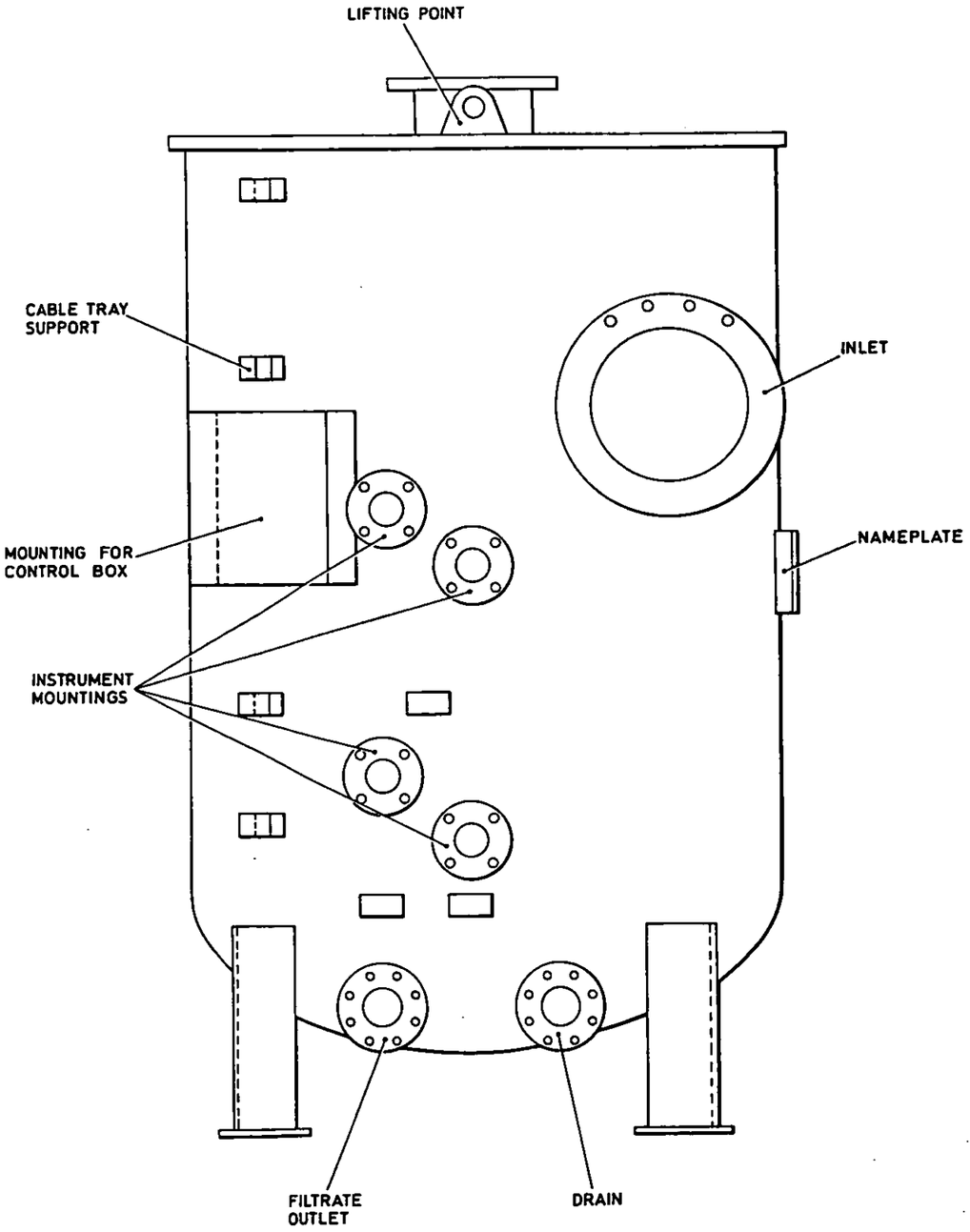
Positioned toward the top of the receiver, above and to the right of the filtrate outlet and drain, is a 350 mm receiver inlet. Through the inlet, the receiver takes in filtrate from the sludge belt filters. The flow into the receiver is regulated by a control valve. A second valve can divert the flow to bypass the receiver and discharge into the receiver drain line. The drain line discharges via a drain trench to the recycle sumps.

Positioned toward the top of the receiver, above and to the left of the filtrate outlet and drain, is a mounting for the control box. Cable tray supports are positioned on the receiver to carry cables to the control box.

A manhole is fitted on the shortest part of the receiver wall, 180 degrees from the centre line on the filtrate outlet and drain. It provides access to the vessel for inspection or maintenance purposes. The manhole is flanged and is 600 mm internal diameter. A manhole door is secured to the manhole by bolts. The interface between the manhole and cover is sealed by a 3 mm rubber gasket. The cover is supported by a davit which itself is fixed to the receiver. The davit permits the cover to be swung clear of the manhole when access to the receiver is required.

A 250 mm vacuum outlet (nozzle) is fitted centrally in the top of the receiver. It is flanged and raised 130 mm from the top of the receiver and connects directly to the sludge vacuum pump. Two lifting points are positioned on the centre line with and either side of the vacuum outlet.





DXF 824

FIG. 1 RECEIVER - GENERAL ARRANGEMENT

PLANT DESCRIPTION MODULE DXFM 246

ITEM	Sludge Filtrate Belt Wash Pump
MANUFACTURER	Durco
TYPE MODEL	$1\frac{1}{2}$ x 1 - 8/65

LIST OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

A sludge filtrate belt wash pump is situated beneath each of the three sludge belt filters in the gypsum dewatering plant house which is located at the south east corner of the Waste Water Treatment Plant.

The sludge filtrate belt wash pump provides a supply of water under pressure to spray the cloth belt of the sludge belt filter after it has passed around the head pulley. The pump takes its suction from a sludge filtrate break tank and discharges to sprayheads on either side of the belt.

2. TECHNICAL DATA

Pump

Manufacturer	Durco
Type	$1\frac{1}{2}$ x 1 - 8/65
Number Off	3
Capacity	7 m^3/h
Inner bearing	SKF 6206ZJ/C3 - MRC 5305G/STD
Outer bearing	SKF 5305NRH/STD - MRC 530G/STD
Impeller diameter	6.625 in
Weight	37 kg

Mechanical Seal

Manufacturer	Borg Warner
Type	BX 1125-9A5X

Motor

Manufacturer	Brook Crompton Parkinson
Type	ADF 112 M
Enclosure	TEFV
Insulation	F
Mounting	Horizontal foot
Power	4 kW
Speed	2890 rev/min

Bearings:	
Drive end	6206ZZ
Non-drive end	6205ZZ
Supply	415 V, 3-ph, 50,Hz
Weight	36 kg
Coupling	
Manufacturer	J.H.Fenner and Co.
Type	F50/100/SM16

3. DETAILED DESCRIPTION (fig. 1)

The sludge filtrate belt wash pumps and sludge vacuum seal water circulating pumps are centrifugal single stage pumps. Each pump is horizontally foot mounted on a common bedplate together with an electric driving motor. Drive is transmitted from the motor to the pump via a flexible coupling. The coupling is fitted with a guard.

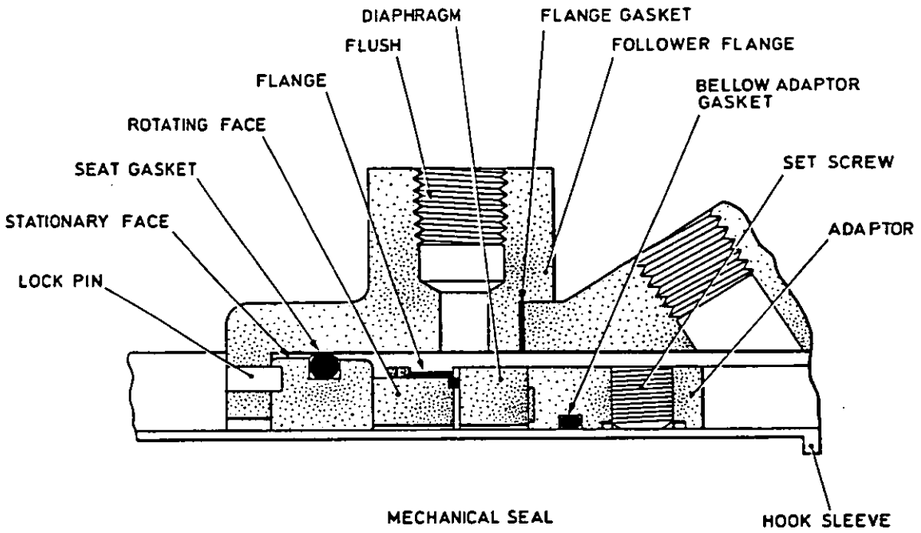
3.1 Pump (fig. 1)

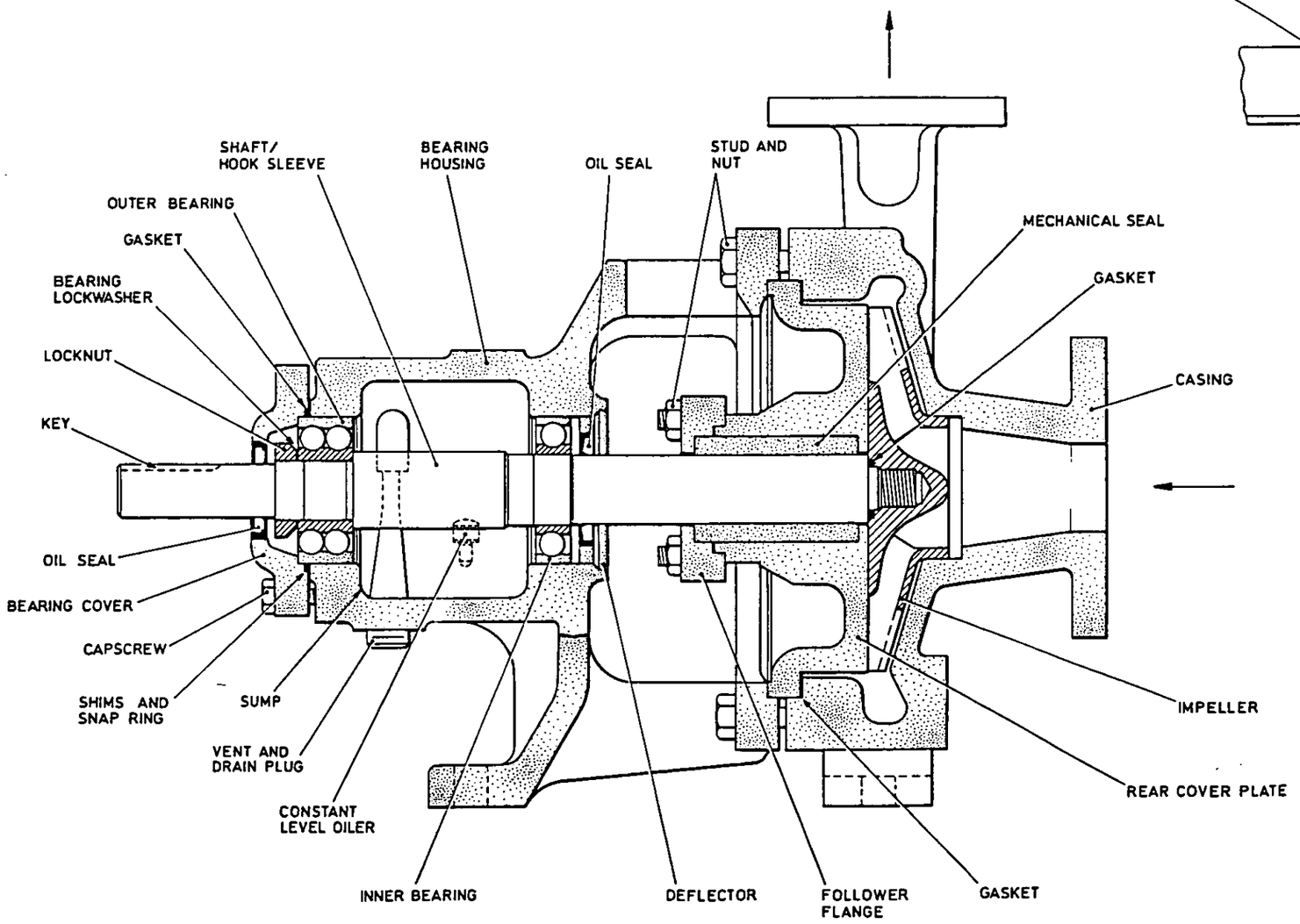
The sludge filtrate belt wash pump is a back pull-out, single stage unit. The pump casing and bearing housing are secured together on the vertical axis with the suction and discharge connections forming an integral part of the casing, as are the casing support feet. The bearing housing is supported centrally by a vertical support foot. This arrangement permits easy removal of the rotating assembly without disturbing the suction and discharge pipework.

The pump casing is machined internally to provide clearances between the casing and the impeller. The casing is closed at the driven end by a rear cover plate which is sandwiched between the casing and the bearing housing. The bearing housing is secured to the casing by studs and nuts. A PTFE gasket is fitted between the rear cover plate and the pump casing.

The rotating assembly consists of the shaft on which is mounted an impeller which screws onto a thread on the end of the shaft. A Teflon/rubber gasket is fitted between the impeller and a shoulder on the shaft. A half coupling is keyed to the drive end of the shaft. The pump shaft is supported at each end of the bearing housing by roller bearings which are an interference fit on the shaft.

The drive end bearing (outer bearing) is a double row ball bearing and abuts a shoulder on the shaft. It is held in position on the shaft by a locknut and lockwasher. The drive end bearing is closed in the bearing housing by a bearing cover which is fixed to the bearing housing by capscrews. An oil seal is fitted in the bearing cover. A cork gasket is fitted at the interface of the bearing housing and the bearing cover. The position of the impeller vanes relative to the rear cover plate is adjusted using shims and a snap ring between the bearing housing and the bearing cover gasket.





DXF 812

FIG. 1 PUMP - SECTIONAL ARRANGEMENT

The non-drive end bearing (inner bearing) is a single row ball bearing. It is closed in the bearing housing by an oil seal and a deflector.

A mechanical seal arrangement is fitted to the shaft where it passes through the rear cover plate. The seal is located in a stuffing box which is an integral part of the rear cover plate. Rubber seals (gaskets) fitted in the seal prevent the migration of water from the pump along the shaft to the bearing housing. The mechanical seal is retained in the stuffing box by a follower flange which is secured to the the rear cover plate by studs and nuts. The stationary part of the seal is located in the follower flange and is prevented from rotating by a lock pin.

Flushing/cooling water for the mechanical seal is provided by a connection from the discharge side of the pump to the the rear cover plate.

The bearings are oil lubricated. The oil in the bearing housing is maintained at a correct level by a constant level oiler (not illustrated) attached to the side of the bearing housing. The bearing housing is also fitted with a vent and drain plug.

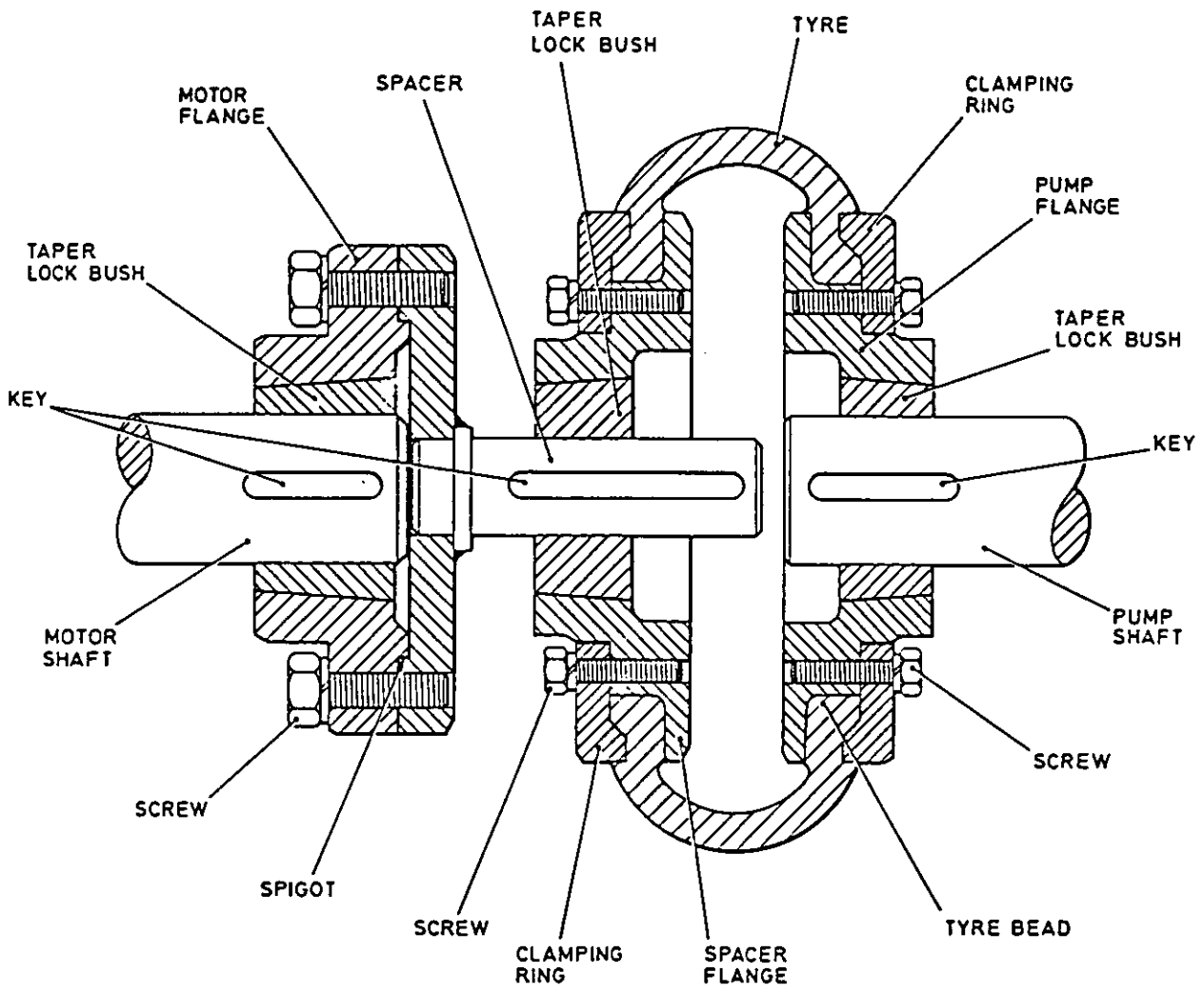
3.2 **Coupling** (fig. 2)

Drive is transmitted from the electric motor to the pump via a flexible coupling. The coupling basically comprises a motor flange, pump flange, spacer assembly and a tyre. The spacer assembly comprises a spacer flange, spacer and clamping ring.

Each flange is mounted on its respective shaft with a taper lock bush located on a key. The split taper bush has a keyway machined along its length. The keys are of such a width that the bush, when tightened, will not nip the key before gripping the shaft. The hub and the bush are drilled and tapped to take two hexagonal headed screws, 180 degrees apart, that when tightened lock the bush and hub to the shaft.

The pump flange (driven) and motor flange (driving) are keyed to and fitted flush with the end of their respective shafts. The driven flange has a spigot machined in its face for the correct location of the spacer, the spacer is connected to the driven flange by screws.

The spacer flange is positioned on the spacer shaft a fixed distance from the motor flange. A tyre, with beaded edges, is fitted over the motor and spacer flanges with the beads locating in a machined radius in the back of each flange. The beads of the tyre are held in position on their respective flanges by a clamping ring which is secured to the flange by screws.



DXF 786

FIG. 2 COUPLING

PLANT DESCRIPTION MODULE DXFM 249

ITEM	Sludge Vacuum Seal Water Cooler
MANUFACTURER	Associated Exchanger Services Ltd.
TYPE MODEL	Dwg No. DXF/HN/25621

LIST OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

A sludge vacuum seal water cooler is situated beneath each of the three sludge belt filters in the gypsum dewatering plant house which is located at the south east end of the Waste Water Treatment Plant (WWTP).

Filtrate is drawn from the sludge on the sludge belt filters by vacuum action. The vacuum is pulled by a water-sealed sludge vacuum pump. The sludge vacuum seal water cooler is provided to cool filtrate which is recirculated back to the vacuum pump from a sludge vacuum seal air separator. Cooling is achieved by passing the filtrate through a fan-cooled water cooler.

2. TECHNICAL DATA

Cooler

Manufacturer	Associated Exchanger Services Ltd.
Type	Dwg No. DXF/HN/25621
Number Off	3
Design pressure	3 bar g
Test pressure	4.5 bar g
Design temperature	100 °C
Inlet temperature	32 °C
Outlet temperature	22 °C
Air design temperature (in)	15 °C
Air design temperature (out)	25.4 °C
Dimensions:	
Height (overall)	1750 mm
Length	3500 mm
Width	1600 mm
Flanges	BS4504 NP16

Fan

Manufacturer	Chittom
Size	60 in
Blades	4

Fan Motor

Manufacturer	Brook Crompton Parkinson
Type	132SB
Speed	575 rev/min
Power	1.5 kW
Supply	415 V, 3-ph, 50 Hz

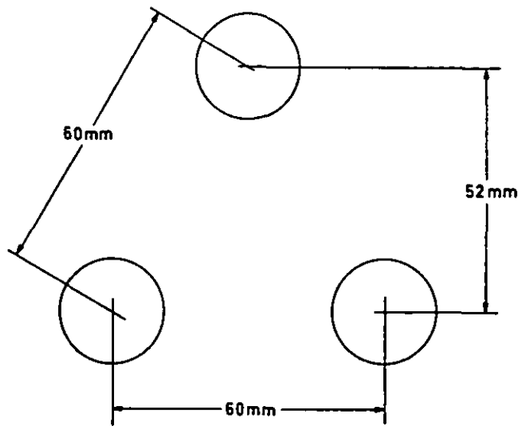
3. **DETAILED DESCRIPTION** (fig. 1 and 2)

The water cooler is a rectangular enclosure 3500 mm long, 1600 mm wide and 765 mm high; it is supported approximately 1000 mm clear of the ground on four steel angle legs. Lifting points for the complete cooler are incorporated in the top of each leg.

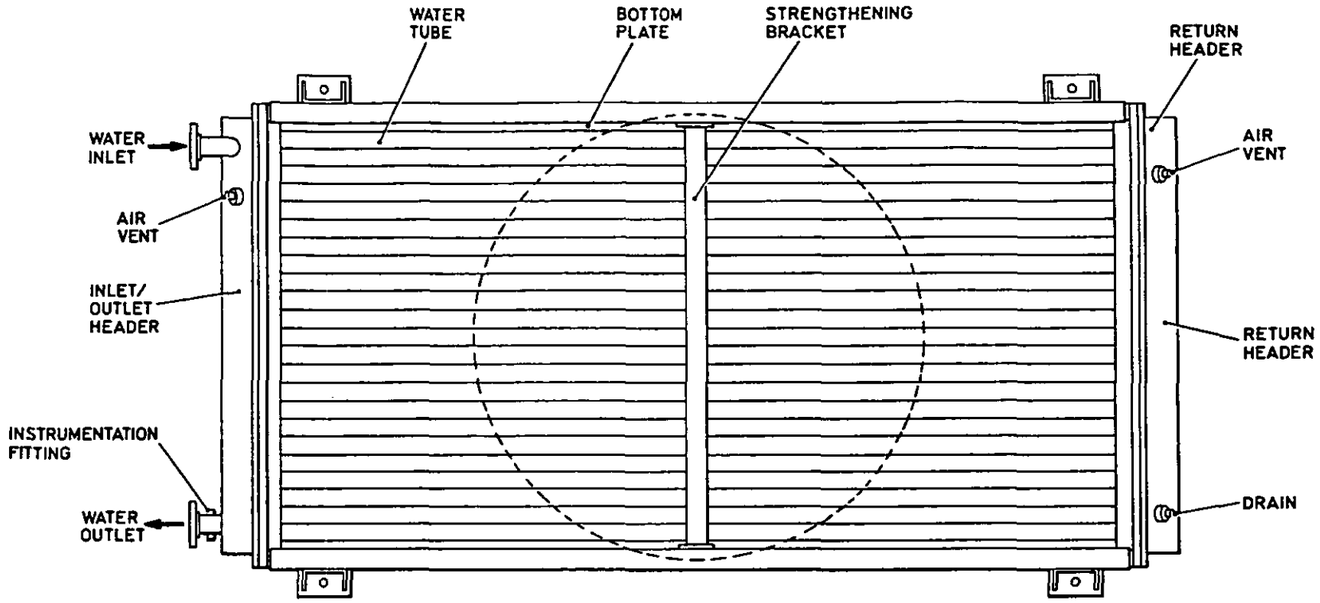
The upper part of the enclosure houses a tube bundle comprising two tube plates supporting five rows of finned water tubes, twenty four tubes in each row.

The enclosure is fitted with an open louvred frame at the top and is enclosed by a sidewall on each side. An electric motor driven axial flow cooling fan is suspended from the bottom plate and blows air upwards through the tube bundle via a circular hole. The empty space between the tube nest and the bottom plate forms the plenum which provides for dispersal of the air flow to give a more uniform cooling effect.

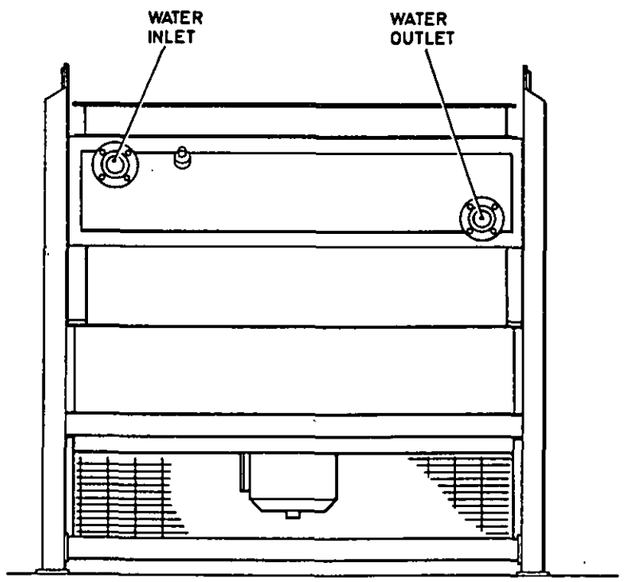
Two headers are fitted to the tube plates; a combined inlet/outlet header at one end and a return header at the other. 1.5 in NB nozzles are incorporated in the inlet/outlet header for the inlet and outlet water connections. Fittings on the outlet connection allow for the fitting of instrumentation as required. The return header is of similar design but has no water connections. Both headers are fitted with air vents; the return header is also fitted with a drain cock. The internal recesses of both headers are fitted with partition plates which cause the water to make ten passes through the tube nest.



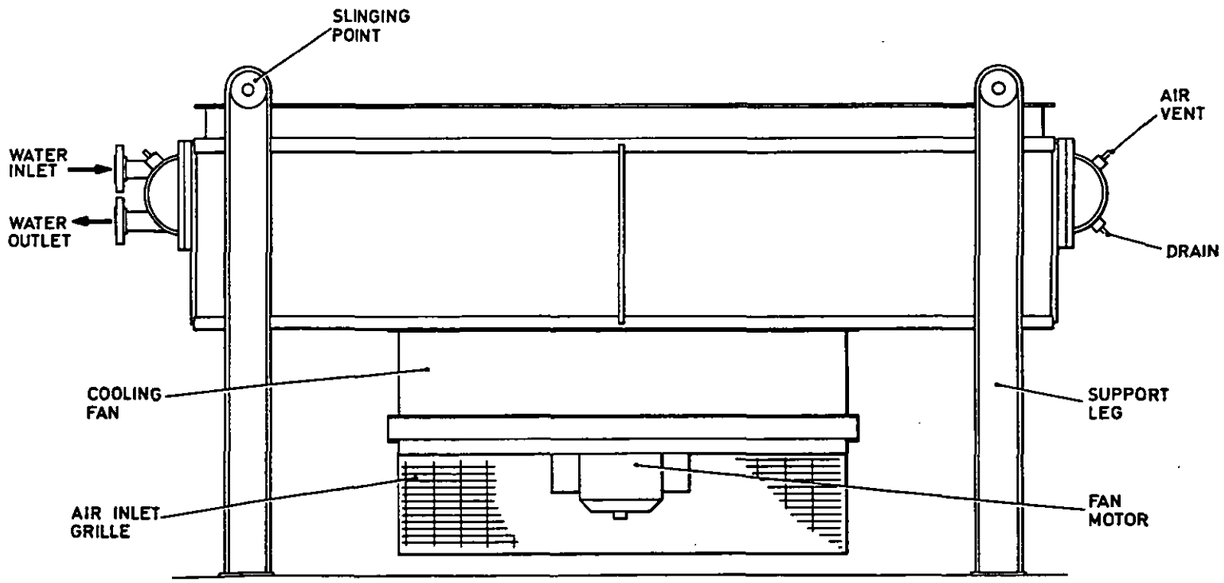
DETAIL OF TUBE PITCH



PLAN VIEW SHOWING TUBE NEST



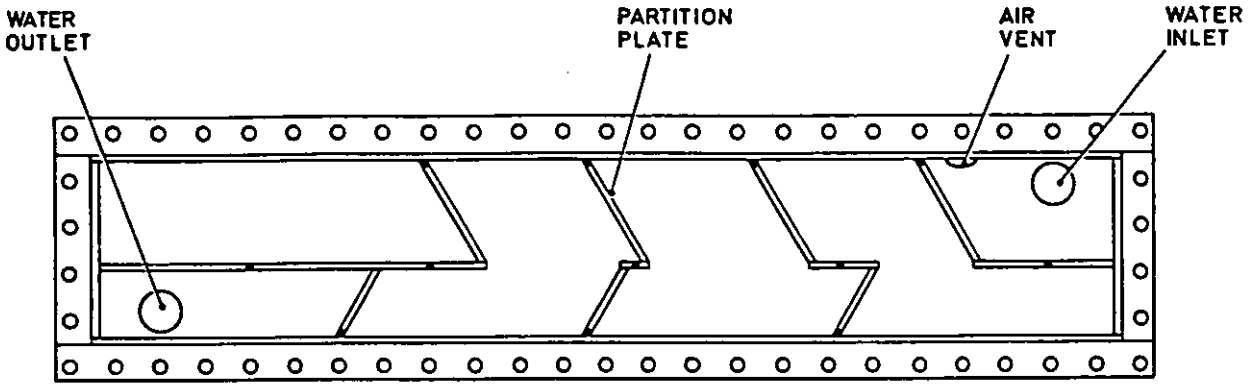
END ELEVATION



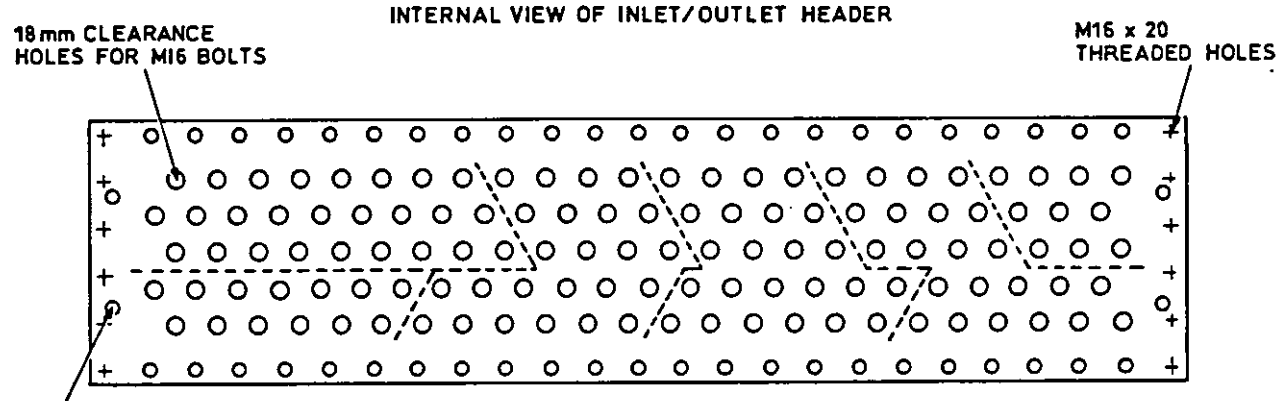
SIDE ELEVATION

DXF 831

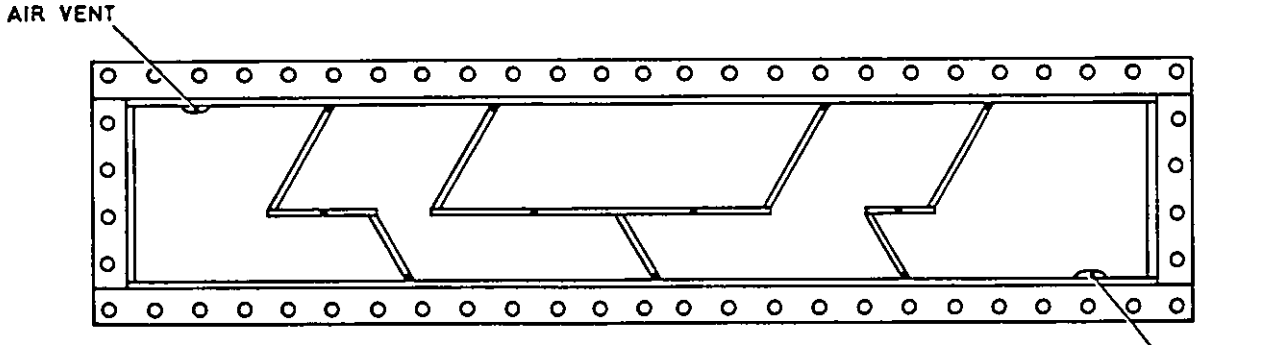
FIG. 1 WATER COOLER - GENERAL ARRANGEMENT



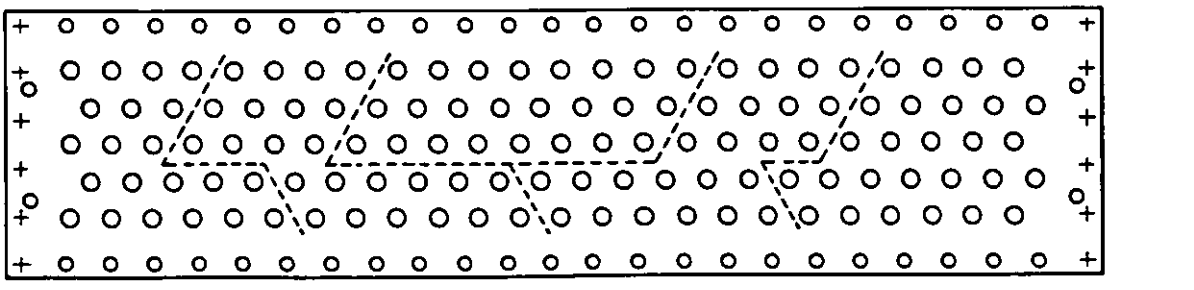
INTERNAL VIEW OF INLET/OUTLET HEADER



VIEW OF INLET/OUTLET HEADER TUBE PLATE
(LOOKING TOWARDS HEADER)



INTERNAL VIEW OF RETURN HEADER



VIEW OF RETURN HEADER TUBE PLATE
(LOOKING TOWARDS HEADER)

DXF 832

FIG. 2 WATER COOLER - DETAILS

PLANT DESCRIPTION MODULE DXFM 250

ITEM	Sludge Vacuum Seal Water Air Separator
MANUFACTURER	Nash Engineering Co. (GB) Ltd.
TYPE MODEL	Dwg. No. DXF/HN/25620

LIST OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

A sludge vacuum seal water air separator is situated beneath each of the three sludge belt filters in the gypsum dewatering plant house which is located at the south east end of the Waste Water Treatment Plant (WWTP).

Filtrate is drawn from the sludge on the sludge belt filters by vacuum action. The vacuum is pulled by a water sealed vacuum pump. The sludge vacuum seal air water separator is provided to permit the air and water mixture drawn by the vacuum pump to be separated. The air is exhausted to atmosphere and the filtrate is cooled and then recirculated back to the vacuum pump for sealing purposes.

To allow for any water loss a ball float valve maintains a pre-set level of water inside the separator from a make-up supply of towns water.

2. TECHNICAL DATA

Sludge vacuum seal water air separator

Manufacturer	Nash Engineering Co. (GB) Ltd.
Type	Dwg. No. DXF/HN/25620
Number Off	3
Dimensions:	
Overall height	1495 mm
Inside diameter	610 mm
Flanges	BS 4504 NP16/3

3. DETAILED DESCRIPTION (fig. 1)

The air separator is a cylindrical vessel of welded construction mounted vertically. The top is domed and carries a short flanged pipe connection. The vessel stands 1495 mm high overall and has an internal diameter of 610 mm; it is welded to a square steel baseplate.

The vessel has seven flanged nozzles as follows:

(1) A 150 mm nb flanged inlet connection for a mixed inflow of air and warm water from the vacuum pump. The inflow is immediately deflected sideways by a deflector plate mounted between two support plates. The deflection causes the water to swirl round the inside wall of the vessel, the centrifugal action releasing the air content.

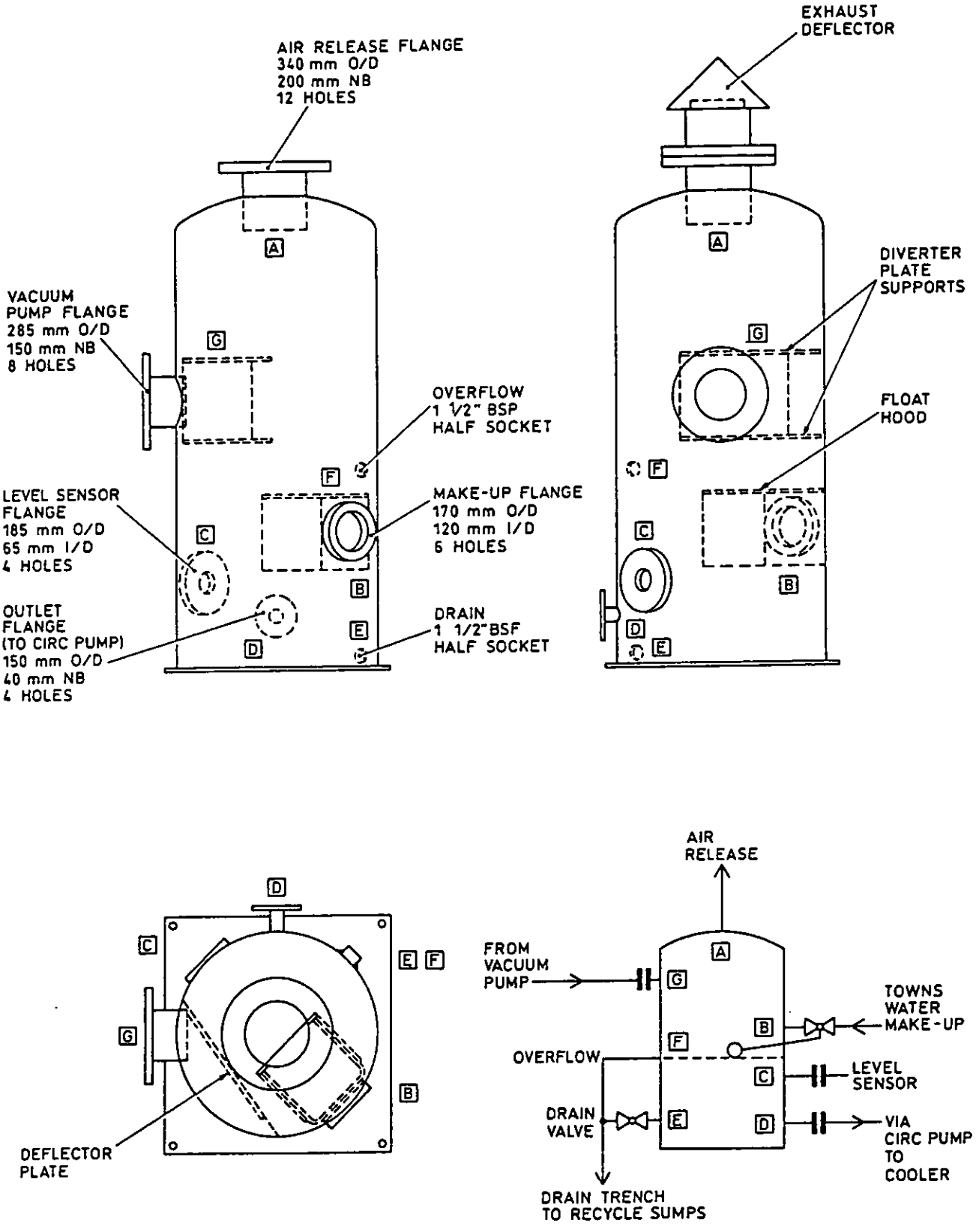
(2) A 40 mm nb flanged outlet connection for the water which is to be recirculated back to the vacuum pump via the water cooler.

(3) A 200 mm nb flanged outlet pipe through which the separated air is exhausted to atmosphere. The outlet is provided with a conical deflector which is bolted to the flange.

(4) A 120 mm inside diameter flanged connection mounted on the side of the vessel through which a make-up supply of towns water is provided. The inflow is controlled by a ball float valve which is shielded from water turbulence by an enclosure, open at the underside.

(5) Two half sockets are welded on the outside of the vessel. They are internally threaded to 1.5 in BSP to provide connections for an overflow pipe and a drain valve. Both outflows run via the drain trench to the recycle sumps.

(6) A 65 mm inside diameter flange connection is provided for seating a level sensor.



DXF 836

FIG. 1 SEAL WATER AIR SEPARATOR - ARRANGEMENT

PLANT DESCRIPTION MODULE DXFM 252

ITEM Sludge Discharge Conveyor

MANUFACTURER Portasilo Ltd.

TYPE MODEL Dwg. No. DXF/HN/25635

LIST OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

The sludge discharge conveyor is fed with dewatered sludge from three sludge belt filters. Normally the sludge is transferred to a tube-type sludge transfer conveyor which delivers it to the fixation and disposal area of the Waste Water Treatment Plant (WWTP). Should the transfer conveyor stop, the discharge conveyor automatically reverses to deposit the sludge into a skip at the opposite end.

2. TECHNICAL DATA

Conveyor

Manufacturer	Portasilo Ltd.
Number installed	1
Material carried	Dewatered sludge (Gypsum)
Density	1.2 t/m^3
Belt speed	1.66 m/s (100 m/min)
Throughput	30 t/h
Temperature	Ambient
Duty	15 h/day, 7 days a week

Motor

Manufacturer	Brook Crompton Parkinson
Type	D160L
Number installed	2
Speed	1470 rev/min
Enclosure	TEFV
Power output	15 kW
Supply	415 V, 3-ph, 50 Hz

Fluid Coupling

Manufacturer	Fluid Drive Engineering Co. Ltd.
Type	11 FCU
Number installed	2
Max. diameter	333 mm
Length between shafts	231 mm
Multidisc plate thickness	9.5 mm

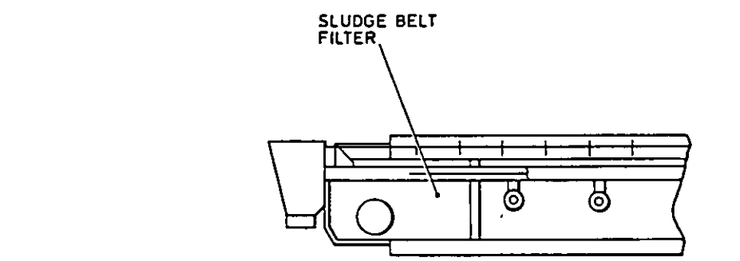
Oil capacity	4.5 litres
Bearings	45 mm ball, 35 mm roller
Disc Brake	
Manufacturer	Johnson Elevanja Ltd.
Type	CU01
Number installed	2 (Reverse drive end only is operational)
Size of disc	300 mm diameter, 15 mm thick
Power supply	110 V, 50 Hz
Gear Unit	
Manufacturer	David Brown Radicon Ltd.
Type	C 1600 RE
Number installed	2
Ratio	18.493:1
Oil capacity	11.3 litres
Cone Ring Coupling	
Manufacturer	David Brown Radicon Ltd.
Type	61107
Number installed	2

3. DETAILED DESCRIPTION

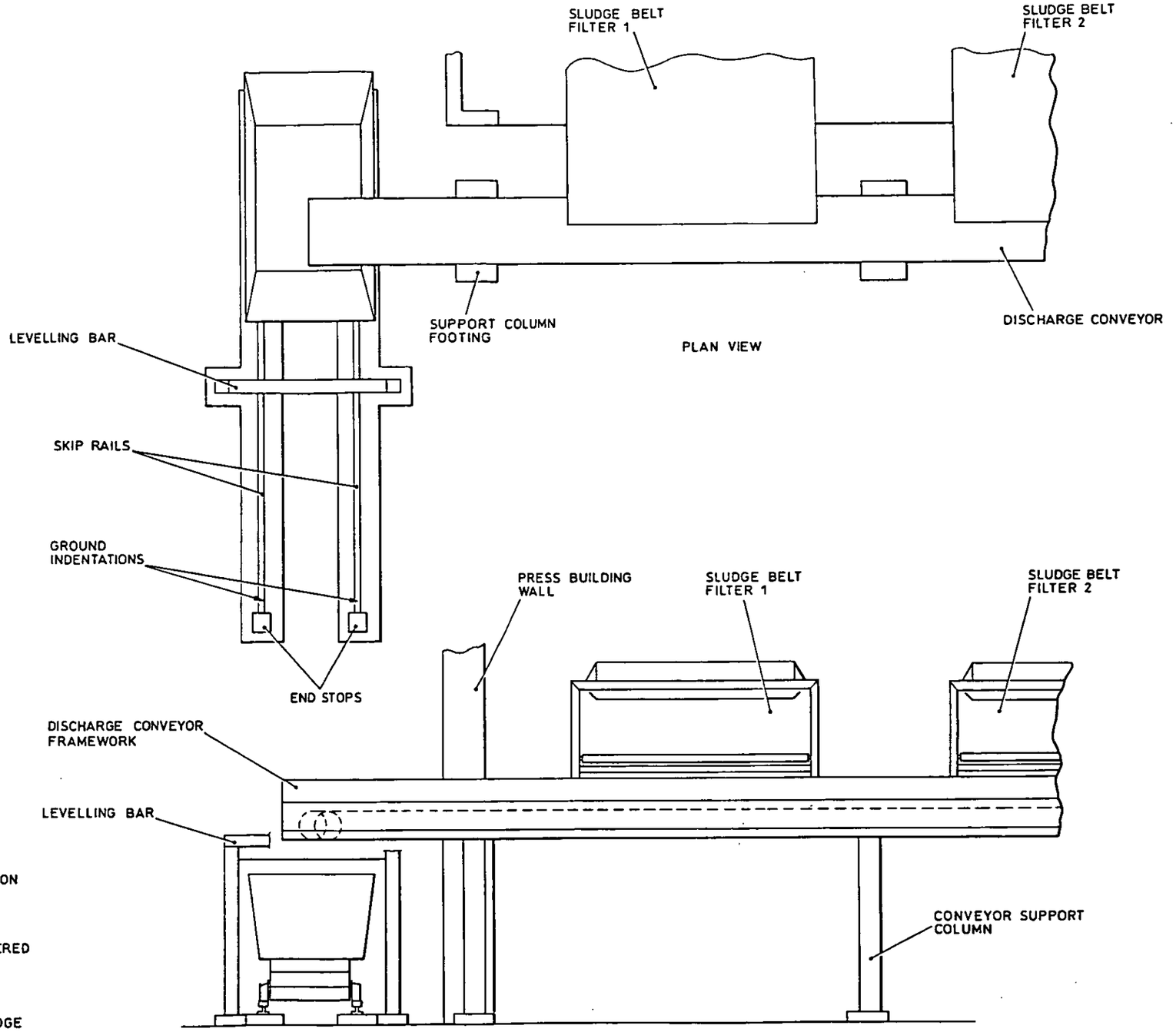
3.1 Conveyor (fig. 1 and 2)

The sludge discharge conveyor is positioned at right angles to and at the end of the three sludge belt filters on an east - west axis outside the sludge dewatering plant house. The conveyor normally drives in one direction (towards the west end) to transfer the sludge into a tube-type sludge transfer conveyor. Should the tube conveyor, which feeds a silo, stop for any reason the discharge conveyor automatically reverses to load a skip at the opposite end.

The 900 mm wide conveyor belt travels in a steel channel framework, approximately 26 600 mm long, which is raised and supported on braced steel columns 2400 mm above ground level. A walkway is fitted along the outside of the conveyor and around both ends. The end sections are widened to accommodate the drive machinery. The walkway provides access to the belt and driving machinery and is reached by vertical ladders at both end platforms.



SIDE ELEVATION

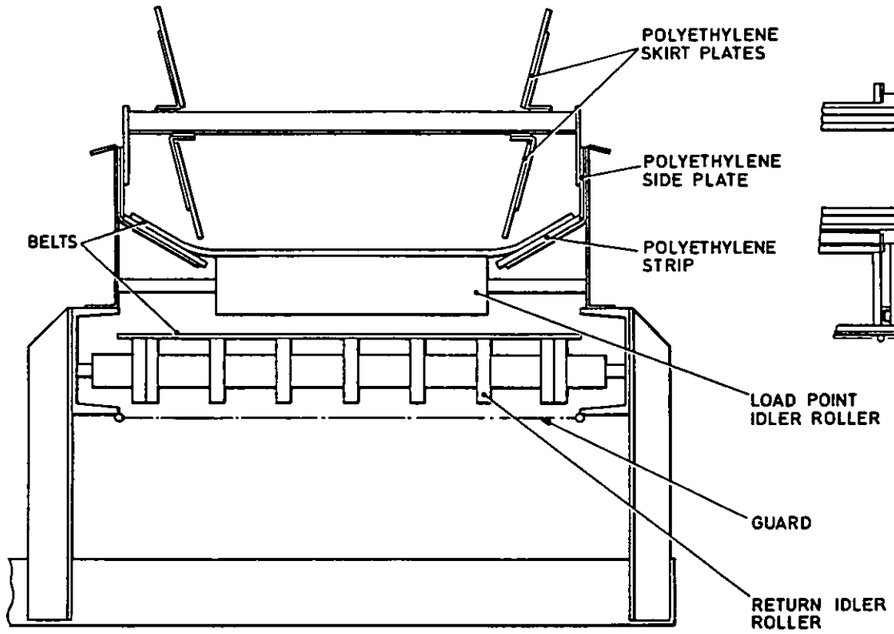


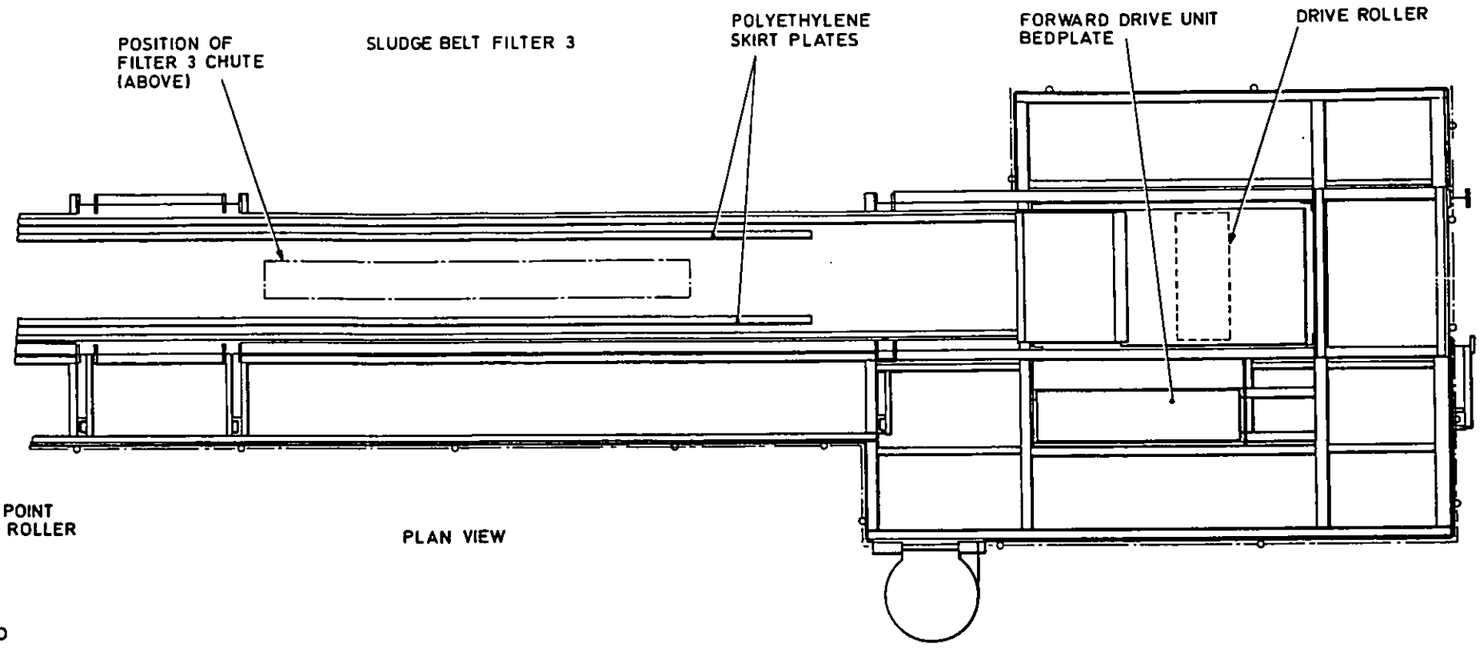
PLAN VIEW

FRONT ELEVATION

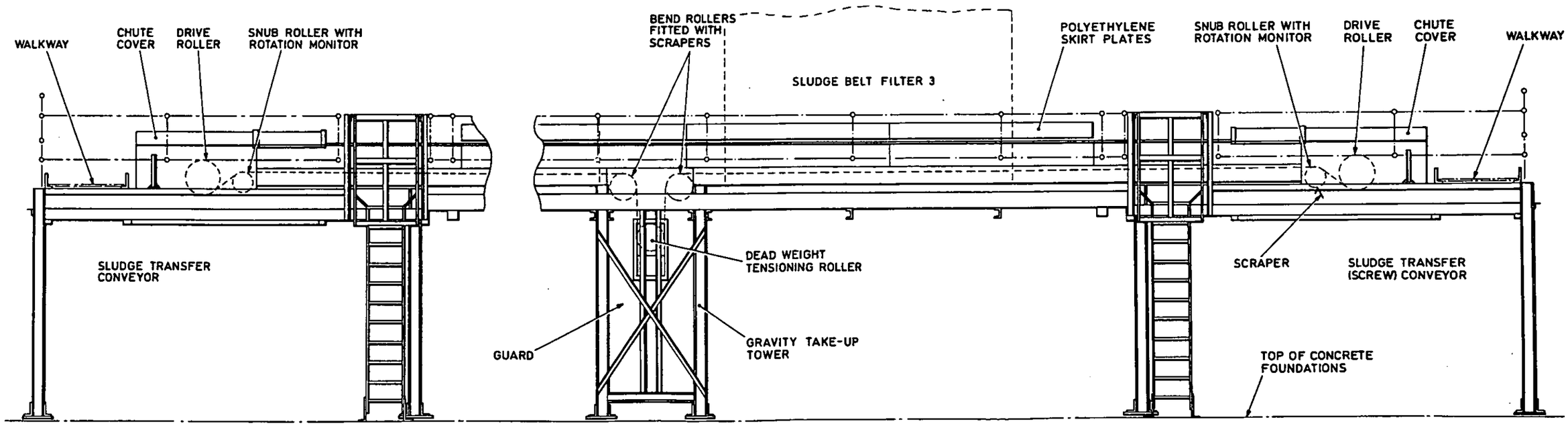
DXF 973

FIG. 1 SLUDGE DISCHARGE CONVEYOR - GENERAL ARRANGEMENT





PLAN VIEW



SIDE ELEVATION

DXF 974

FIG. 2 SLUDGE DISCHARGE CONVEYOR - DETAILS

Two, non-reversible, electric motors, one at each end of the conveyor, are used to drive the belt in opposite directions. The forward drive is located at the west end and transfers sludge to the tube-type sludge transfer conveyor chute; the reverse drive is located at the east end and transfers sludge to the skip chute. When one motor runs the other is unpowered and idles freely. Both motors are controlled from a weather proof pushbutton control panel mounted on an adjacent building column.

The belt runs almost the full length of the framework. Chutes are provided at each end to deliver the sludge to the sludge transfer conveyor or to the skip. The drive units, each comprising a motor, coupling, brake and gear unit, are mounted on bedplates which are aligned parallel to the belt. Each unit drives its respective belt end roller through a right angled transmission. The reverse drive electro-mechanical brake only is operational. The two drive rollers are lagged with chevron patterned rubber. A snub roller is positioned adjacent each drive roller. A belt rotation sensor is mounted on the snub roller shaft at the forward drive end. Scraper plates are fitted at the two drive rollers and are positioned adjacent the chutes.

The belt is tensioned by a dead weight tensioning roller suspended inside a gravity take-up tower from two bend rollers. The bend rollers are fitted with scrapers. The gravity take-up tower is located between the chutes of sludge belt filters 2 and 3 and is enclosed by protective mesh guards. The weighted roller is positioned between vertical guide rails.

Polyethylene strips, 10 mm thick, fixed to the belt support steelwork form the load carrying part of the belt into a trough thereby preventing sludge from spilling over the edges. Continuous 10 mm thick polyethylene skirting plates, fixed to mild steel backing plates on each side of the belt, extend across the three sludge belt filter discharge areas to direct the sludge down on to the flat part of the belt. Polyethylene side plates, 6 mm thick, are attached to the vertical part of the of the belt supporting steelwork enclosing the belt on each side.

The loaded part of the belt is carried on the following rollers:

(1) 42 Load point idlers: 14 at 250 mm pitch under each sludge belt filter chute which are covered with 6 mm thick impact rubber sleeving.

(2) 24 Heavy duty carrying idlers at approximately 500 mm pitch elsewhere. These idlers are covered with 6 mm non-stick polyethylene.

The belt return is supported on eight return idlers each of which is fitted with a symmetrical arrangement of 10 rubber discs.

The belt is enclosed by a series of guard plates which are attached to the structural steelwork underneath the belt return idlers on either side of the gravity take up tower.

3.2 Skip

The skip has a capacity of 11 tonnes and is normally used only when the tube conveyor is stopped for any reason. The skip is placed on an unpowered 4-wheel bogie which runs over a short length of track to position the skip either under the conveyor discharge chute or at the roadside for removal by lorry. The track is in two sections, one length of 5400 mm is mounted directly onto concrete footings and the other, a shorter length of 2087 mm under the discharge chute, is mounted on four load cells to form a weighbridge. The opposite ends of the track are provided

with end stops and the upper surfaces of the rails adjacent the end stops are ground down 5 mm at a radius of 100 mm near to the end stops to prevent unwanted movement of the skip. The abutting ends of the two sections of rails are chamfered but unbolted to enable free vertical movement of the weighbridge section.

The load cells provide signals to the weigh controller in a local control panel; one signal confirms that the skip is correctly positioned, the other provides a signal when the skip is full. The control system inhibits the reverse drive when the skip is not present or if it is fully loaded.

A levelling bar spans the track and ensures that the load is well distributed within the skip as it is removed.

3.3 Control System

Control of the discharge conveyor is vested in the adjacent control panel. The panel is subdivided, the left hand panel contains the weigh controller unit which can be viewed through a window in the door panel. The right hand section, containing relays, has a hinged door panel carrying controls and indications as follows:

(1) Manual start and stop pushbuttons which control the discharge conveyor reverse drive only.

(2) Emergency stop pushbutton which trips the discharge conveyor, transfer conveyor and the sludge belt filters.

(3) Fault reset pushbutton.

(4) A lamp test pushbutton.

(5) Seven indicating lamps which show the following conditions:

(a) Forward chute blocked.

(b) Reverse chute blocked.

(c) Weigh controller fault.

(d) Skip in position.

(e) Forward gearbox high temperature.

(f) Reverse gearbox high temperature.

(g) Rotation fault.

Normally auto control of the conveyor is selected at the WWTP control panel. On receiving a signal that the sludge transfer conveyor is running a klaxon sounds for ten seconds after which the sludge discharge conveyor starts up and travels in the forward direction. Operation of the sludge belt filters is then enabled.

The sludge discharge conveyor automatically reverses if the sludge transfer conveyor is stopped provided that an unfilled skip is in position. The reverse drive ceases when the weigh controller detects a load exceeding 11 tonnes; a signal is sent to stop the sludge belt filters at the same time. The conveyor reverse drive is

restarted using manual control once an empty skip is positioned in place of the full one.

Manual start and stop pushbuttons are provided for the sludge discharge conveyor at the WWTP control panel. Manual start and stop controls at the local panel are used mainly for maintenance purposes.

Instrumentation fitted to the sludge discharge conveyor comprises two tilt switches for detecting blocked conveyor discharge chutes, temperature sensors at both gear units and a belt speed (rotation monitor) sensor. Alarms, if initiated, are indicated locally and are repeated to the WWTP control room as a discharge conveyor system fault alarm.

A safety pull-wire is arranged along the length of the conveyor. When pulled the wire operates a switch which trips the running belt drive motor and consequently applies the electro-mechanical brake. The stopping of the discharge conveyor belt initiates tripping of all sludge belt filters.

3.4 Drive Unit

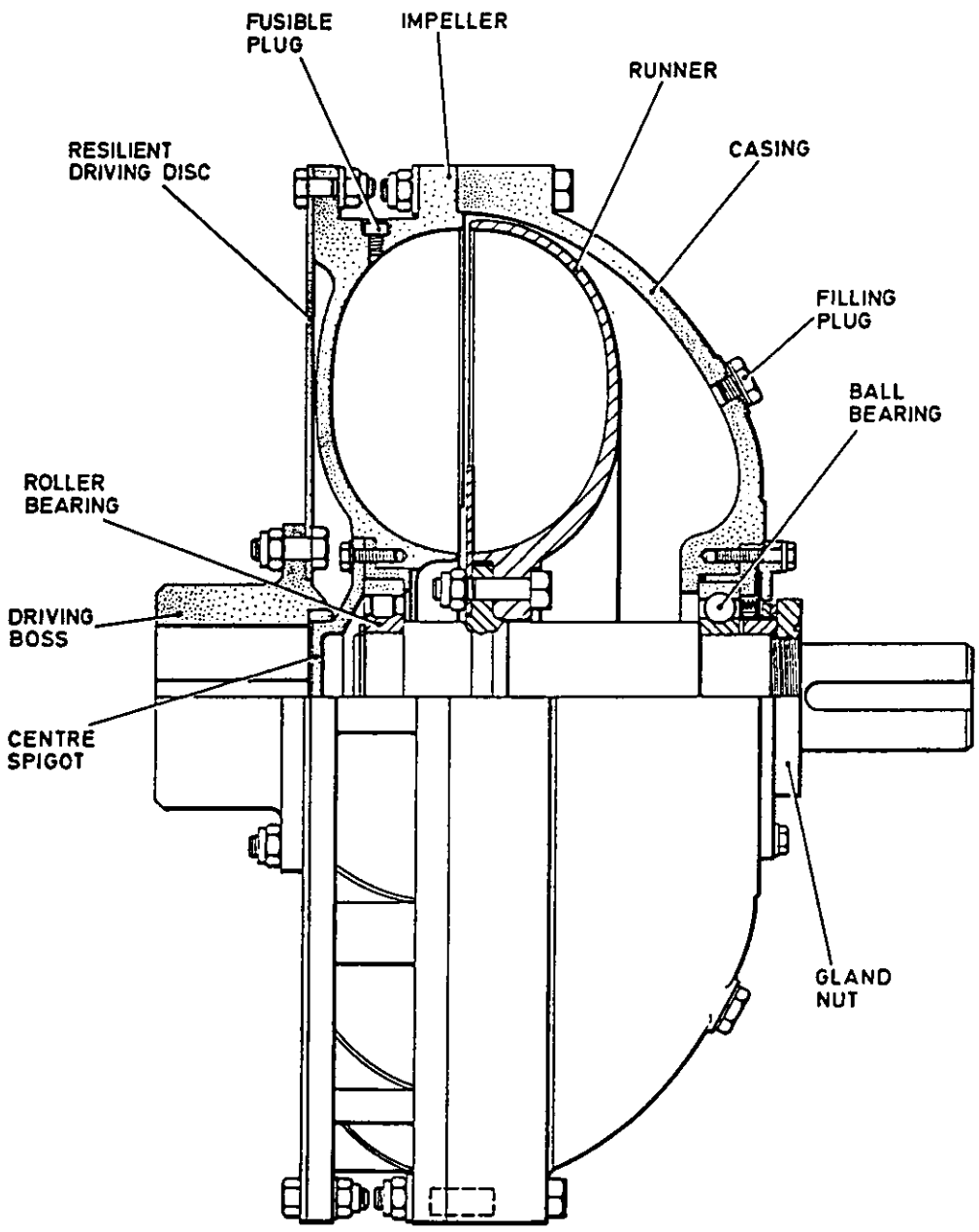
The forward and reverse drive units are mounted on bedplates at opposite ends of the conveyor frame. Each unit consists of a motor coupled through a fluid coupling and a disc brake to the input of a helical worm gear reduction unit. The output of the gear unit is connected to the drive roller via a cone ring flexible coupling. The reverse drive unit only is fitted with an operational electro-mechanical brake. The gear unit is fitted with an oil overtemperature sensor.

3.4.1 Fluid Coupling (fig. 3)

The Type FCU fluid coupling consists basically of two rotating assemblies, an impeller and a runner, contained in a casing. The impeller is connected to and driven by the electric motor and the runner is coupled to the reduction gear unit. There is no mechanical interconnection between the impeller and the runner, but both of these units have a large number of radial vanes on their facing sides which, through the medium of low viscosity oil, serve to transmit the torque from the motor to the gear unit.

The impeller is bolted to the coupling casing and is supported by ball and roller bearings on the output shaft. It is centred on the roller bearing by a centre spigot bolted to the casing and is coupled to the driving motor through a resilient driving plate. The resilient driving plate is bolted to a driving boss which in turn is keyed to the motor shaft.

The runner is bolted to the output shaft which is connected to the gear unit via a disc brake.



DXF 409

FIG. 3 FLUID COUPLING

3.4.1.1 Operation

When the motor is started with the driven gear unit at rest, the fluid coupling has zero torque capacity and the motor has to overcome only the inertia of its rotor and the coupling primary parts. Because of the light-load starting, the motor quickly attains working speed, hence the starting current is of short duration.

As the motor accelerates, the torque induced by the fluid coupling increases smoothly and quickly, thus the driven gear unit is started with the motor running at high efficiency. The amount of torque available for accelerating the driven machinery is dependent upon the amount of oil inside the coupling.

3.4.1.2 Fusible Plug

A fusible plug is incorporated in the impeller to provide an additional safeguard for the motor and to prevent overheating in the event of a prolonged stall and failure of the motor overload trips.

The plug contains a fusible alloy which melts and allows the oil in the fluid coupling to escape, thus removing the load from the motor. A spare fusible plug is screwed into the driving boss.

3.4.2 **Disc Brake** (fig. 4)

The disc brake forms part of the complete drive unit and is positioned on the shaft between motor and gear unit, after the fluid coupling. The rectangular baseplate of the disc brake is mounted on the same bedplate as the motor and gear unit. Although similar brake units are mounted at both ends of the conveyor only that at the reverse drive end is operational.

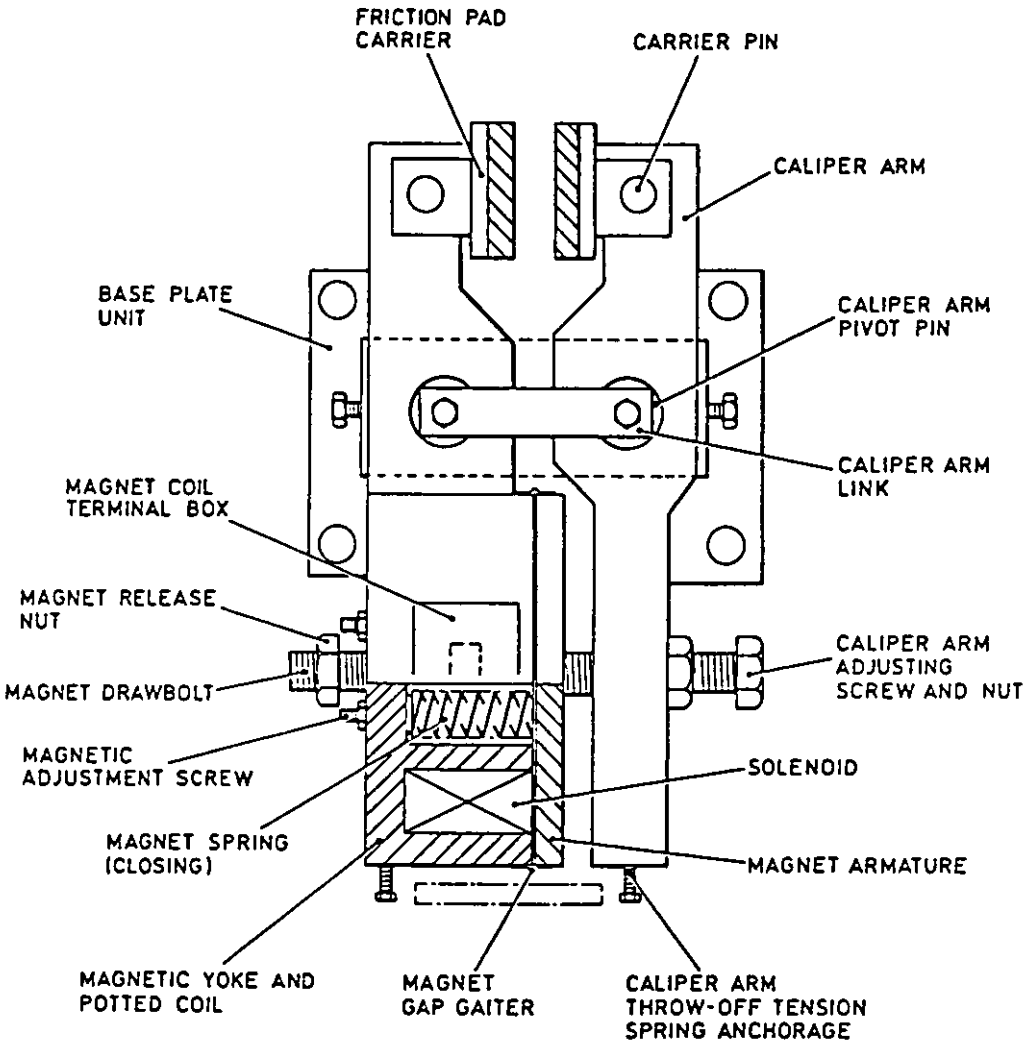
The disc is of 300 mm diameter and is 15 mm thick. The baseplate unit, calliper arms and friction pad carriers are steel fabrications. All rods and pins are machined from stainless steel. Main pivot points are fitted with self lubricating bushes to reduce maintenance. The friction pad linings are asbestos free and are bonded to the carriers.

The brake is of fail safe design being applied by a spring and released by an electro magnet; the brake is therefore automatically applied on a brake power supply failure. A screw-off release with detachable lever provides for emergency release.

The baseplate unit is positioned 85 mm below the shaft centreline and 142 mm off centre. The overall height of the brake unit is 142 mm.

The solenoid coil magnet is potted and incorporates the closing springs. The magnet is mounted on one calliper arm and attracts a disc shaped armature linked to the other arm. When the coil is energised the brake pad pressure is released. The calliper arms are pivoted from the baseplate unit. The air gap between magnet and disc is protected by a removable gaiter which prevents the ingress of dust particles, etc. The working air gap measured between magnet face and the disc shaped armature is initially set to 0.7 mm (0.027 in). The gap will increase with wear and need readjustment at 1 mm (0.04 in).

The magnet operates from a rectified 110 V, 50 Hz supply. The solenoid circuit incorporates resistors which provide a coil discharge path ensuring quick release.



DXF 2512

FIG. 4 DISC BRAKE

3.4.3 **Gear Unit** (fig. 5)

The reduction gear unit is a stand alone unit and consists of a helical steel wormshaft and a phosphor bronze wormwheel which is fitted with a helical gear input shaft reducer and a single extension output shaft. The unit is housed in a cast iron case which is foot mounted on the drive unit bedplate. The case is waveform styled to dissipate heat and improve thermal efficiency.

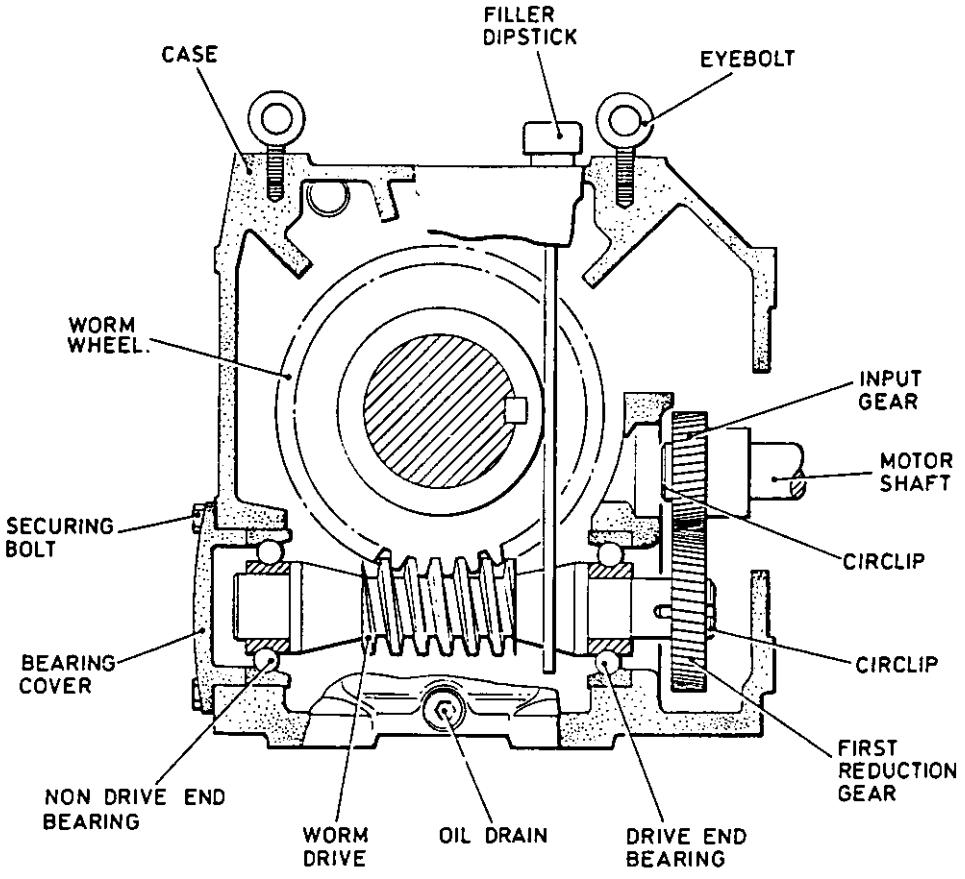
The gear unit is oil filled with approximately 11.3 litres of oil. A dipstick is incorporated in the top filler cap and a drain plug is located on the side of the case below the output shaft. A heat sensor is fitted to the unit which initiates an alarm at the local control panel and at the main control room panel if overheating of the gear unit occurs.

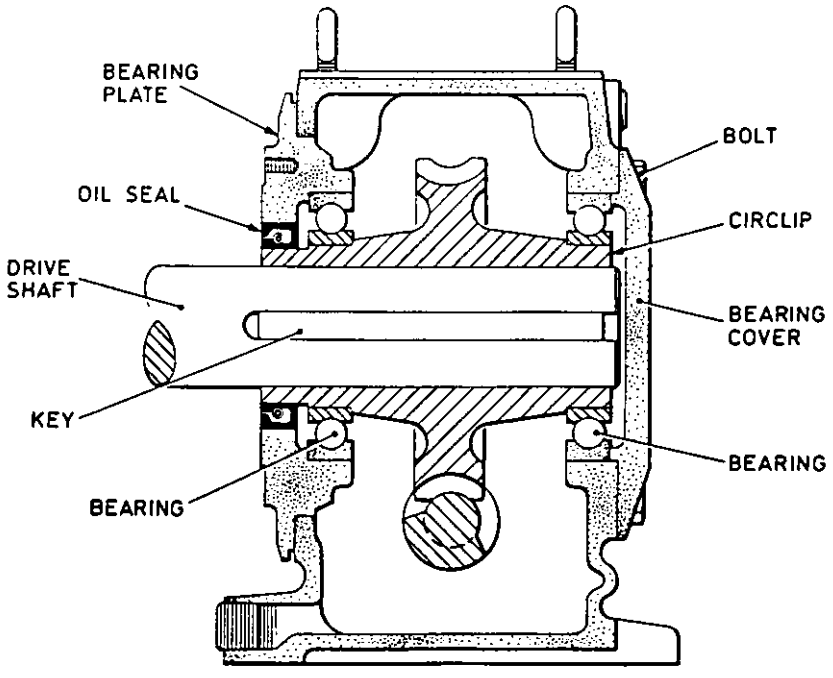
3.4.4 **Cone Ring Coupling** (fig. 6)

Drive is transmitted from the electric motor to the drive roller via a cone ring flexible coupling. The coupling basically comprises driving and driven coupling halves which are keyed to their respective shafts, and rubber cone rings mounted on pins.

The cone ring coupling is of pin and bush design and can accommodate slight misalignment. In addition, it permits axial movement of the driven shaft relative to the driving shaft as there is no mechanical link between the two coupling halves.

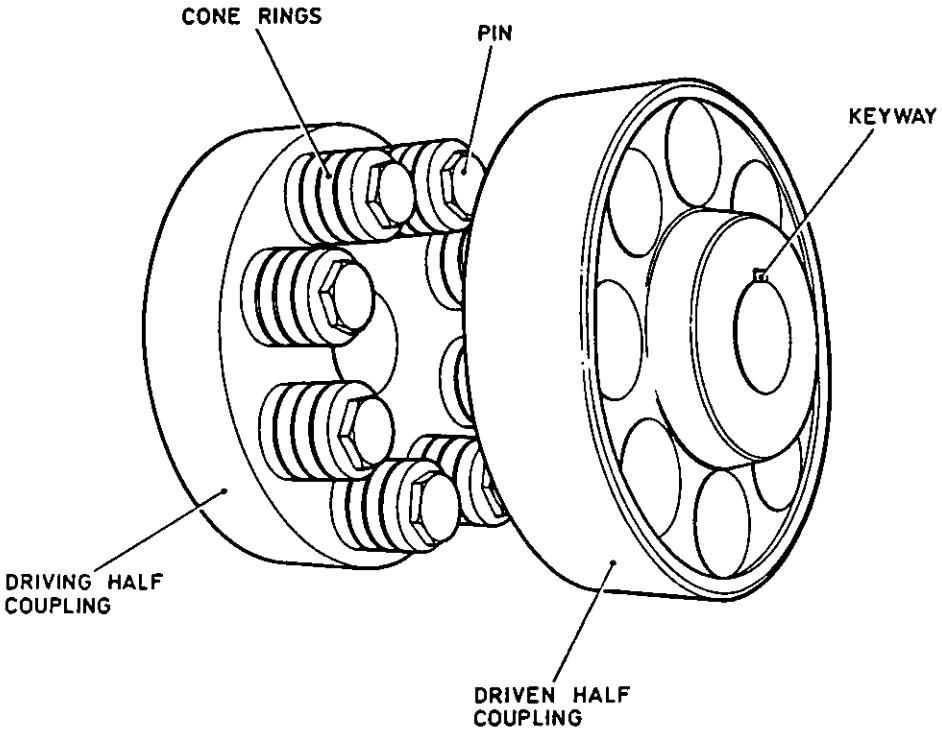
Four cone rings are mounted on each collared bolt (pin), the collar on each bolt locates against the face of the driving half coupling and is secured to the coupling half by a nut. The bolts and cone rings on the driving half coupling locate in holes on the driven half coupling, the drive being transmitted through the rubber cone rings.





DXF 2545

FIG. 5 GEAR UNIT



DXF 792

FIG. 6 CONE RING COUPLING

PLANT DESCRIPTION MODULE DXFM 402

ITEM Sludge Belt Filter

MANUFACTURER Delkor Ltd.

TYPE MODEL 300T/1200

LIST OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

The three sludge belt filters are each supplied with sludge from a ring main which, in turn, is supplied from either of two sludge thickeners.

The sludge belt filters are installed alongside each other in the sludge dewatering plant house. Each filter accepts wet sludge, dewaters it by vacuum action and then deposits it for disposal onto a single sludge discharge conveyor which travels across the outside of the plant house and serves all three filters.

An ancillary plant skid is positioned under each sludge belt filter. The plant comprises a number of vessels and pumps which service the filters and handle the water drawn off from the sludge during dewatering.

Each sludge belt filter is controlled by a control panel. The control panel incorporates a programmable logic controller which provides for sequenced starting, automatic control and sequenced stopping. The panel also provides for manual control of individual plant items and valves.

2. TECHNICAL DATA

Sludge Belt Filter

Manufacturer	Delkor Ltd.
Type	36 m^2 (Bond) filter
Model No.	300T/1200
Number off	3

Filter cloth

Manufacturer	Versidag
Type	Polynova 6505 PES
Length	32 380 mm
Width	3250 mm
Joint type	Clipper seam

Filter tray

Material	Polypropylene
Length	12 000 mm
Width	3000 mm

Drive pulley

Shell thickness	10 mm
Size	240 mm

Roller position	Underneath
Material	RLMS
Rubber:	
Type	Natural rubber
Thickness	10 mm
Bearings	Self aligning sealed roller type
Shaft	070M20 BS970 pt 1983 Rubber lining extends over end of pulley and terminates in a drip ring
Cloth spray pipes	
No. off	2
Diameter	40 mm
Nozzles per pipe	1 off with 24 / 1 off with 27
Drive Motor	
Manufacturer	Brook Crompton Parkinson
Type	ADF 160 MD
Enclosure	TEFV
Rating	Continuous
Speed	440 to 1750 rev/min
Supply	415 V, 3-ph, 50 Hz
Power	5.5 kW
Bearings:	
Drive end	6309Z
Non-drive end	6307
Inverter	
Manufacturer	Toshiba
Type	Pulse width modulated current
Model	VFA3 4055P
Control range	15 - 50 Hz

Gear unit

Manufacturer	SEW Eurodrive
Type	KA106 R82 LP160
Ratio	226:13
Output speed	1.99 to 7.96 rev/min

Control Panel

Manufacturer	Delkor Ltd.
Number off	3
Panel size:	
Height	1700 mm
Width	1800 mm
Depth	400 mm

3. DETAILED DESCRIPTION (fig. 1)

3.1 Sludge Belt Filter

Three identical sludge belt filters are located side by side in the sludge dewatering plant house. Each filter comprises a welded mild steel framework which supports and guides an endless filter cloth belt. Parts which come into contact with the process are manufactured in polypropylene. Sludge is fed onto the upper level of the belt as the belt moves slowly. When the upper level is covered in a layer of sludge the belt stops and a vacuum pump draws water out of the sludge into trays below the belt. The belt then restarts to discharge the dewatered sludge down a chute onto a conveyor serving all three filters. The belt returns along the lower level where it is washed by water sprays before returning to the upper level for another feed of sludge.

Below each sludge belt filter is a skid on which are mounted a number of items of ancillary plant which serve the belt filter.

The sludge belt filter framework incorporates the following items:

(1) The sludge distributor.

(2) The vacuum tray.

(3) The drive unit.

(4) The return rollers.

(5) The belt tensioning and tracking equipment.

(6) The belt washing system.

The operation of each sludge belt filter is intermittent, under the control of a Programmable Logic Controller (PLC) which is housed in an adjacent local control panel. The operation of each filter is totally independent of the others.

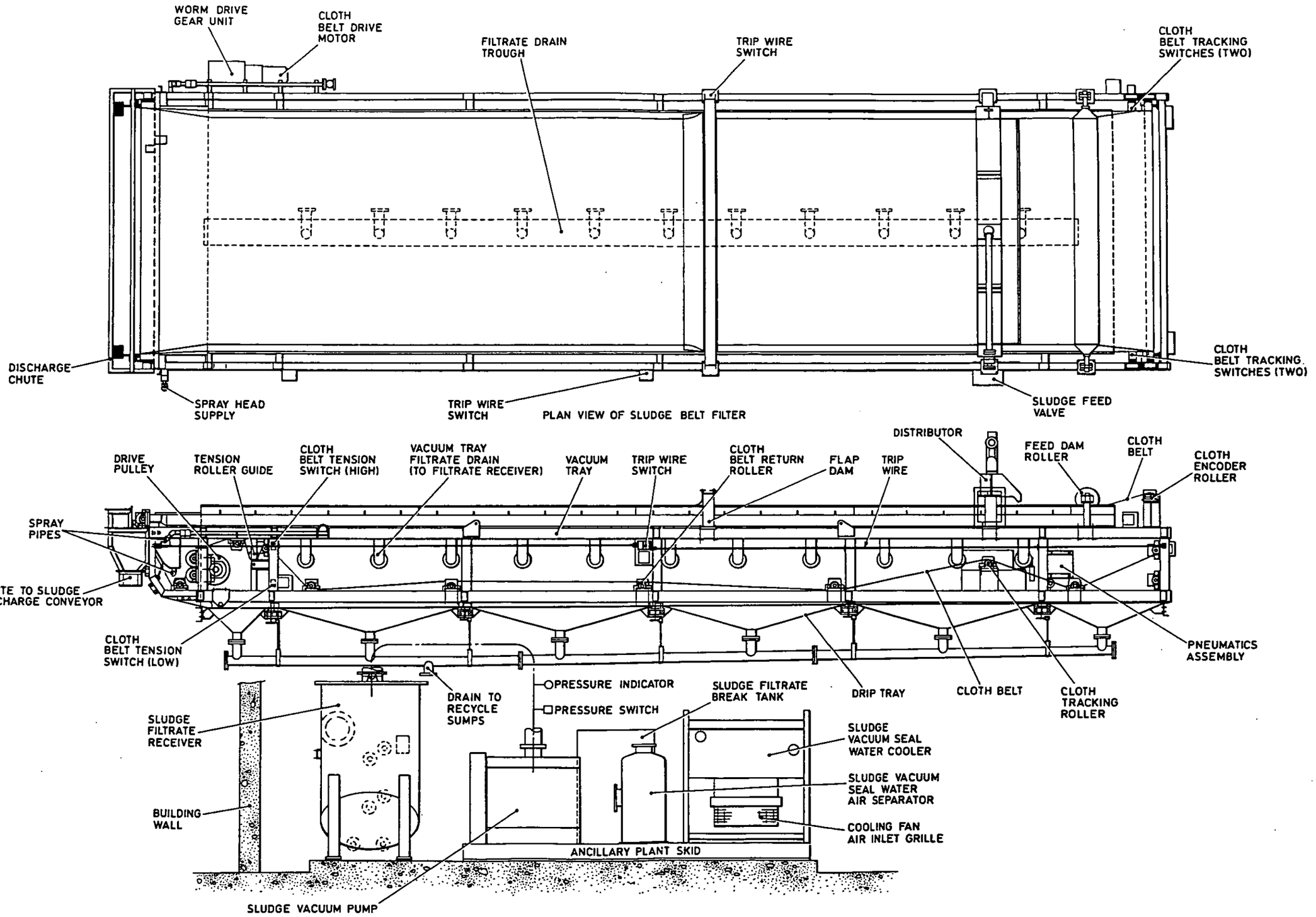
Sludge is admitted to the belt filter via a sludge feed valve which is connected by a flexible hose to a feeder assembly. The feeder assembly distributes a layer of sludge over the full width of the belt as it advances. When the covering of sludge coincides with the position of the vacuum tray the belt drive stops. A vacuum is applied to the trough below the porous belt and water (sludge filtrate) is drawn through the belt and into the trough. The filter bed comprises two rows of horizontal plastic panels either side of the central trough. The top surface of the panels is grooved so that the filtrate drains into the trough. The outer edge of the panels is angled up to prevent sludge spillage. The trough is connected by flexible hoses to a manifold which runs along the outside of the framework on the motor side; the manifold is not shown in the illustration. Filtrate flows from the manifold to a sludge filtrate receiver (one of the ancillary items) for later re-use.

The vacuum is applied to the vacuum tray by the opening of the sludge filtrate manifold valve between the manifold and the sludge filtrate receiver. After a preset time the valve closes and a sludge filtrate manifold drain valve opens. Water remaining in the manifold is drained off to the recycle sumps. This prevents any tendency for deposits to build up in the manifold and its associated pipework. After a preset time the manifold drain valve closes and the filter drive motor restarts. The event sequence described can be modified as a result of operational experience, ie the vacuum could be applied as soon as sludge feed commences; the belt would stop when the vacuum tray was fully covered to complete the dewatering action.

The sludge is off-loaded from the belt over the end roller and via a chute onto the sludge discharge conveyor. A scraper is in constant contact with the belt at the discharge roller. The scraper blade is mounted on the long side of a centrally pivoted rectangular frame. Counter weights are bolted to the long side opposite the blade. The belt runs at the lower level over a series of return rollers. However, the belt first runs round the drive roller and then round a tensioning roller. The drive roller is driven directly by the filter drive motor via a reduction gear unit. The drive roller is manufactured from mild steel and is covered with chevroned natural rubber. The rubber extends over the ends of the pulley and along the shafts to terminate in drip rings.

The tensioning roller is a weighted roller (270 kg) which is free to move up and down in vertical polypropylene guide rails. The height of the roller is a measure of belt tension. As the belt lengthens the tension weakens and the roller height decreases. If the roller drops to a preset level due to stretching, or if the belt parts, a low level tension switch operates to initiate an alarm and stop the belt drive. A high level tension switch is also fitted but this is unlikely to be activated. A hand winching facility is fitted on either side of the framework to permit the tensioning roller to be lifted when a new belt is fitted.

After the tension roller the belt traverses over the return rollers. These are manufactured from mild steel lagged with polypropylene. The rollers are supported at both ends by self-aligning ball bearings which are housed in plummer blocks. On leaving the return rollers the belt runs over a steering roller which is movable in the horizontal plane at one end and pivoted at the other. A belt tracking sensing arm mounted vertically is pivoted at its lower end and rests against the side of the belt at its upper end. If the belt moves off-centre the arm pivots to admit compressed air to one of two bellows acting against the movable



DXF 888

FIG. 1 SLUDGE BELT FILTER - GENERAL ARRANGEMENT

bearing of the steering roller. As the belt tends to move off track the steering roller alters its alignment to re-centre the belt. Four tracking switches are associated with this arrangement; two initiate an alarm if the belt goes off track by a preset amount, and two will initiate an emergency shutdown if the condition worsens.

Prior to returning to the upper level the belt passes through two sets of water sprays positioned either side. These sprays operate continuously irrespective of whether the belt is stopped for dewatering or running. The water used is sludge filtrate previously removed from the sludge with a make up if necessary of filtered water. The water is pumped from a sludge filtrate break tank by a belt wash pump, both of which form part of the ancillary plant.

An additional roller is fitted adjacent the sprays but is not normally used. It can be introduced when required to prolong the working life of a stretched belt which is otherwise serviceable.

The first roller on the upper level is an encoder roller. The roller provides a series of electric pulses to the PLC which define the belt position and the amount of travel at any time. The pulses are generated by a lamp, a slotted disc and a photo-electric cell. The data ensures that the belt movement positions the sludge accurately over the vacuum tray and also ensures that the belt moves an adequate distance before being fed with more sludge.

The second roller on the upper level is a feed dam roller. This roller ensures that the sludge does not spread upstream of the distributor. The roller is provided with filler caps and is filled with water; the heavy weight forces the belt down on to the vacuum tray to minimise vacuum leakage. The ends of the roller are shaped which causes the belt, flat as it passes over the encoder roller, to take up the profile of the vacuum trays which have angled sides. The shaft bearing of the roller incorporates a small carbon brush to discharge static which can build up on the roller.

The PLC controls the speed of the motor using a solid state inverter. The inverter allows the motor to accelerate and decelerate in a controlled manner and also enables the speed to be varied from the preset speed in the manual control mode. The ability to vary the speed is required when carrying out maintenance tests of the belt drive.

Each sludge belt filter has a walkway down each side and access across the end inside the building. Two switches are operated by trip wires which run the length of the framework on opposite sides. The local control panel has a red coloured emergency stop push button. Operation of a trip wire or the emergency stop push button initiates an immediate trip of the sludge belt filter and ancillary plant and closure of the four associated valves.

3.2 **Ancillary Plant** (fig. 1)

Ancillary plant mounted on a skid below the sludge belt filter comprises the following items, all are described in detail in separate Plant Description Modules within this chapter:

(1) Sludge filtrate receiver. A vessel to which vacuum is applied and which initially holds the filtrate drawn from the dewatered sludge.

(2) Sludge vacuum pump. The pump draws the vacuum in the sludge filtrate receiver. The pump employs water sealing. The discharge from the vacuum pump is a mixture of saturated air from the filtrate receiver and seal water.

(3) Sludge vacuum seal water air separator. A vessel which accepts the discharge from the vacuum pump. The air is exhausted to atmosphere and the water is initially held in the vessel.

(4) Sludge vacuum seal water circulating pump, water cooler and fan. The seal water circulates in a closed loop. The water is heated by the action of the vacuum pump and requires cooling. The water is pumped by a circulating pump through a water cooling tube nest before being returned to the vacuum pump. The tube nest is fan-cooled.

(5) Sludge filtrate break tank and sludge filtrate pump. Filtrate is pumped from the sludge filtrate receiver to a sludge filtrate break tank. The pump is started and stopped according to the level in the receiver.

(6) Sludge filtrate belt wash pump. Water stored in the sludge filtrate tank is pumped to the belt wash sprays.

3.3 Automatic Valves

Four automatic valves are associated with each sludge belt filter. The valves are opened by 48 V solenoids controlled by the local control panel and closed by return springs. The valves are:

(1) Sludge feed valve: The valve is mounted on the fixed framework and is connected to the feed assembly by a flexible hose. The valve opens for a preset time to deposit a layer of sludge over the slowly moving belt.

(2) Sludge filtrate manifold valve: The valve is situated in the line between the manifold and the sludge filtrate receiver. When the valve opens a vacuum is applied to the vacuum tray and filtrate is drawn into the receiver.

(3) Sludge filtrate manifold drain valve: The valve is situated in the line between the manifold and the recycle sump drains. When the valve is opened any water remaining in the manifold is drained to the recycle sumps.

(4) Sludge filtrate pump discharge valve: The valve is opened when the pump is running and is shut when the pump is stopped. Shutting the valve when the pump is stopped reduces loss of vacuum in the sludge filtrate receiver.

3.4 Local Control Panel (fig. 2)

A local control panel is provided for each of the three sludge belt filters. The panel is a fabricated metal construction, floor mounted with bottom cable entries. The front of the control panel is subdivided into three sections, each of which carries controls and indicators. Each local control panel incorporates a PLC for plant control.

The left hand section door panel carries the main power isolator, a belt speed indicator and a speed adjust control. Power supplies of 415 V, 3-phase, 50 Hz and 110 V single-phase are routed to the interior of the panel via door switches. The 415 V supply powers the sludge belt filter drive motor. The 110 V supply is used

generally for control circuits and instrumentation and is also transformed down and rectified to 48 V dc to provide supplies for solenoid-operated valves. The power circuits employ moulded case circuit breakers which on tripping initiate an alarm.

The speed of the belt is set by two potentiometers (low speed and high speed) at the rear of the panel and once set should need no further adjustment. However there is a requirement for maintenance purposes to run the belt at different speeds, eg for testing a replacement belt. For this purpose a speed adjust control is provided on the front of the control panel; the control is effective only if manual control is selected.

An inverter provides the means for varying motor speed. Initially, an optimum belt speed is set by adjustment of the high speed potentiometer. If the belt appears to be stopping too abruptly the motor can be decelerated to run at a lower speed before stopping. The time taken to ramp up to fast speed and the time taken to ramp down to low speed or stop are set into the inverter. The distance the belt travels before decelerating to stop is set into the control panel PLC via the keyboard/display unit on the front panel.

The right hand section door panel carries an auto/manual/remote keyswitch, and a number of pushbuttons and indicating lamps mainly associated with opening and closing of the four automatic valves. Pushbuttons are also provided for process starting, process stopping, alarm acknowledgement and alarm reset.

The centre section door panel carries a keyboard/display unit and a number of pushbuttons and indicating lamps mainly associated with starting and stopping of the ancillary plant pumps. Pushbuttons also provide for the starting and stopping of the sludge belt filter.

The auto/manual/remote switch selects the mode of control as follows:

(1) Manual: Individual pumps and valves are controlled by the operator. Normally used for maintenance where plant items need individual test runs. Also used if local control panel PLC fails.

(2) Auto: Auto is the normal operating mode. It is used in conjunction with the process start and process stop push buttons. When process start is initiated the PLC carries out a sequence to start the ancillary pumps before the sludge belt filter. When running the PLC controls, valves and the belt drive to carry out dewatering until such time as a process stop or emergency shutdown is initiated. When a process stop is initiated, feed stops and the belt makes several passes through the water spray before the belt drive stops, the ancillary plant then stops and the valves shut.

(3) Remote: As for auto except the process start and process stop sequences are initiated by the start and stop pushbuttons at the WWTP control panel.

Before the filter can start in auto or remote mode the following pumps must be running:

(1) Sludge transfer pump.

(2) Sludge filtrate pump.

(3) Sludge vacuum pump.

(4) Sludge vacuum seal water circulating pump.

(5) Sludge filtrate belt wash pump.

The sludge transfer pump forms part of the Sludge Handling System and cannot be controlled from the local control panel. The sludge filtrate pump is enabled by the PLC; its actual starting and stopping is controlled by level switches in the sludge filtrate receiver. The sludge vacuum seal water cooler fan should also be started; although it is not a starting pre-requisite, the seal water temperature will rise without it and could lead to a shutdown.

A process start comprises six PLC controlled steps after which steps 3,4,5 and 6 are repeated until a process stop or shutdown are initiated. The six steps are as follows:

(1) Step 1: The selection of auto or remote.

(2) Step 2: The operation of the process start pushbutton at the local control panel or the start pushbutton at the WWTP control panel. The sludge vacuum pump, the sludge vacuum seal water pump, circulating pump and the sludge filtrate belt wash pump start. The sludge filtrate discharge valve opens and shuts when the sludge filtrate pump starts and stops.

(3) Step 3: The sludge belt filter drive motor starts.

(4) Step 4: The sludge feed valve opens and sludge is spread.

(5) Step 5: The sludge belt filter drive motor stops. The sludge filtrate manifold valve opens and water is drawn off. The valve shuts.

(6) Step 6: The sludge filtrate manifold drain valve opens and water is drained from the manifold. The valve shuts.

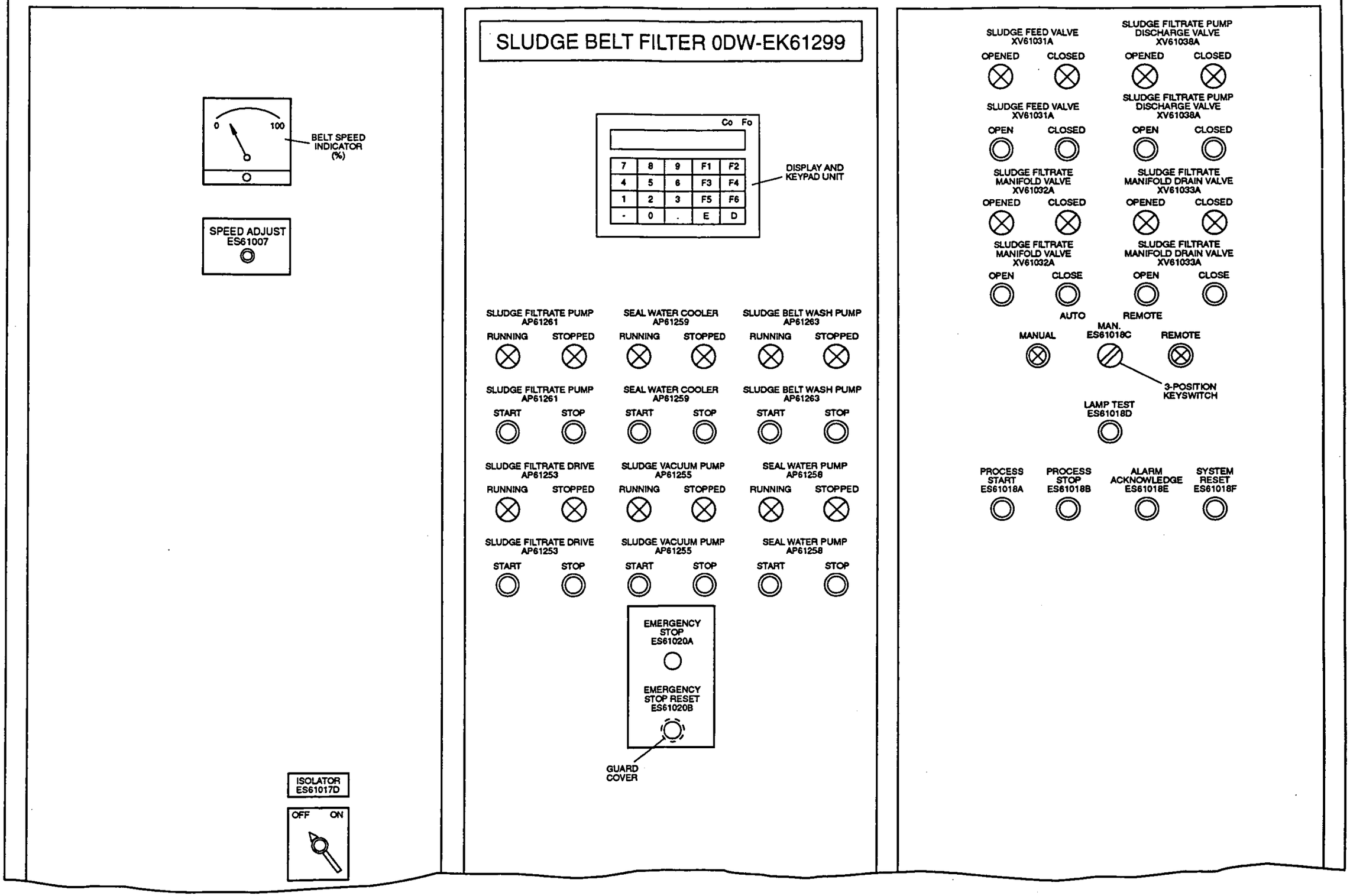
(7) Steps 3, 4, 5, and 6 are repeated until a process stop or shutdown is initiated.

An emergency shutdown is initiated by operation of the local control panel emergency stop pushbutton, operation of a trip wire or on detection of a major fault. The sludge belt filter and the ancillary plant pumps stop immediately and the automatic valves shut.

Most indicator lamps on the right hand panel are associated with valves; a green lamp indicates that a valve is open, a red lamp that it is shut. White lamps indicate whether manual or remote control is selected; normally auto control is selected.

Indicating lamps on the centre panel are associated with motors, mostly pump drives. A green lamp indicates running, a red lamp indicates stopped.

In the event of an alarm condition or shutdown a beacon flashes and a klaxon sounds adjacent the panel, also the relevant indicating lamp on the panel flashes. Pressing the alarm acknowledge pushbutton on the right hand panel will extinguish the beacon, silence the klaxon and steady the indicating lamp. Following rectification of the condition the system reset pushbutton is pressed to reset the alarm circuits. If an alarm fault condition is still present the alarm will be raised again.



DXF 889

FIG. 2 LOCAL CONTROL PANEL

The keyboard/display unit on the centre panel displays fault conditions as a message. It can also display parameter set points and provide for them to be changed. The parameters are selected by six keys as follows:

(1) F1 VAC TIME

(2) F2 VENT TIME

(3) F3 STOP SET P

(4) F4 SLOW SET P

(5) F5 FEED TIME

(6) F6 WASH TIME

A set point is altered as follows:

(1) The relevant function key is pressed (say F1).

(2) The present setting is displayed (VAC TIME 30).

(3) The new value is entered (keys 4, 0 and ENTER).

(4) The new setting is displayed (VAC TIME 40).

(5) Exit the parameter (key F1 is pressed again).

The belt drive motor is set to run at two speeds. The motor ramps up to fast speed, drives the belt for a set distance, ramps down to slow speed and after driving the belt for a second set distance ramps down to stop. The ramp times are set into the inverter unit, the set distances are set into the display panel of the local control panel and the fast slow speeds are set by the two potentiometers at the rear of the local control panel. The parameters are adjusted as required to optimise filter throughput performance. The settings can be reset if necessary at a later date as a result of operational experience.

3.5 Speed Control Inverter

The solid state speed control inverter is a wall mounted unit adjacent each sludge belt filter. The inverter panel contains the inverter electronic circuits and a keyboard/display operating panel. The display can display current performance data, e.g. inverter output frequency, and also set parameters, e.g. overload protection levels.

Below the display panel are keys enabling parameter settings to be increased or decreased and keys that can start and stop the motor for normal steady running, intermittent running (jogging) and patterned running as previously described. Setting and monitoring keys, placed to the right of the display include:

(1) Mon: Toggles the inverter operating panel between monitoring and setting modes.

(2) ACC/DEC: Sets acceleration and deceleration (ramp) times.

(3) UL/LL: Sets upper and lower speed limits.

(4) OL: Sets the current overload protection level.

(5) READ: Displays current parameters and data.

The panel is supplied with 415 V, 3-phase, 50 Hz and provides an output variable over a range of frequencies. The inverter enables the motor speed to be varied over a range of speeds and its acceleration and deceleration rates to be controlled.

Some operational values can be set remotely, for example the running characteristics of the induced sludge belt filters as follows:

(1) Ramp times - at the inverter.

(2) Fast and slow speeds - at the local control panel.

(3) Travel distance (running time) - at the local control panel.

APPENDIX 2

LIST OF ASSOCIATED DRAWINGS

LIST OF ASSOCIATED DRAWINGS

DWG. NO	TITLE
DXF/HN/25022	Sludge Dewatering Process Flow Diagram
DXF/HN/25025	Sub Arrangement Sludge Thickeners, Recycle Sumps, Dewatering Area
DXF/HN/25057	Sub Arrangement Sludge Thickeners, Sludge Belt Filters and Skip Handling
DXF/HN/25059	Sub Arrangement Sludge Thickeners, Recycle Sumps, Dewatering Area
DXF/HN/25060	Sub Arrangement Sludge Transfer Pumps
DXF/HN/25099	Sectional Arrangements of Pipework and Equipment in Primary/Secondary Settlement Area
DXF/HN/25600	Dewatering Area Stream 1 Piping and Instrumentation Diagram
DXF/HN/25601	Dewatering Area Stream 2 Piping and Instrumentation Diagram
DXF/HN/25602	Dewatering Area Stream 3 Piping and Instrumentation Diagram
DXF/HN/25611	General Arrangement of 36 m^2 Sludge Belt Filter
DXF/HN/25612	Filter and Auxiliary Layout 36 m^2 Sludge Belt Filter
DXF/HN/25614	Sludge Filtrate Break Tank
DXF/HN/25615	Sludge Filtrate Receiver General Arrangement
DXF/HN/38000	Instrument Cable Block Diagram
DXF/HN/38003	Instrument Loop Diagram 0DW-61032, 0DW-61033, 0DW-61001 and 0DW-61038 Sludge Belt Filter
DXF/HN/38005	Instrument Loop Diagram Loop Nos.0DW-61031, 0DW-61032Z, and 0DW-61031 Sludge Belt Filter
DXF/HN/38007	Instrument Loop Diagram Loop Nos. 0DW-61005 and 0DW-61008 Sludge Belt Filter
DXF/HN/38006	Instrument Loop Diagram Loop Nos. 0DW-61003 and 0DW-61004 Sludge Belt Filter
DXF/HN/38008	Instrument Loop Diagram Loop Nos. 0DW-61022, 0DW-61021, and 0DW-61023 Sludge Belt Filter
DXF/HN/38009	Instrument Loop Diagram Loop Nos. 0DW-61025, 0DW-61042 and 0DW-61043 Sludge Belt Filter
DXF/HN/38010	Instrument Loop Diagram Loop Nos. 0DW-61024, 0DW-61041 and 0DW-61039 Sludge Belt Filter
DXF/HN/38018	Schematic Diagram for Sludge Belt Filter 0DW, Power Supplies, ES Relay
DXF/HN/38019	Schematic Diagram for Sludge Belt Filter 0DW, PLC Input Modules
DXF/HN/38021	Schematic Diagram for Sludge Belt Filter 0DW, Trip and Interlock Circuits
DXF/HN/38022	Schematic Diagram for Sludge Belt Filter 0DW, Lamp Circuits
DXF/HN/38024	Schematic Diagram for Sludge Belt Filter 0DW, PLC Output Modules
DXF/HN/38025	Allen Bradley Rack Layout Sludge Belt Filter 0DW
DXF/HN/38033	Stream 1 Panel Interconnection Diagram
DXF/HN/38034	Stream 2 Panel Interconnection Diagram
DXF/HN/38035	Stream 3 Panel Interconnection Diagram