South Australian Heritage Act 1978-80

HERITAGE SURVEY ITEM IDENTIFICATION SHEET

PROJECT
HERITAGE SURVEY REGION 5

Item Ref. No. 12

ITEM NAME: Cobdogla Pump

Former or other

Office Use
ITEM No.
DOCKET No.

HERITAGE SIGNIFICANCE

This pump is of international significance. It is one of only twelve pumps built to the design of H.A. Humphrey and which is significant because of the use of a column of water to fulfil the role of a piston in a normal pump. Only five of these pumps are known to survive, this is the only one in Australia. It was built by William Beardmore & Co. of England. This pump was installed in 1925, by the State's Irrigation Department, and was ready for irrigation purposes in 1927. The pump is also of immense State significance, because of its association with the settlement of the Murray during the inter-war period, and the extensive irrigation works which made this settlement possible. The pump continued in operation until it was superseded by an electric pump in 1965.

LOCATION

Address Cobdogla
Town
Postcode
Section 339
Hundred Out of Hundreds
County
L.G.A. Barmera
S.H.P. Region 5
A.M.G. Ref. 6929-I
54 44460 621010

SUBJECT

4.9

PERIOD

State

Study Area
1906-1940

REFERENCES

National Trust, 1373
McLauchlan "The Humphrey Pump" in Engineers Australia Transactions of the Institution Vol. XII
Woolmer, The Barmera Story: A History of Barmera and District, pp 57-58
Institution of Engineers Australia, S66

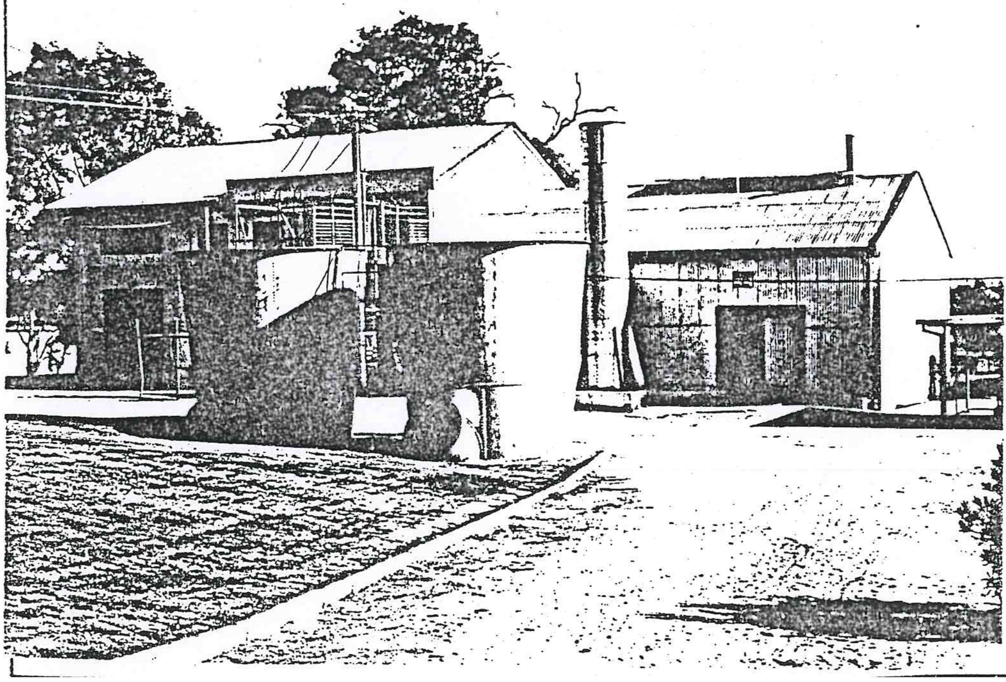
Verbal
Archival photographs

TYPE OF ITEM

LAND Natural feature [ ]
Historical site [ ]
Historical Gdn. [ ]
BUILDING [ ]
STRUCTURE [X]
PHYSICAL CONDITION

PHOTOGRAPH

Film No. 807 Negative No. 13
Direction of view to W



STATUS

Reg. of State Her. Items
Reg. [ ] Interim L. [ ]
Nominated [ ]
National Estate
Reg. [X] Proposed L. [ ]
National Trust
CL [X] RL [ ] File [ ]
Other
Inst. of Engineers

RECOMMENDATION

(A) State [X] (B) Local [ ]

PREPARED BY
HERITAGE INVESTIGATIONS

Date: 1983

HIS/D4/25.11.81

THE HUMPHREY PUMP AND THE INSTALLATION OF TWO 1.68 METRE UNITS AT COBDOGLA, RIVER MURRAY

The two Humphrey Pumps for the Cobdogla Irrigation Area were taken out of commission in June 1965, after having provided irrigation water for the adjacent areas for a period of forty years. Actually only one pump was used at a time, the other pump acting as a standby.

The Humphrey Pump, which was the invention of Mr. H.A. Humphrey, an eminent gas engineer and chemist, is an internal combustion pump which differs from all previous attempts to obtain a similar result in the fact that all non return valves and pistons are eliminated from the water path within the pump and the liquid itself is made to perform the functions of the piston and fly-wheel as we know them in the ordinary gas engine.

The oscillation of the water column in the pump (approximately 300 tonnes) serves to draw in a fresh supply of water, exhaust the products of combustion, take in a new charge of combustible mixture, and compress and ignite it during each four stroke cycle.

The design of the pump is that of a very large uneven U-shape pipe, the short end being closed as a combustion head fitted with gas and air inlet valves, exhaust valves and spark plugs, while the long end is open in the form of an inverted conical tower with an outlet for delivery as the water is elevated by the explosive force of a mixture of producer gas and air.

Water suction valves are fitted on the U-pipe below the combustion head and are usually arranged so as to be submerged in the supply water although a suction lift of a metre or so can also be supplied if necessary.

Starting from the combustion head end the parts are named and the combustion chamber, water inlet valve chamber, playpipe and water tower, and there is a full bore opening right through to the tower.

Mr. Humphrey's first successful pump was put to the test in 1909 and several satisfactory installations were elected prior to the 1914-1918 War, which, however, stopped further development as the services of the gas engineers were commandeered for war work.

The most notable installation was that of five large pumps at Chingford for the London Water Supply, four of which deliver 182 megalitres each in 24 hours and the other 91 megalitres.

These pumps were installed in 1913 for the purpose of pumping water from the River Lea into a storage reservoir during times of high flow. At present four out of the five pumps are still in working order and are now used only as supplementary units when required, having been largely superseded by an electric station capable of pumping 682 megalitres per day.

The two pumps installed at Cobdogla to replace the original steam plant, 1922 to 1925, are the only Humphrey pumps erected since the war and the only ones in the Southern Hemisphere. Each of them delivers 6 megalitres per hour or approximately 144 megalitres every 24 hours, the water being used for irrigation purposes on the Cobdogla, Loveday or Nookamka areas on the River Murray.

A few of the principal dimensions are:-

Combustion chamber, internal diameter	2 metres
Water valve chamber, internal diameter	2 metres
Playpipe, internal diameter	1.7 metres
Total lift of water pumped	8.2 metres
Number of gas inlet valves	6
Number of air inlet valves	6
Number of exhaust outlet valves	12
Number of water inlet valves	448 flaps
Number of spark plugs	8
Cubic metres of combustible mixture admitted each cycle	5 cubic metres

The action of the pump is as follows:-

Imagine the U-pipe to be standing full of water up to the delivery outlet at the top of the water tower. A charge of a combustible misture of producer gas and air is pumped into the combustion head to start the operation and is exploded by pressing an electrical button switch which causes high tension sparks at the spark plugs and the cycle begins.

1st outward or power stroke. The exploded gases expand and the water is forced away from the combustion head at high velocity into the water tower. The momentum of the water column causes the pressure in the combustion and water valve chambers to fall below atmospheric so that on this stroke, air is taken in to occupy the space above the exhaust valves, a new quantity of water is admitted to take the place of that discharged and the exhaust valves are opened ready to emit the waste products on the next return stroke.

1st return stroke. The outward flow of the water column ultimately comes to rest and begins to return by gravitational force. The water valves then close and waste products are exhausted until the surface of the water strikes and closes the exhaust valves. Continuing on at high velocity the water column compresses the air trapped above the exhaust valve level and comes to rest on the compressed air cushion so formed.

2nd outward stroke. The cushion expands forcing the water back until the pressure is again below atmospheric taking in a charge of gas and air to mix with the air already admitted.

2nd return stroke. The column again returning by gravitational force compresses the new combustible charge which is fired automatically commencing another cycle of events.

Automatic interlocking gear worked by pressure from the combustion head enables the valves to open and remain closed, as required, during the cyle. Similar gear operates the automatic ignition.

The pump then carries on with a regular pendulum action, an explosion taking place every 4th stroke. The number of complete cycles at Cobdogla is about 9 per minute, and the delivery syphon emits a continuous supply of water to the receiving basin which is measured over a Cippoletti Weir 9.75 metres wide.

The construction work was a fairly arduous undertaking as a cofferdam 36 metres long, 13.7 metres wide and 12 metres deep had to be constructed to enable working through a 9 metre layer of quicksand to a stiff clay and sandstone rock foundation.

The concrete foundation work and the erection of the pumps, together with all concrete construction, was carried out within the cofferdam and the earth then replaced to floor level. The river channel then had to be dredged to form an inlet to the suction sump. Approximately 2 700 tonnes of cement concrete were pla in the construction work and the heaviest castings erected were the combustion heads 18 tonnes each and the valve boxes 16 tonnes each.

The producer plant consists of two "Saunders" updraft wood gas generators with a complete gas purifying installation consisting of tar extractors, coke, woodwool and sawdust scrubbers. The gas is received into a gasometer which regulates the pressure of delivery to the Humphrey Pumps.

The undertaking which costs $96 000 was necessarily costly on account of the formation of the ground at the site and of having to provide for pumping at the lowest state of the river, while, at the same time, similar work had to be allowed for during the highest floods when the level rises as much as 6 metres above normal pool level.

Any type of pumping plant, therefore, in the absence an electric supply, would have been costly to install at the same site, but the Humphrey Pump was chosen on account of its economy in maintenance, sinking fund contributions, fuel consumption and running costs.

The total cost of irrigation water delivered into the channel at Cobdogla was reduced from $1-10 per megalitre for the 1925/26 season by the original steam installation, to 57 cents per megalitre for the 1931/32 season by the Humphrey Pumps, or taking running costs only, from 46 cents per megalitre pumped in the former instance to 13 cents in the latter.

The reduction was not all due to the more economical pumping by the Humphrey Pumps because of reductions in wages and fuel costs and the fact that more water had to be pumped, now enters into the comparison, but a fair percentage of the saving is entirely due to the Humphrey Pumps.

Due to shortage of materials, some modifications were made to the Ignition system of the Humphrey Pumps, during the War years, which incidentally improved their reliability. Apart from this, the pumps have operated satisfactorily up to the latter half of 1965, when they were replaced by a 30"/33" electrically driven Harland Uniglide pump with a capacity of 1 590 litres per second.

It is interesting to note that the Humphrey Pumps were replaced not because they were worn out, but for economic reasons. This was partly due to the high price and decreasing availability of firewood and the comparatively high maintenance and upkeep of the wood gas generators and ancillary equipment. Also by converting the pumping station to all electric, a considerable saving is effected due to reduction of six personnel in manpower required to operate the station.

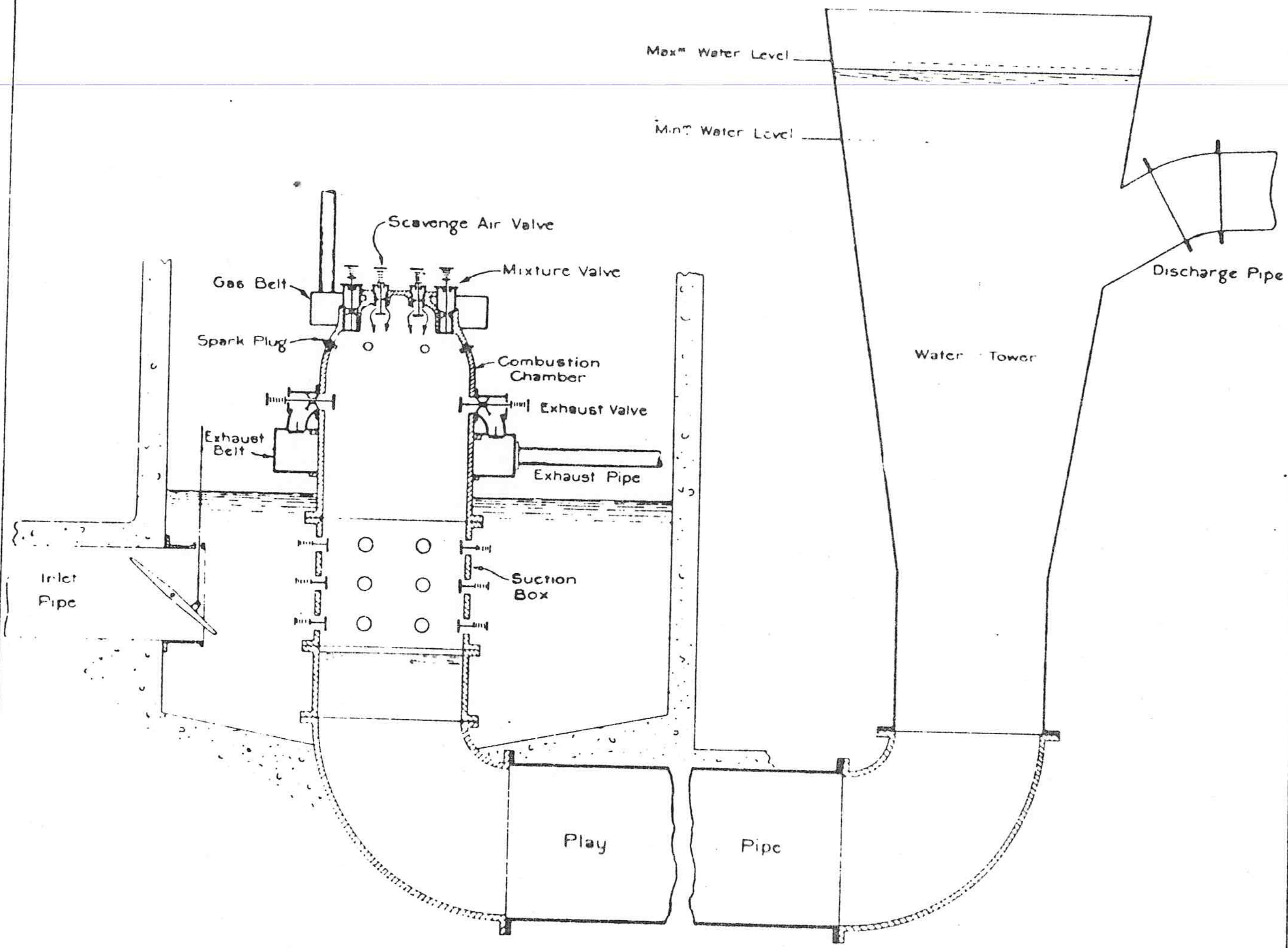


DIAGRAM OF HUMPHREY PUMP
EXPLAINING FOUR CYCLE OPERATION

OPERATIONS — DURING FIRST OUTWARD STROKE

The pressure exerted on the water by the force of the explosion & the expansion of the heated gases sets the water column in motion with increasing velocity. The kinetic energy acquired by the rapidly moving column causes it to flow outwards until a partial vacuum is formed at the combustion end of the playpipe. However, when the pressure falls to nearly that of the atmosphere the exhaust valves open inward with the assistance of springs. The lightly spring loaded water inlet valves open, admitting a large quantity of new water into the playpipe, partly to follow the still outgoing column of water & partly to endeavour to fill the pipe to the same level as that in the suction sump. With a further fall in pressure the scavenge air valve, also lightly spring loaded, opens, allowing pure air to be admitted to occupy the space above the exhaust valve level, a retentive valve in the exhaust valve casing preventing the return of burnt products from the exhaust pipe. By means of an interlocking apparatus operated by the pressures within the combustion head, the exhaust & scavenge valves were released when the explosion occurred & the gas mixture valve was locked in the closed position.

DIAGRAM POSITION ÷ NEAR END OF FIRST OUTWARD STROKE

Nº I

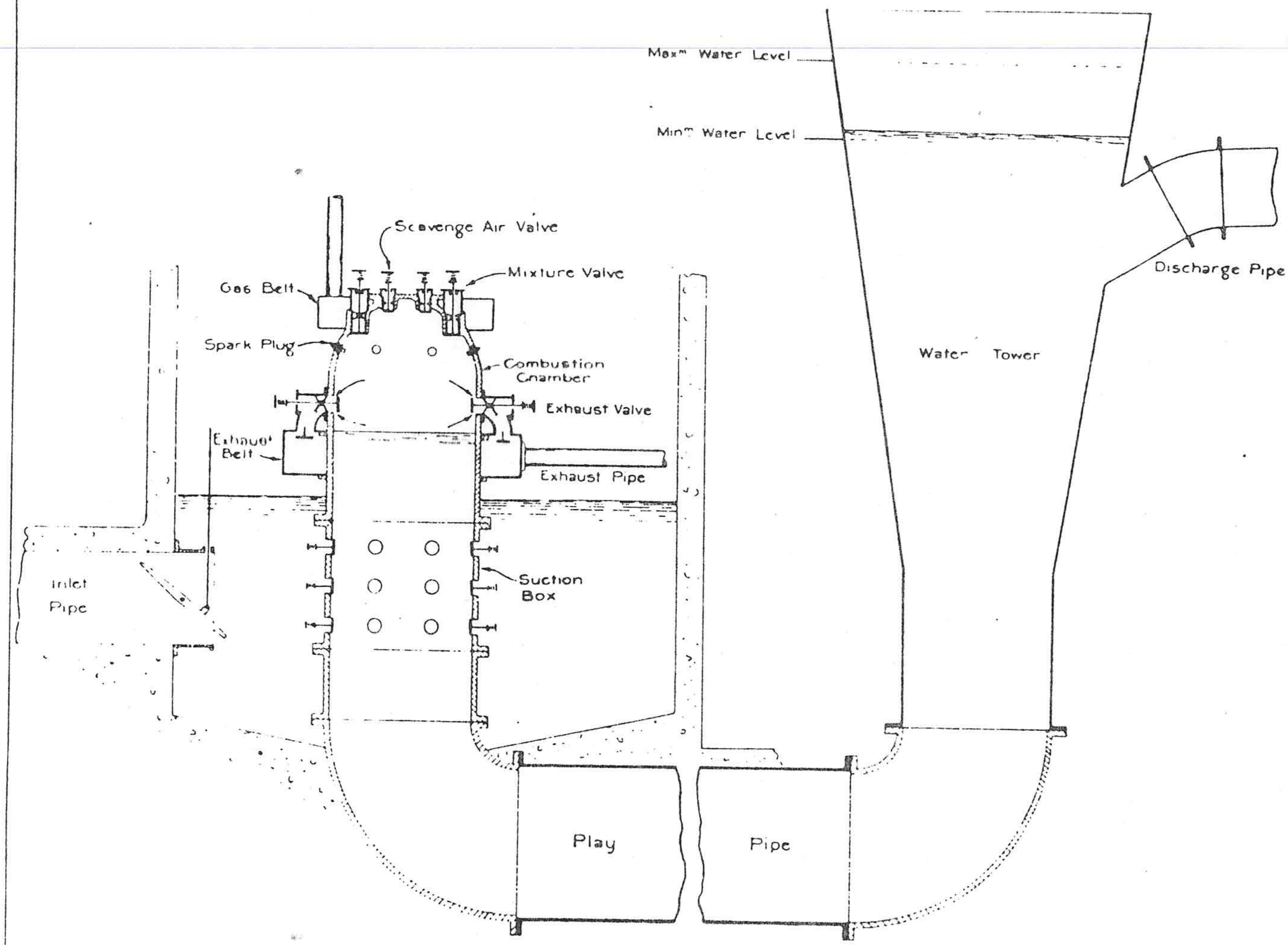


DIAGRAM OF HUMPHREY PUMP
EXPLAINING FOUR CYCLE OPERATION

OPERATIONS – DURING FIRST RETURN STROKE

The momentum given to the water column on the outward stroke having exhausted itself, it now begins to flow back, by gravitational force, towards the combustion head, driving the burnt products through the open exhaust valve & ultimately closing it by impact. The spring-loaded water inlet & scavenge air valves were closed when the pressure again rose to approximately that of the atmosphere. The returning water column having gained considerable velocity, now compresses the scavenge air (mixed with a percentage of spent gases) in the top of the combustion chamber, forming a compressed elastic cushion. The energy thus stored in this elastic cushion is then equal to the energy given out by the rapidly moving water column urged on by the static head behind it, so that the cushion pressure is considerably in excess of that due to static head. The interlocking mechanism now operated by the cushion pressure automatically releases the catch from the mixture valve & locks the exhaust & scavenge valves.

DIAGRAM POSITION ÷ NEAR END OF FIRST RETURN STROKE

Nº 2

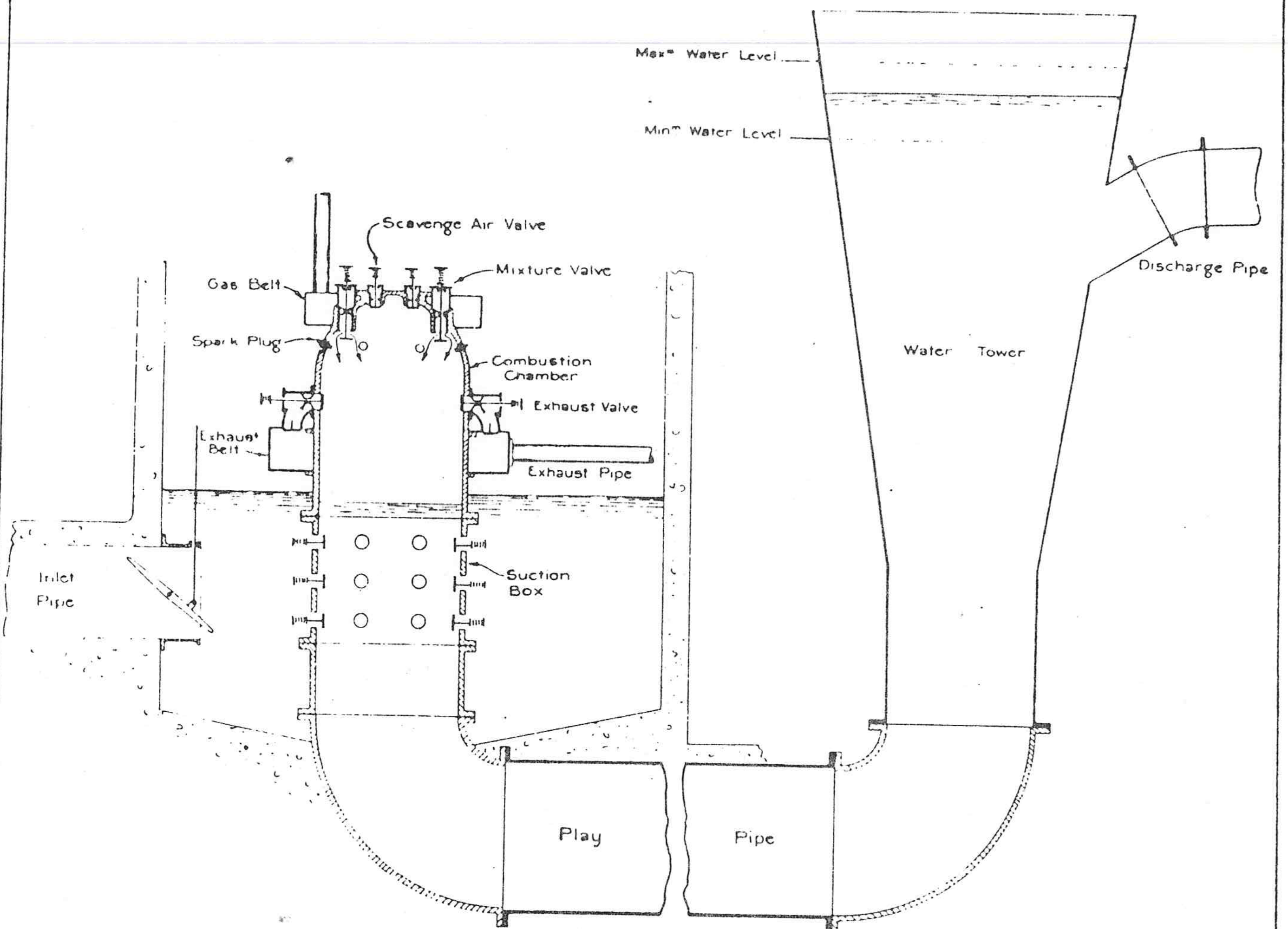


DIAGRAM OF HUMPHREY PUMP
EXPLAINING FOUR CYCLE OPERATION

OPERATIONS – DURING SECOND OUTWARD STROKE

The expansion of the compressed air cushion now drives the water column outwards again, the pressure becoming atmospheric as the surface reaches the exhaust valve level & if it were not for the friction losses in the playpipe, it would ultimately be driven outwards to approximately the same position that it occupied prior to the commencement of the first return stroke. The outward movement of the water column continues until a partial vacuum is again formed & the water inlet valves again open, admitting a large quantity of water into the playpipe. The gas mixture valve alone being free to open, a new charge of inflammable gas & a small amount of air is admitted, which, mingling with the scavenge air taken in on the previous stroke, forms a fresh combustible mixture.

DIAGRAM POSITION ÷ NEAR END OF SECOND OUTWARD STROKE

Nº 3

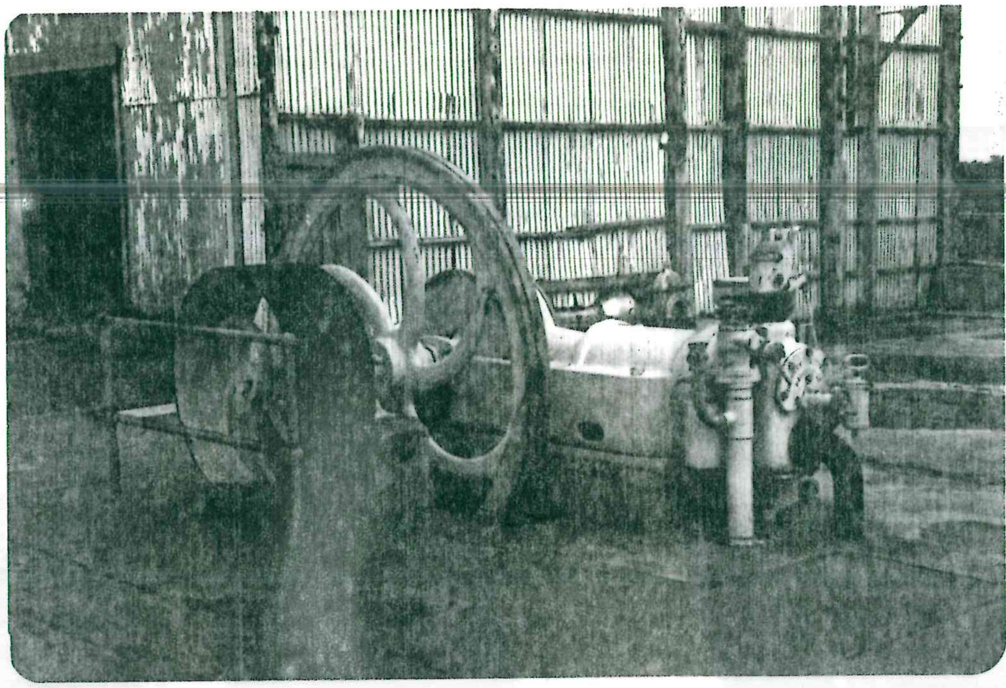


Photo No. 4 Gas Engine. Crossley Bros., Manchester.

Type S120. No. 82843. 30 H.P.
Drove 2 tar extractors and fans, elevator for wood, saw bench, electric dynamo, circulating pump for scrubbers, vacuum pump, compressors and ventilating fans. Started on petrol, ran on producer gas.

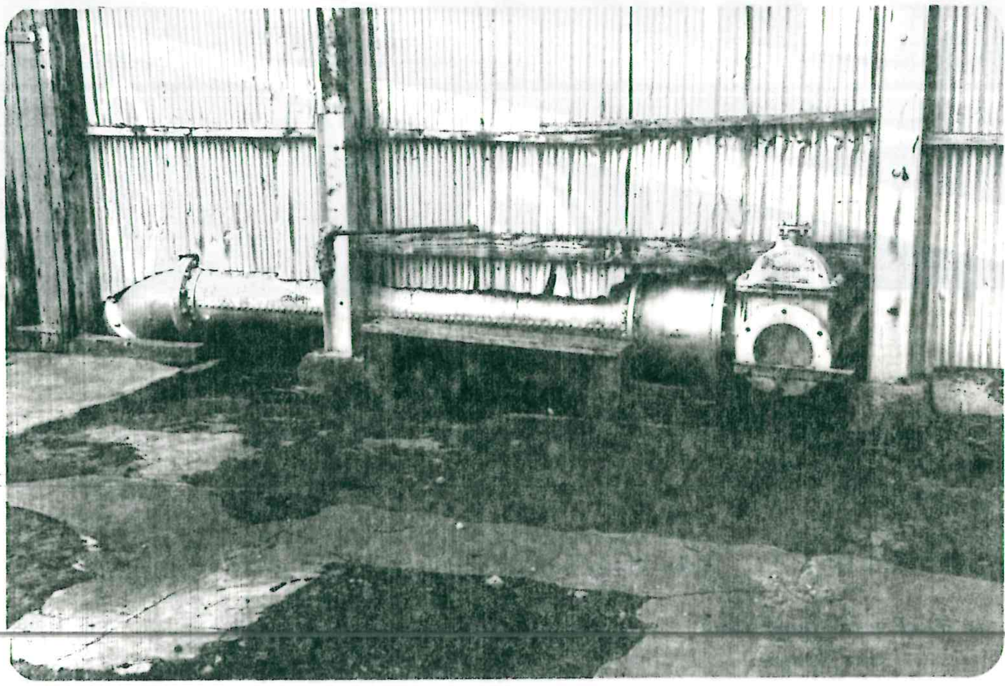


Photo No. 5 Wall between pump house and producer house.

Note the May Bros. shut - off gate valve and riveted gas pipe between the gasometer and pump. See also Photo No. 9.

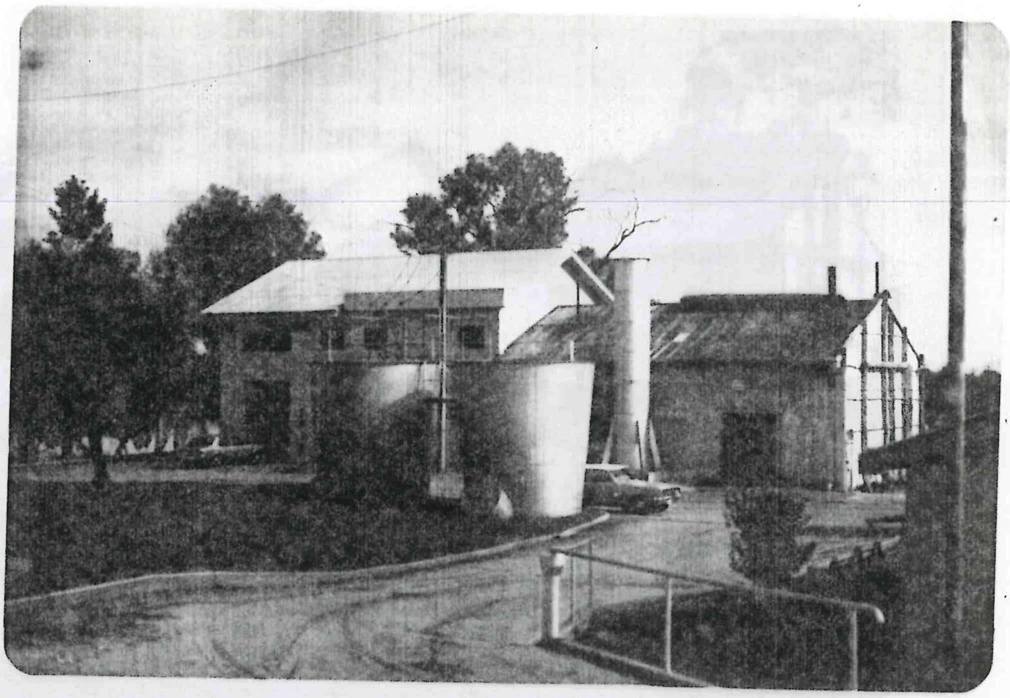


Photo No. 6 View from delivery end of pumps

The delivery syphons from the water towers have been removed and the flanges blanked (just above lawn). The Humphrey pumps are in the building behind the exhaust duct, the gas producer station was on the right. The newer electric pumps are in the high buildings on the left. The building just visible on the right is the engine room of the steam plant superseded by the Humphrey Pump.

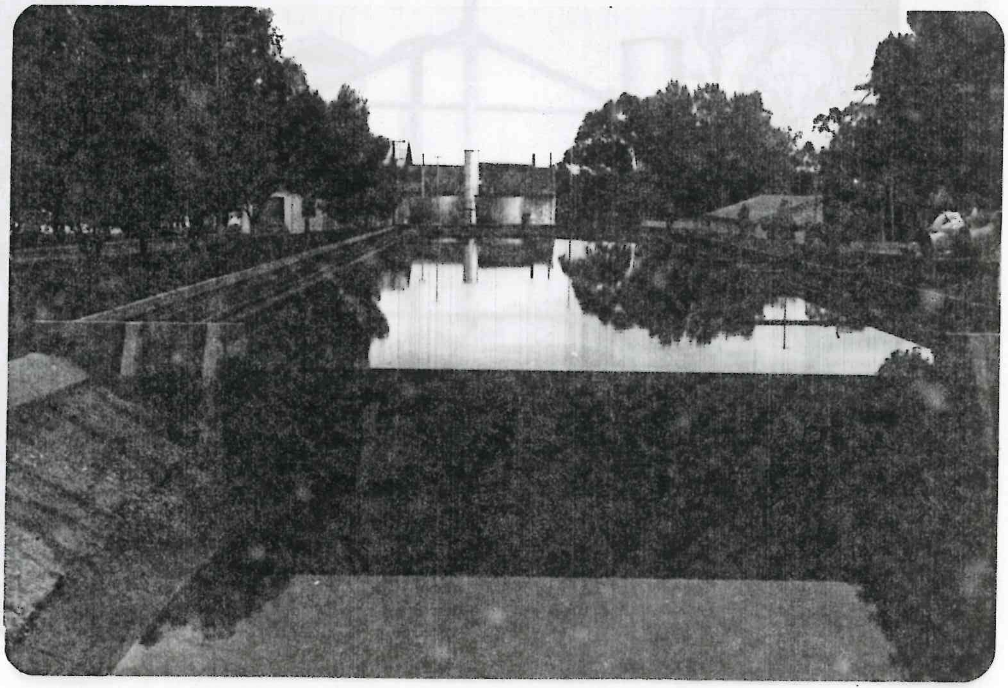


Photo No. 7 The Humphrey Pump building, water towers and exhaust duct, centre background.

Viewed from bridge over channel to irrigation areas. Syphon pipes (now removed) from towers fed water to the pool from which it flowed over the measuring weir into the channel. The old steam pump house on right background. The pumps etc. on right are in a new museum area.

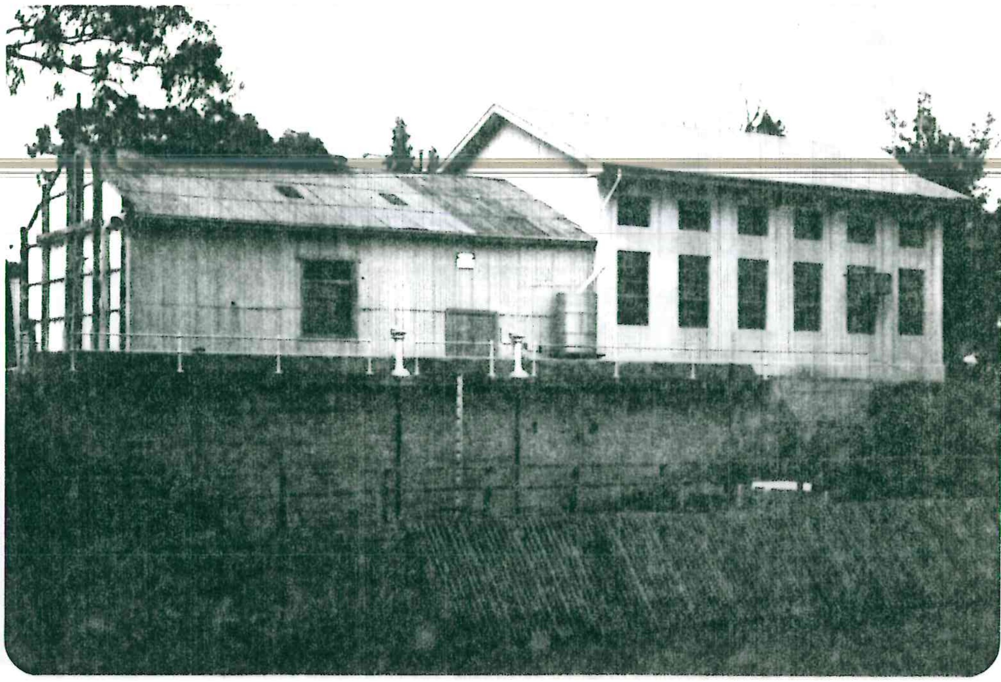


Photo No. 8   Trash racks in the inlet channel.

Protecting water inlets to the Humphrey and electric pumps. The penstock valve control columns for the Humphrey pumps are visible, one each side of the door.

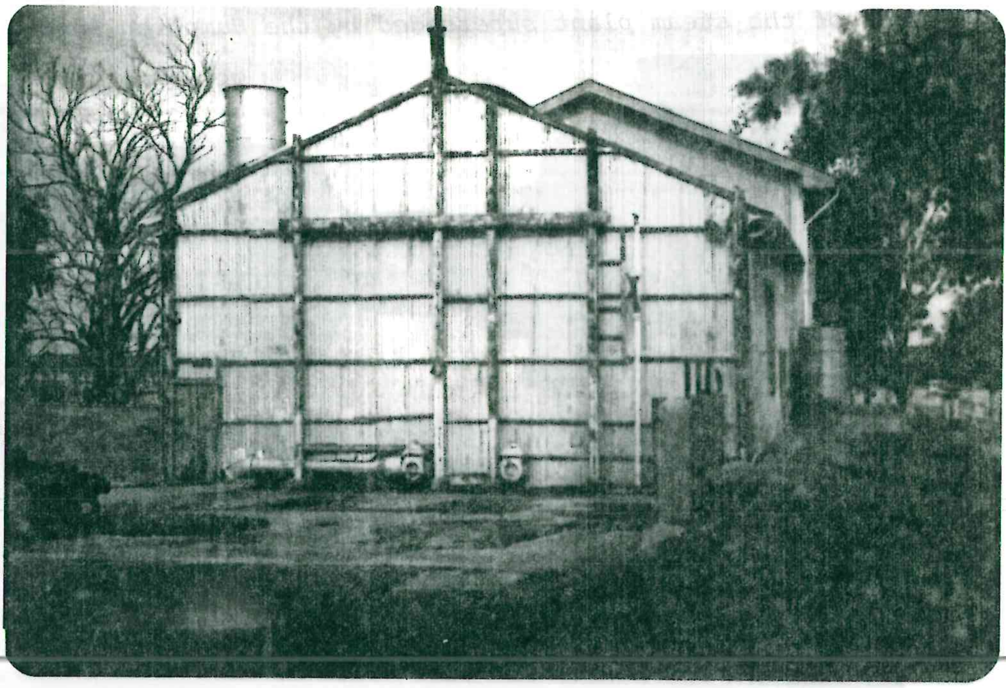


Photo No. 9   The wall between the Producer House and Pump House.

Refer also to Photo No. 5.
The penstock valve controls can be seen on the extreme right. The saw bench is on the extreme left and the Crossley engine is just off the photo on the left.