


S. S. W. W.

DESCRIPTION OF PUMPING STATIONS
1921.

VOL. I

FRED. J. DIXON, M. INST. C.E.
ENGINEER.

SOUTH STAFFORDSHIRE WATERWORKS COMPANY.

PUMPING STATIONS.

<u>Index.</u>	<u>Page.</u>
Ashwood	1
Bourne Vale	31
Brindley Bank	47
Cawney Hill	61
Coneygre	68
Fradley	82
Hinksford	93
Huntington	106
Lichfield	118
Maple Brook	139
Moors Gorse	159
Pipe Hill	171
Romsley	196
Shavers End	204
Shenstone	210
Springs Mire	229
Trent Valley	246
Winshill	268
Wood Green	277

and supplementary
pages 156 A & J.

LICHFIELD PUMPING STATION.

situate at

LICHFIELD in the COUNTY OF STAFFORD.

S U M M A R Y.

No. 1 Engine.	Power per day..	1,144,368 gallons.	} <u>SCRAPPED</u>
No. 2 Engine.	ditto.	1,144,368 "	
No. 3 Engine.	ditto.	1,144,368 "	
No. 4 Engine.	ditto.	2,000,000. "	

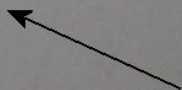
Total Engine power at Station is equivalent to 5 million gallons per 24 hours.

Nos. 1, 2 & 3 Engines.	Total specified Heads.	355 feet.
No. 4 Engine.	ditto Head.	355 feet.

C O S T S.

		£.	s.	d.
Land and Law Charges.	....	519.	0.	0.
Well (estimated.)	....	2,500.	0.	0.
Engine & Boiler Houses (estimated)	....	11,054.	0.	0.
Boundary Wall.	....	133.	0.	0.
3 Cottages.	....	1,048.	0.	0.
Nos. 1, 2 & 3 Engines & Boilers.	....	16,855.	0.	2.
No. 4 Engine.	....	6,690.	0.	0.
<u>TOTAL COST.</u>		<u>£ 38,799.</u>	<u>0.</u>	<u>2.</u>

Nos. 1, 2 & 3 Engines first started pumping into main, 26th October, 1858



This is incorrect.
Engine Number 3 was not installed and commissioned until 1866
CLP August 2020

L A N D.

Date purchased.	...	January 1863.
From whom purchased.	...	The Vicars of Lichfield Cathedral & The South Staffordshire Railway Co.
Area of Land.	...	1 Acre , 2 roods, 22 poles.
Level of E.H.F. above O.D.	...	310.85 feet.

CONTRACTORS.

WELLS.

NO. 1 Well	...	Unknown.
NO. 2 "	...	do.
NO. 3 "	...	do.
NO. 4 "	...	do.
NO. 5 "	...	do.

BUILDINGS

First Engine & Boiler Houses.	...	Branson & Co.
Second Engine House for No.4 Engine.		Becket & Co.
Boundary Wall.	...	Branson & Co.
3 Cottages.	...	Branson & Co.

ENGINES.

Nos. 1, 2 & 3 Engines erected by	...	J. Watt & Co., B'ham. Year 1858.
No.4 Engine erected by	...	J. Davis, Tipton. Year 1873.
3 Boilers by	...	E. Danks & Co.Ltd., Oldbury. Year 1907.

1866
CLP August 2020

NOTE. 5 Old Boilers at Station have been condemned.

C O S T S.

	£.	s.	d.
Land and Law Charges.	519.	0.	0.
Well (estimated)	2,500.	0.	0.
Engine & Boiler Houses (estimated)	11,054.	0.	0.
Boundary Wall.	133.	0.	0.
3 Cottages.	1,048.	0.	0.
Nos. 1, 2 & 3 Engines & Boilers.	14,505.	8.	2.
No. 4 Engine.	6,690.	0.	0.
3 New Boilers (1907) (Dank's Tender.)	2,349.	12.	0.
<u>TOTAL COST.</u>	<u>£38, 799.</u>	<u>0.</u>	<u>2.</u>

PARTICULARS OF NOS. 1, 2 & 3 ENGINES.

DESCRIPTION OF ENGINE HOUSE.

Internal dimensions,	....	46 feet long.
ditto.	....	43 " $\frac{3}{4}$ inch wide.
Approximate height to top of Well Plate.	....	40 "
Depth of Foundations.	....	22 "

DESCRIPTION OF BOILER HOUSE.

Internal dimensions.	....	92 feet , 6 inches long.
ditto.	....	50 " wide.
Height of Stack from ground line.	....	137 "

WELLS.

Nos. 1, 2 & 3.

Diameter of Wells.	....	8 feet.
Depth of Wells from E.H.F.	....	70 feet.
Top of Well Below E.H.F.	....	14 feet.

WELLS (cont.)

Distance apart of one Well from the other. ... 14 ft. 10 $\frac{1}{2}$ inch.
centres.

NOTE. No.2 Engine is in line with the centre of No.2 Well and the centre line of Nos.1, & 3 Engines are 13 feet off each side of centre line of No.2 Engine, which is in the central position of Well.

NO. 5 PILOT WELL AND TUNNEL.

Diameter of Well. ... 14 feet.
Depth of Well below E.H.F. ... 76 " 9 inches.

The Pilot well is situated outside of Engine Houses, and is connected by a tunnel to Hanch Reservoir.

Floor of Tunnel below E.H.F. ... 68 feet.
Height " " " ... 5 "
Width " " " ... 4 " 6 inches.
Length of Tunnel. ... 20,300 feet or 3.84 miles.
Fall of Tunnel towards Pilot Well. ... 3.65 feet.
Ground line below E.H.F. ... 5 feet, 7 inches.

The Pilot Well is connected to No.4 Well by an opening 5 feet high by 4 feet wide at the bottom of No.4 Well.

Distance between centres of Pilot and No.4 Wells. 25 feet, 6 inches

The Pilot Well is also connected to No.3 Well by an opening 5 feet high by 4 feet wide at a distance between centres of Wells of 44 feet, 9 inches.

The Nos.1, 2 & 3 Wells are in turn connected at the bottom by openings 5 feet high, 4 feet, 6 inches wide between them.

No. 3 Well is distance from No. 4 Well. 19 feet, 3 inches

The Nos. 1, 2 & 3 Flywheel Engines at Lichfield Pumping Station are each of the same size and capacity in every respect.

Nos. 1 & 2 Engines are coupled and work together. No. 3 Engine works separately.

TYPE OF ENGINES.

Double-acting, condensing single-cylinder, flywheel Beam Engines.

ENGINE CAPACITY.

Net quantity pumped per 24 hours by each engine at a speed of 9 revolutions per minute. ... 1,144,368 gallons.

SPECIFIED HEAD.

Total Specified Head on Pumping Main.	...	355 feet.
Engine Speed per minute.	... ..	144 "
Pump Horse power based on 9 revolutions per minute, and head on main of 355 feet....		85.

RISING MAINS OR LIFTS.

One lift to each engine in each well.

Each Lift is made up of a strainer.

Clack Box, Well Pump Bucket Inspection. box, with 2 lengths of piping of 10 feet and 5 feet. Well Pump Working barrel.

Force Pump Barrel with Force Pump delivery valve box cast on side of same.

The Well and Force Pumps are worked off the end of the engine beam. The Well Pumps are single-acting bucket type with Force Pumps in the same Lift, which are of the Bucket and Plunger Type. The water passing through the Well Pump Bucket on the down stroke to the top of same and then delivered by the bucket on the up stroke through the Force Pump Delivery Valve.

STRAINERS.

Outside diameter.	...	2 feet, 10 inches
The bottom of strainer is bevelled, the length one side measures.	... ..	3 " 6 "
Length on other side	... ..	2 " 9 1/2 "

LICFIELD P.S.

The strainer is perforated with oblong holes $8\frac{1}{2}$ inches x $1\frac{1}{2}$ inches, and a pipe length without a flange is inserted into top of strainer.

Depth pipe in Strainer, about	...	...	2 feet, $4\frac{1}{2}$ inch
Total length of above pipe.	...	...	10 "

A second pipe with a flange at each end is fixed between strainer and clack box, length

...	10 feet, 3 inches.	
Diameter of Pipes.	...	18 inches.
Thickness of Metal.	...	1 inch.
Flanges on Pipes.	...	26 inches.

CLACK VALVE BOXES.

Length of Boxes.	...	6 feet, 2 inches.
Thickness of Metal.	...	$3\frac{1}{2}$ inches.

Each Box is fitted with a door at one side for the purpose of changing or inspecting the Clack.

Opening when door removed.	...	3 feet 3" inches x 2 " 5 "
Bases of Boxes.	...	3 " 9 " x 3 " 2 "
Diameter of Flanges at top of Boxes.		32 inches.

RISING MAIN OR LIFTS.

The Clack Valve and Bucket Inspection boxes are supported by Cast Iron Girders built into sides of Wells.

WORKING BARRELS IN LIFTS.

Diameter of Barrel.	...	$18\frac{1}{4}$ inches.
Length " "	...	10 feet.
Thickness of Metal.	...	$2\frac{1}{2}$ inches.
Diameter of Flanges.	...	32 "

LICHFIELD P.S.

BUCKET INSPECTION BOXES.

Length of Boxes. ... 5 feet.

FORCE PUMP BARRELS.

Length of Barrel. ... 8 feet.

Diameter of Plunger. ... 14 inches.

Stroke of " ... 8 feet.

Gallons discharge per double stroke ... 88.592.

Multiplier given to Foreman. ... 88

Diameter of Inlets and Outlets
on Force Pump Valve Boxes. ... 15 inches.

Diameter of Mild Steel Rod inside
Plunger. ... 5 inches.

WELL PUMP CLACK.

Cast Iron Hat Band Valve Type.

Diameter at bottom of tapered seat. ... $28\frac{3}{4}$ inches.

Number of tiers of Hat Bands. 4.

1st India Rubber Band, inside diameter. $12\frac{3}{4}$ "

2nd " " " " $16\frac{3}{4}$ "

3rd " " " " $20\frac{5}{8}$ "

4th " " " " $24\frac{1}{2}$ "

WELL PUMP BUCKET.

Double Beat with white metal beats, and G.P. Gearing of
Special design.

Diameter of Bucket. ... $18\frac{1}{2}$ inches.

Stroke " " ... 8 feet.

Free lift of Valve on Bucket. ... $2\frac{1}{2}$ inches.

FORCE PUMP DELIVERY VALVE.

Cast Iron double Beat with G.P. Beats.

LICHFIELD P.S.FORCE PUMP DELIVERY VALVE (cont.)

Diameter of Seat.	...	18 inches.
Free Lift on Valve.	...	$\frac{5}{8}$ inch.

STEAM CYLINDERS.

Diameter of Cylinder of each Engine.		46 inches.
Stroke	" "	8 feet.
Diameter of Piston Rod.	...	$5\frac{1}{2}$ inches.
Piston Rod Packing.	...	Soft.
Cylinders Steam Jacketted.		

TYPE OF PISTON RINGS.

No. 1 Engine.	...	Broad Packing. Ring with Coil Spring inside.
No. 2 Engine.	...	3 Pamsbottom Rings in packing ring.
No. 3 Engine.	...	Broad Cast Iron Packing Ring, fitted with Coach Springs.

TYPE OF ENGINE VALVE GEAR.

Cornish Gear with drop valves operated by plug rods
and by bevel wheel gearing from crank shaft.

Diameter of drop Valves for Steam.	...	$10\frac{1}{2}$ inches.
" " " " Exhaust	...	$12\frac{1}{2}$ "
Expansion Grades.		1/10, 2/10, & 3/10.

TYPE OF AIR PUMP.

Single-acting, vertical Pump operated from engine beam.

DIAMETER OF AIR PUMPS.

No. 1 Engine.	...	$28\frac{1}{8}$ " inches.
No. 2 "	...	$28\frac{1}{8}$ inches.
No. 3 "	...	$28\frac{1}{2}$ "
Type of Valves.	...	India Rubber.

Diameter of Bucket Valve.	...	23 inches.
Head Valve.	...	24 inches x 7 inches.
Foot Valve.	...	24 " x 7 "
Diameter of Bucket Rod.	...	2 $\frac{5}{8}$ "
Stroke of Bucket.	...	4 feet.

TYPE OF CONDENSORS.

Old Fashioned Jet Condensers are fitted to these Engines. The Condensers are in large brick cisterns through which the water from the main circulates, the overflow gravitating into the canal.

The injection water to kill the steam is from the canal and as this water has been known to pit the boilers it is pumped back into the Canal.

Cold Feed Water from the Company's main is used for feeding the Boilers.

No. drawings and no particulars are available of these condensers.

TYPE OF DELIVERY AIR VESSELS.Cast Iron.

There is one delivery Air Vessel on each main from each of the Engines.

Approximate height inside.	...	12 feet.
" diameter inside.	...	5 "
" height above Branches.	...	10 " 4 $\frac{1}{2}$ inches.
" thickness of Metal.	...	3 inches.
Working pressure per square inch.	...	165 lbs.
Capacity above Branches.	...	191 c. feet.
Approximate total capacity.	...	225 c. feet.

FEED WATER PUMPS.

2 Plunger Type operated from engine beams.

FEED WATER PUMPS (cont.)

Diameter of Plungers.	...	$3\frac{7}{8}$ " inches.
Stroke of Pumps.	...	2 feet, approximate.
<u>NOTE:- Pumps not used.</u>		

AIR SUPPLY PUMPS TO AIR VESSELS.

These were worked from the engine Beams but have been disconnected and done away with.

FLYWHEELS.

No. of Flywheels to Engines.	...	2.
Diameter "	...	24 feet.
Width of Rim.	...	$10\frac{3}{4}$ inches.
Depth "	...	12 "
Inside diameter of Boss.	...	17 "
Wheels are built with	...	8 arms.
Diameter of Crank Shaft Bearings.	...	13 inches.
Length " "	...	16 "
Diameter of Crank Pins.	...	9 "
Length " "	...	$9\frac{1}{2}$ "
Length of Connecting Rods.	...	23 feet, 4 inches.
Distance from Centre line of Crank Shaft to centre line of Engine Beam.	...	23 feet, 4 inches.

ENGINE BEAM.

Diameter of Centre Gudgeon Bearings.	12 inches, approximate
" " from Pumping Gudgeon.	13 feet, 7 inches. approximate
" " Cylinder Gudgeon.	ditto.
Diameter of Pump Gudgeons.	6 inches.
Length " " Bearings.	6 "
Diameter of Bearings on Engine Beam for connecting Rods.	7 "
Length of above Bearing.	9 "

ENGINE COUNTERS.

No. of Counters on Engines.	...	2
Maker's Name.	...	T.R.Hardinge & Son, Leeds.
Type.	...	Hardinge Improved.

STEAM BOILERS.

There are 8 Boilers at this Station, 5 of which have been condemned.

Number of Boilers in use.	...	3.
Maker's name.	...	Edwin Danks & Co., Oldbury.
Type of Boiler.	...	Lancashire.
Maker's order numbers.	...	5044 - 5 - 6.
Diameter of Boilers.	...	8 feet.
Length "	...	30 "
Thickness of shell plate.	...	9/16 inch.
" " end Plates.	...	5/8 inch.
Diameter of internal Flues front end.		3 feet, 2 inches.
" " " back "		2 " 8 "
<u>Thickness of Flue Plates.</u>		
Front Section.	...	1/2"
Middle Sections	...	7/16"
End Section.	...	1/2"
Type of Manhole.	...	Mc.Neils.
Size "	...	16 inches x 12 inches
Working pressure per square inch	...	100 lbs.
Hydraulic Test Pressure " "	...	180 lbs.
Actual working pressure " "	...	40 lbs.
Total heating surface	...	1,068 sq ft
Fusible Plugs in furnace crowns	...	2.

MOUNTINGS ON EACH BOILER.

All of Hopkinson's own make. Specification "A", 1906.

One Figure 1,000 Patent "Tried" Junction Valve. ...	7 inches diameter.
One Cast Iron Anti-priming Pipe for above. ...	
One Figure 7 Patent "Duad" Safety Valve for high steam and low water with plate weights complete. Working pressure 40 lbs. per square inch.	
One Figure 20 dead weight safety Valve for working pressure of 40 lbs. per square inch. ...	3 inches diameter
2 Sets of Hopkinson's Absolute Water Gauges. ...	$\frac{3}{4}$ inch. diameter.
Figure 6440 with Safety Shields "B" to 18" centres.	
One figure 1320 Accessible Check Feed Valve. ...	2 $\frac{1}{2}$ inches.
One Figure 2540 parallel Slide Blow- off Valve. ...	2 $\frac{1}{2}$ "
One Cast Steel taper-eblow pipe for above. ...	Figure 9064.
One Brass engraved working level pointer. ...	" 6250
One Figure 400 Steam Gauge. ...	10 inches diameter.

MILD STEEL MAIN STEAM RANGE.

Installed year 1921.

Diameter of copper pipes from Nos.3 & 5 Boilers. ...	7 inches diameter.
Diameter of Mild Steel Pipe from No.4 Boiler.	7 " "
<u>Steam Receiver.</u>	
Diameter of Mild Steel Receiver.	24 inches.
Length " " "	19 feet, 4 $\frac{1}{2}$ inches.
Diameter of Branches, Steam to Cornish Engine, 9 inches enlarger to	12 inch pipe.
Diameter of Branches, steam to Flywheel Engines, 12" enlarging to 18 inch diameter and reducing in Engine House to 15 inches diameter.	

MILD STEEL MAIN STEAM RANGE (cont.)

In the Engine House the 15 inches diameter Pipe is again reduced to 10 inches Branch Pipes to each engine.

STOP VALVES ON STEAM RANGE.

For Cornish Engine.

2 Dewrance's Patent Renewable Stop Valves,
Figure 3090. 9 inches diameter.

For Flywheel Engines.

2 Dewrance's Patent Renewable Stop Valves
Figure 3090. 12 " "

STEAM TRAP ON RANGE.

One Lancaster & Tonge's Bucket Type Steam
Trap. 1 " "

OVERHEAD CRANE IN FLY-WHEEL ENGINE HOUSE.

Type. Hand-Power.
Maker's name. R. Wood & Sons,
Leeds.
Load. 5 to 6 tons.
Span measured by Foreman. 42 feet, 9 $\frac{1}{2}$ inches.
Barrel of Crab. Grooved.

There is no brake and no catch on Crab for holding load.

Bridge of Crane is composed of wooden beams, 14 inches x 9 inches, each beam tressed with 2 - 1 $\frac{1}{2}$ inches diameter Tie Rods.

Shaft right across Crane. 1 $\frac{3}{4}$ inches diameter.

CORNISH ENGINE NO. 4.

Description of Engine House.

Internal dimensions, 52 feet long.
ditto. 20 " wide.

CORNISH ENGINE NO. 4 (Cont.)

Height to top of Wall Plate.	.....	42 feet.
Depth of Foundations.	.....	22 "

WELL.

No. 4

Diameter of Well.	.....	9 feet.
Depth of Well from E.H.F.	.....	70 "
Top of Well below E.H.F.	.....	22 "

TYPE OF ENGINE.

Cornish Expansion Condensing Single-acting Beam Engine.

ENGINE CAPACITY.

Net quantity pumped for 24 hours at 7 strokes per minute.	.....	2,000,000 gallons.
<u>Specified Head.</u>		
Total Specified Head on pumping main	.....	355 feet.
Engine Speed per minute.	.....	126 "
Pump Horse Power at 7 double strokes per minute with head of 355 feet	.....	149.

RISING MAIN OR LIFT.

One lift in Well to Engine.

Each lift is made up of a Strainer, Clack Box, Well Pump Working Barrel, Force Pump Barrel with 2 pipe lengths of 9 feet 6 inches and one of 4 feet 6 inches. The Force Pump delivery Valve Box is bolted to the side of the Force Pump Barrel.

The Well and Force Pumps are worked off the end of the Engine beam. The Well Pump is single-acting, of the bucket type with Force Pump in the same lift which is of the bucket and plunger type, with weight box on top of plunger. The water passes through the Well Pump Bucket

RISING MAIN OR LIFT. (cont.)

on the down stroke to the top side of same and is then delivered by the Bucket on the up stroke through the Force Pump Delivery Valve.

PARTICULARS OF NO. 4 ENGINE.

(1) STRAINER.

Outside diameter.	...	3 feet.
Length of Strainer.	...	3 feet 3 inches.

The Strainer is perforated all round with oblong holes $8\frac{1}{8}$ inches x 1 inch and a pipe length without flange is secured to top of strainer.

(2) Diameter of above pipe length.	...	2 feet 3 inches.
Length " " " outside strainer.	8 " 10 "	
Diameter of flange at top of same.	3 "	
(3) One pipe length flanged at each end, length.	...	4 " 6 "

(4) Clack Box.

Length of Clack Box.	...	6 feet, 2 inches.
Thickness of Metal	...	$1\frac{5}{8}$ inches.
Diameter of Clack Box, largest inside diameter.	...	3 feet, 4 inches.
Diameter of Clack Box at top inside.	...	2 " $5\frac{5}{8}$ "
Diameter of bottom flange.	...	3 " 2 "
" " top "	...	3 " 5 "

(5) WORKING BARREL.

Diameter of Barrel.	...	2 feet, 1 inch.
Length "	...	11 " 8 inches.
Thickness of Metal.	...	$1\frac{3}{4}$ inches.
Diameter of bottom flange.	...	3 feet, 5 inches.

(5) WORKING BARREL (cont.)

Diameter of top flange.	...	3 feet, 1 inch.
(6) One pipe length flanged at each end.		9 feet, 6 inches.
Diameter of Pipe.	...	2 " 3 "
Flanges.	...	3 " 1 inch. diameter

(7) FORCE PUMP BARREL

Distance of Main Gudgeon to centre of F.P, Gudgeon on Main Beam.	...	17 feet, 4 $\frac{1}{2}$ inches.
Total length of Barrel.	...	13 " 10 "
Inside diameter of Barrel.	...	2 " 7 "
Thickness of Metal.	...	1 $\frac{3}{8}$ inches.
Diameter of Bottom flange.	...	3 feet, 1 inch.
" " top "	...	3 " 4 $\frac{1}{2}$ inches.
" " Branch to Delivery Valve Box.	...	2 "
" " Flange on Branch.	...	2 " 10 "
" " Plunger.	...	17 13/16 inches.
Stroke " "	...	9 feet.
Gallons discharged per double stroke.		200.9
Multiplier given to Foreman.	...	198.
Diameter of Inlet and Outlet Branches on Force Pump Valve Box.	...	2 feet.
Diameter of Iron Pump Rod inside Plunger.	...	6 inches.

WELL PUMP CLACK.

Type.		Cast Iron Hat Band Valve.
Diameter at bottom of seat		2 feet, 5 $\frac{1}{2}$ inches.
Number of Tiers of Bat Bands.	...	5.
1st India Rubber Band, inside diameter.		14 $\frac{3}{4}$ inches.
2nd " " "		17 $\frac{5}{8}$ "
3rd " " "		20 $\frac{5}{8}$ "
4th " " "		23 $\frac{1}{4}$ "
5th " " "		26 "

WELL PUMP CLACK (cont)

All the above Bands are $\frac{7}{8}$ inch thick by 8 inches deep.

WELL PUMP BUCKET.

Type. Double Beat with white metal beats and G.P.
Gearing of Special design.

Diameter of Bucket. ... 25 $\frac{5}{8}$ inches.
Stroke. ... 9 feet.
Free Lift of valve on bucket. ... 3 inches.

FORCE PUMP DELIVERY VALVE.

Double Beat Valve with white metal beats, seat of valve cast iron and valve gunmetal.

Diameter of Seat. ... 2 feet, 8 inches.
Free Lift on Valve. ... 3 inches.

STEAM CYLINDERS.

Diameter of Cylinders. ... 65 inches.
Stroke of Engine. ... 9 feet.
Diameter of Piston Rod. ... 6 $\frac{3}{4}$ inches.
Piston Rod Packing. ... Soft.
Cylinder is Steam Jacketted.

Type of Piston Ring.

Broad Cast Iron packing ring fitted with coach springs.

Type of Engine Valve Gear.

Cornish gear with drop valves operated by plug rods.

Steam Nozzles.

Diameter of Regulator Valve to Cylinder. 12 $\frac{3}{8}$ inches.
" Steam " " 12 $\frac{7}{8}$ "
" Equilibrium Valve to Cylinder. 14 $\frac{3}{8}$ "

STEAM NOZZLES. (cont.)

Diameter of Exhaust Valve on bottom
Nozzle. ... $15\frac{1}{2}$ inches.

TYPE OF AIR PUMP.

One single-acting vertical pump operated by rod
from main engine beam.

Distance of Air Pump Gudgeon from main
gudgeon on engine beam. ... 9 feet.

Diameter of Air Pump. ... $22\frac{1}{2}$ inches.

Stroke " ... 4 feet, 8 inches.

Type of Valves. ... India Rubber.

Diameter of Bucket Valve. ... 16 inches.

" Head " ... 23 "

Size of Flap Foot Valve. ...

Diameter of Bucket Rod. ... $2\frac{1}{2}$ inches.

Diameter of Outlet for Condensed
Water. ... 6 "

Size of Inlet for Condensed Water ... 20 " x 6 inches.

Bucket Rod Packing. ... 1 inch hemp.

TYPE OF CONDENSER.

Open type with Tubes screwed into lower tube plates and
secured by nuts and rubber washers against face of upper
tube plates. Condenser placed in cast iron cistern through
which the water from the Canal gravitates, a circulating pump
being employed to pump it back again into the Canal.

Cooling Surface. 661 sq.

Number of Tubes. 202.

Diameter of Tubes externally. 2 inches.

Length of Tubes. 6 feet, $7\frac{1}{2}$ inches.

Thickness of Tubes. Unknown.

Number of Stay Rods. 7.

Diameter of " $1\frac{1}{2}$ inches.

Pitch of Tubes. 4 inches x $3\frac{1}{2}$ inches.

TYPE OF CONDENSER. (cont.)

Distance apart over tube plates.	6 feet. $5\frac{3}{4}$ inches.
Diameter of Tube Plate castings.	
Thickness " " " "	top. bottom. $1\frac{1}{2}$ inches. $1\frac{1}{4}$ inches.
Diameter of Exhaust Inlet.	15 inches.
" " " Outlet.	$22\frac{1}{2}$ "

CAST IRON CONDENSER CISTERN.

Depth of Cast Iron Cistern.	11 feet, 4 inches.
Length " " " "	10 " 6 "
Width " " " "	7 " 6 "
Thickness of Metal of Cistern.	$\frac{7}{8}$ inch.
Diameter of Water Inlet.	15 inches.
" " " Outlet.	15 "

TYPE OF DELIVERY AIR VESSEL.

Cast Iron.

Total height inside.	25 feet.
Diameter inside.	5 feet, 6 inches.
Height above Inlet Branch.	21 feet $9\frac{1}{4}$ inches.
Thickness of Metal.	$2\frac{3}{4}$ inches
Working pressure per square inch	165 lbs.
Capacity above branches.	493 c. feet.
Total capacity.	570 c. feet.
Diameter of Branches.	24 inches.

BOILER FEED WATER PUMP.

One single-acting plunger type pump operated from Main

Engine Beam.

Distance of Boiler Feed Water Pump Gudgeon from main gudgeon on Engine Beam.	4 feet, $5\frac{1}{2}$ inches.
Diameter of Plunger.	6 inches.
Stroke. " "	2 feet, 4 inches.

BOILER FEED WATER PUMP. (cont.)

Diameters of Inlet and Outlet Pipes. 4 inches.

COLD WATER CIRCULATING PUMP.

Type. One single-acting bucket pump operated from main Engine beam for circulating the condenser in condenser cistern.

Distance of Pump Gudgeon from Main Gudgeon on Engine Beam.	...	4 feet, 10 $\frac{1}{2}$ inches.
Diameter of Bucket.	...	22 $\frac{1}{4}$ inches.
Stroke.	...	2 feet, 6 inches.
Type of Valves.	...	India Rubber.
<u>Foot and Bucket Valves only.</u>		
Diameter of Foot Valve.	...	19 $\frac{1}{2}$ inches.
" Bucket Valve.	...	17 "
Packing round Pump Bucket.	...	$\frac{7}{8}$ inch diameter.
Diameter of Bucket Rod.	...	2 $\frac{1}{4}$ inches.
Sizes of Inlet and Outlet.	...	15 inches diameter.

AIR SUPPLY PUMP FOR AIR VESSEL.

Type. Single-acting piston pump operated from main engine beam.

Distance of Pump Gudgeon from main gudgeon on Engine Beam	...	4 feet, 5 $\frac{1}{2}$ inches.
Diameter of Piston.	...	7 inches.
Stroke of Pump.	...	2 feet, 4 inches.
Diameter of Rubber discs for Valves.	...	5 $\frac{3}{4}$ inches.
Thickness " "	...	$\frac{3}{4}$ inch.

NOTE. This pump is not used.

MAIN BEAM OF ENGINE.

Diameter of main gudgeon Bearings.	12 inches.
Length " "	16 "
Distance from Pump Gudgeon to main Gudgeon. ...	17 feet, $4\frac{1}{2}$ inches.
Diameter of Bearings for Main Links.	$6\frac{3}{4}$ inches.
Length " " ...	$7\frac{3}{16}$ inches.
Distance from Cylinder end Gudgeon to Main Gudgeon. ...	17 feet, $4\frac{1}{2}$ inches.

AIR COMPRESSOR.

Compressor is connected up so that air can be forced into the Air Vessels of all 4 Engines.

Type. ...	Single Stage.
Maker's name. ...	The Westinghouse Brake Co., London.
Size. ...	$8\frac{1}{2}$
Class. ...	"F"
Steam Inlet, ...	1 inch diameter.
Exhaust Outlet. ...	$1\frac{1}{4}$ " "
Air Delivery. ...	1 " "
Maker's number. ...	37060.
" London Works Number. ...	12679.
Height of all delivery pressure Gauges from E.H.F. ...	5.66 feet.

SIGHT FEED LUBRICATORS.

Maker's name. ...	Hunt & Mitton, B'ham.
Type. ...	Single-feed.
Name of Lubricator. ...	Killingbeck.

ENGINE COUNTER.

Maker's name. ...	W.H. Bailey & Co., Salford, Manchester.
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