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RESTORING THE ELMINA PELTON WHEEL AT CUNNAMULLA

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A SHORT HISTORY OF THE WATER WHEEL

The water wheel would rank as one of the first mechanical devices used by humans to diminish or replace energy created from human effort.

A water wheel is a device that uses the power of running water directed to a wheel by either overshot or undershot design. The wheel contains either paddles or buckets located around the periphery of the wheel which receive the kinetic energy from the running water, thereby causing the wheel to turn.

> *A simple illustration can be the use of a garden hose to spin an object such as a bicycle wheel.*

From the centre main axle, the turning wheel gives rotary power which can be used for many applications. Early wheels were used to lift water for crops, grind grain, move drinking water etc.

In later times, especially in Australia and the United States, they were used to drive pumps in mines, supply power for electric generators, saw benches etc. and in the case of the subject of this book, homesteads and shearing plants.

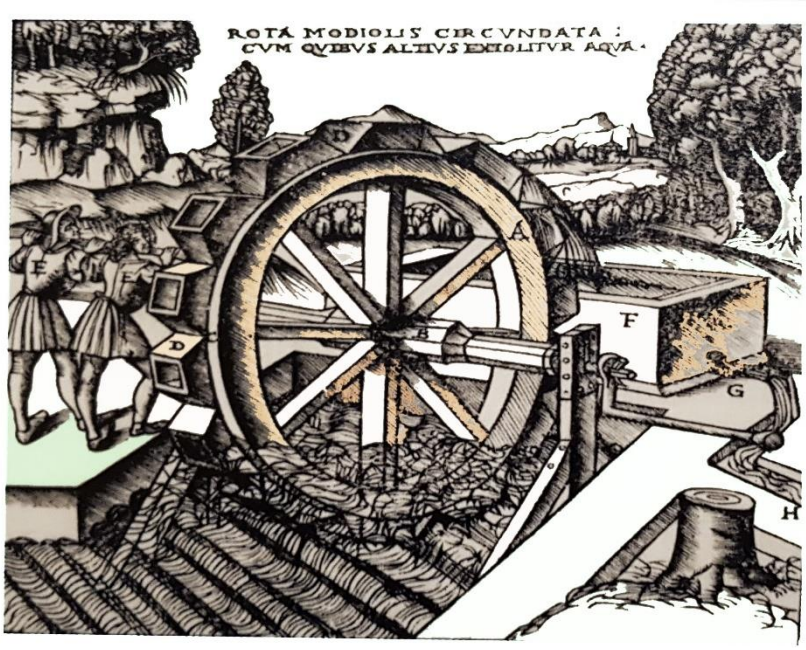
> *The first reference to a water wheel dates back to around 4000 BC. Vitruvius, an engineer who died in 14 BC, has been credited with creating and using a vertical water wheel during Roman times. An early horizontal wheel in Greece which was used for grinding grain was known as a Norse Mill, While in Syria water mills were known as Noriah's*

Early water wheels were probably horizontal in operation with vertical paddles lowered into a stream causing a vertical axle to turn. These types of wheels were gradually replaced over time by water wheels of the vertical design, however, some manufacturers today still produce modern versions of this principle.

The second type, known as an overshot wheel where water flows from an upper source and the gravity of the falling water turns the wheel.

The third type is the undershot water wheel where water is taken from a source such as a flowing stream as in the Brown Mountain Electric Supply or, sourced under pressure from pipe lines coming down from high ground, as used in the Snowy Mountains Hydro-Electric Scheme, or, as in the case of this book, bore water emanating from an underground source such as the Australian Great Artesian Basin.

EARLY UNDERSHOT WATER TURBINES



Viruvius De Architectura Illustrated 1521 Edition

A wooden reconstructed Norian Waterwheel from the year 512AD
(Courtesy Cobb and Co Museum, Toowoomba)

THE PELTON TYPE WATER TURBINE

The simple water turbine consists of a heavy cast wheel, with buckets around its periphery. These buckets catch a stream or streams *(jets)* of water accurately directed at them from either overhead or underground sources. Through the wheel is a main shaft that, when spinning can be connected to various attachments ranging from a simple saw bench, through to large generating plants that can supply towns and cities with electricity.

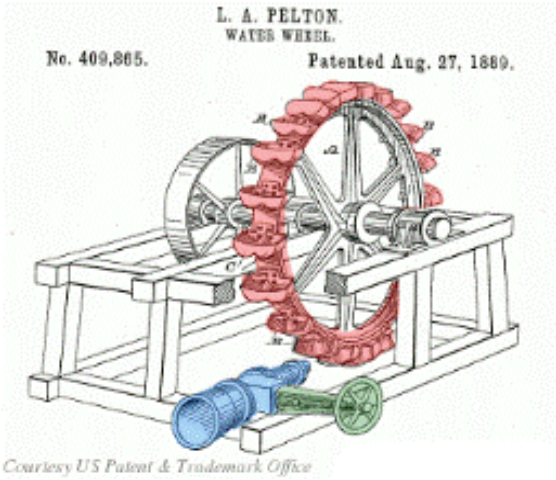
An example of these adaptions can be seen at Thargomindah where a complete working setup is in operation, and at Brown Mountain near Bega where Pelton wheels operate on demand, while the Snowy Mountains Hydro Generating plant utilises this technology in one of its generators also.

Over time many companies have produced Pelton type wheels especially for use in mountainous or hilly country. They have however, been adapted for use in dry flat country in the United States and Australia to utilise bore water pressure. Many emerging economies have embraced the use of Water Turbine-Technology.

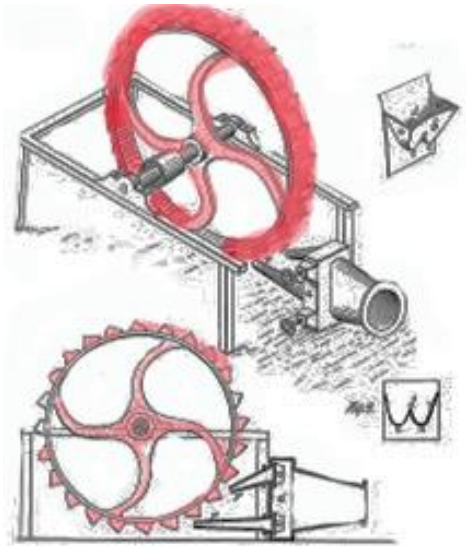
In simple old-style installations, the turbine can be exposed or as they are now, enclosed for high speed and efficient operation. The horse-power generated at the main shaft can be set, raised or lowered by varying the input of water that is directed at the buckets.

In the mid-1880's, as knowledge of the Artesian Basin and its extremities came to light, these turbines became sought-after by pastoralists who's land was located over this huge reservoir of water and many properties in the dry outback of Australia, and utilised this resource to supply power to remote stations and bring water to dry land via channels, bore drains, and flumes.

IMAGES OF THE ORIGINAL PELTON PATENT



Courtesy US Patent & Trademark Office



Original Drawing of Lester Alan's Patent Water Motor
(Taken from the book "The Pelton Wheels of Cunnamulla)

THE ELMINA PELTON WHEEL

(Most water turbines are loosely referred to as Pelton Wheels, or Pelton Water turbines).

The Cunnamulla water turbine wheel and other parts were found and identified in 2012 while visiting Elmina station (East of Wyandra) for research. These components were found near the bore adjacent to the Managers residence. *(Not the Homestead)* behind what was the location of the first wool-shed. The remains of the old wool-shed and some channeling etc. are still evident.

Reference to this wheel is made in the book *"The Pelton Wheels of Cunnamulla "* with the inclusion of several letters written by Fletcher Brothers and others. It appears at this time that the wheel was acquired by the Fletcher Brothers around 1903.

Mr. E. H. Fletcher states in one of his letters that the Elmina wheel was one of the first, if not the first water turbine to be installed in the Warrego and Nebine regions, and that it was purchased from America.

At that time, it was suggested to several persons within Cunnamulla, that if this wheel was restored and setup as a working display, it would be a tremendous attraction to visitors, specially being the first of its kind in the district and of its American origins.

In July 2019. the author of this book was contacted by a staff member of the Cunnamulla Visitor Information Centre, seeking information on Pelton Wheels, as they were thinking that a Pelton Wheel display may help with attracting more tourists to the town. It was then that the Visitor Centre staff learnt about the Elmina Wheel and what a good tourist attraction it would make if it was reconstructed as a working exhibit. After consultations, it was decided to proceed with the restoration as a project. Shire and Information Centre staff arranged to have the remnants picked up from Elmina and brought into Cunnamulla, where they could be worked on.

The owner of Elmina, Mr. Bill Tomlinson of YoYo Station near Augathella, very graciously donated the old parts to the Information Centre, as was the offer to commence restoration work to be done at Rocky Station workshop, courtesy of Barbara and Mark Mason.

At this time an offer of assistance was made by Bob Bird and Ian Itter to go to Cunnamulla and do the necessary setup work and so start the restoration work. In August 2019 work commenced on the reassembling of two of the main components, these being the wheel itself and a rather large and heavy three nozzle cast housing. The third item was a large heavy round end-plate being the diameter of the wheel itself. This item was not used in the reconstruction. Two suitable flat pulleys were found at Elmina.

As there were ancillary parts missing, identification of what year, make and model it was and what it looked like was impossible to know, so it was decided to restore what we had, using illustrations from the Pelton and Leffel manuals of which we had copies.

It was decided to adopt the design configuration of the earlier illustrated wheels and leave off the covers so as to be able to allow viewing of the working wheel which would turn at a reduced speed *(rpm)*. It was also decided to drive the wheel using a hose connection to the three nozzles, thereby illustrating the water leaving the nozzle and hitting the buckets.

This initial work comprised the manufacture of a steel frame (Chassis) to mount and most importantly, align the wheel to the nozzle housing. Two main bearings were created using nylon bearing inserts to facilitate lubrication by water.

The wheel was then settled into working position on its bearings and then rotated by hand to check its smoothness of operation and alignment.

During the period following this initial work, investigations were started to collect as much information as we could about this water turbine.

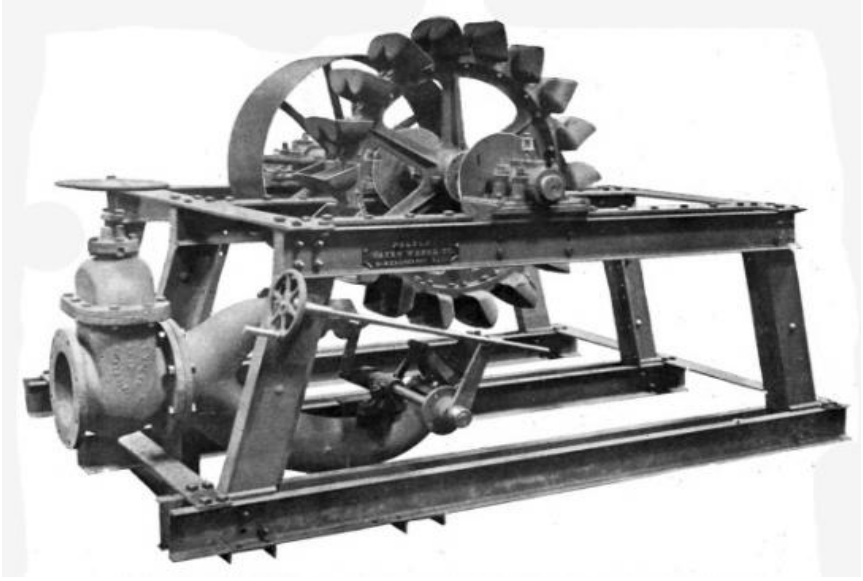
The Term "Pelton Wheel" refers to the actual wheel that has the buckets attached. It does not refer to the Water Turbine or Engine as a whole. Therefore a Turbine made by any person or company other than The Pelton Company that has a main wheel with buckets attached, has been, and is, loosely called a Pelton Wheel.

In trying to identify the manufacturer of the Elmina wheel, the nearest manufacturer we could find other than the Pelton Water Wheel Co, was the Leffel Water Turbine Company of the USA. By studying these two manuals it appears probable that the Pelton Company did not produce a three nozzle turbine as their range of models seems to go up in pairs of nozzles. i.e. 2, 4, etc. whereas the Lefell company made three nozzle engines. The answer to who made the Elmina turbine is still unanswered.

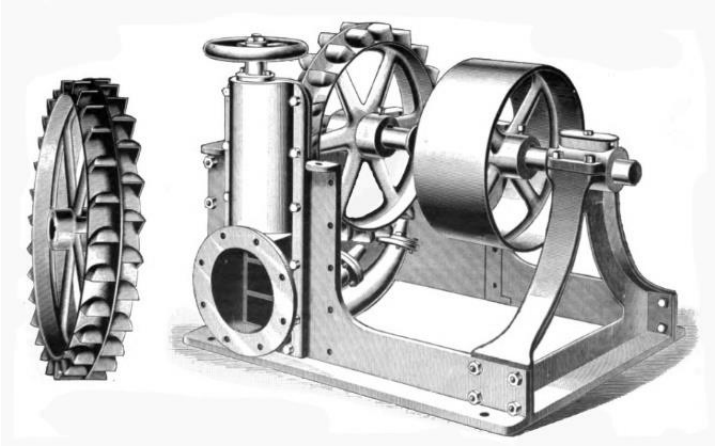
Ian Itter
2021

Lester Alan Pelton (1829 – 1908)

MODELS USED FOR RECONSTRUCTION



The 2 Nozzle Pelton Wheel that was used as a model for the reconstruction.
(There were many model variations recorded)



A Lefell water turbine of similar vintage showing a staggered bucket wheel seperately
(Leffel Cascade Water Wheel Company of America)
(Ian Itter collection)

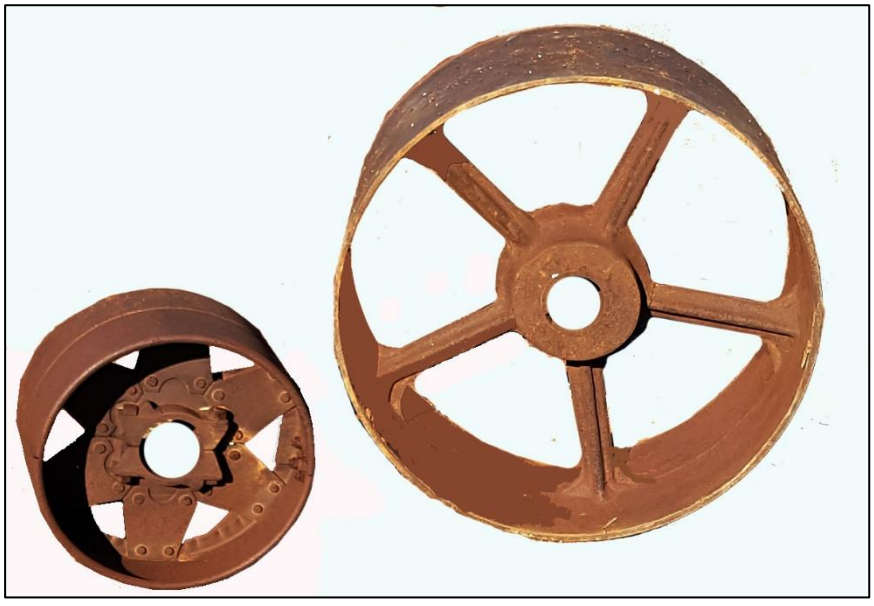
A genuine Pelton Wheel held by the Queensland Museum, showing offset buckets
This patented wheel is to be found in other turbine engines
(Courtesy Queensland Museum)

A close-up photo of the three nozzle arrangement used by the
Lefell Company in one of their 1890 models.
(Bob Bird collection)

WHAT WE STARTED WITH

Side Pate (No identification)

Nozzle housing



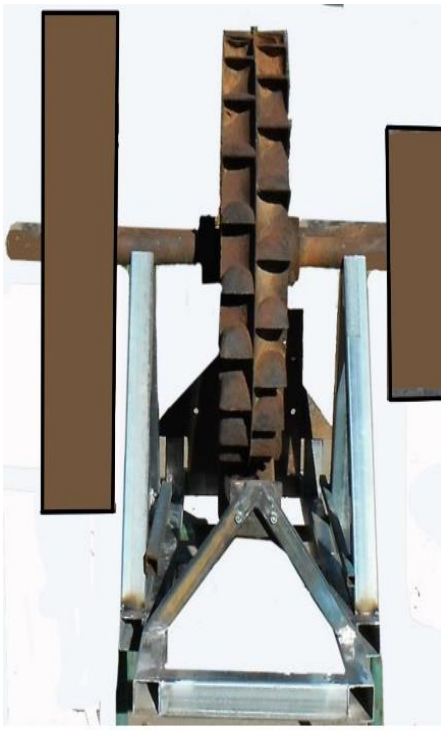
Two flat-belt pulleys

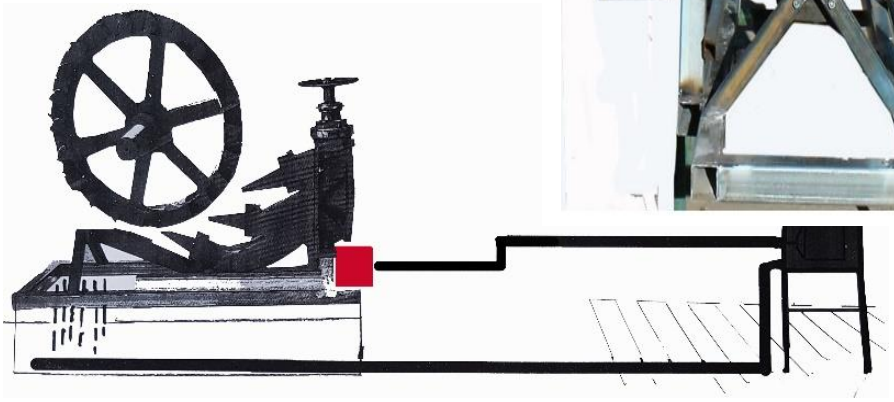
COMMENCING THE RESTORATION PLANNING

PUTTING THOUGHTS TO PRACTISE

A computer image showing the gate valve, nozzles and their shrouds in place (Ian Itter collection)

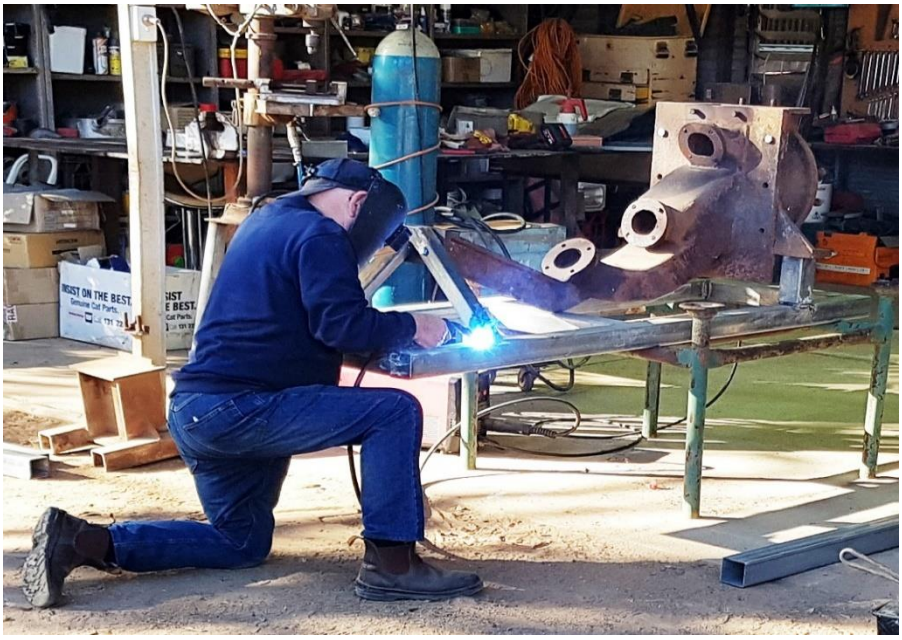
End on view of proposed setup with two pulley's





Overall layout of complete plant

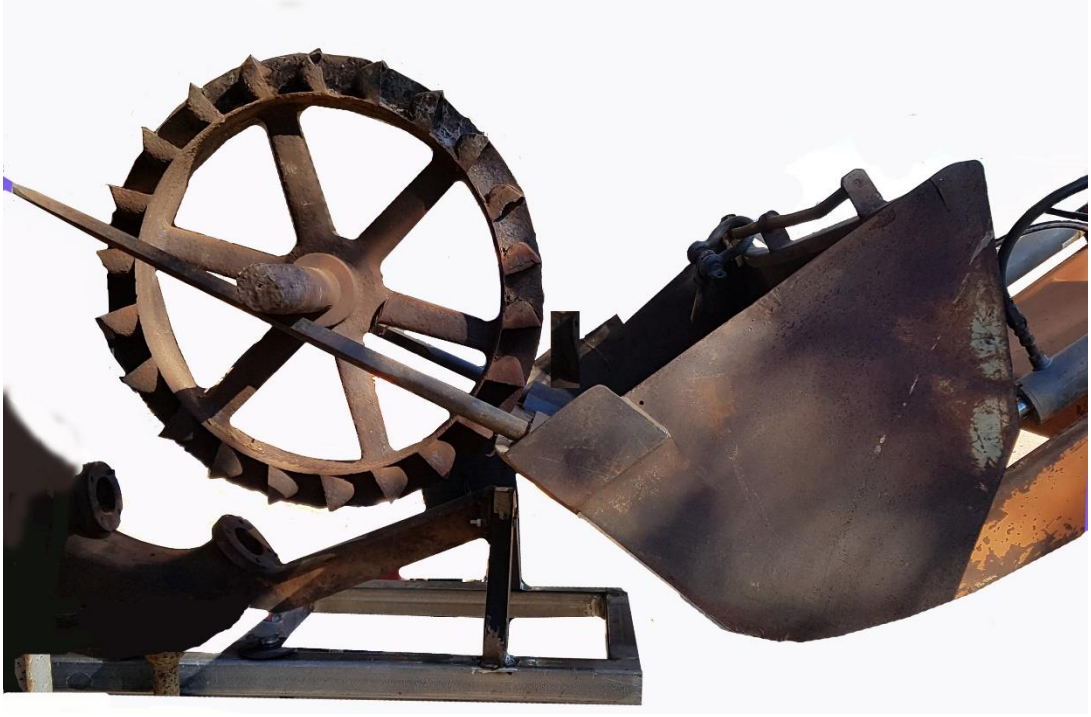
THE FRAME



Welding the frame

Lining up the nozzle housing during welding

Finished frame ready to match with the nozzle housing



Using a forklift to position the wheel to determine its relationship to the nozzle housing

The main bearings supporting the Pelton Wheel have been manufactured locally to a non-original design. Old drawings suggest a brass bush or plummer block arrangement may have been used, or in the case of this wheel the side covers which we did not use, however it was decided when reconstructing to adopt a more simple arrangement using a nylon based bearing that could be lubricated using water.

MAIN BEARINGS

Fitting and adjusting the non-original main bearings

The completed stage 1 assembly at Rocky Station, Cunnamulla

THE NOZZLES

The three sets of nozzles were manufactured locally using illustrations from the *Leffel Cascade Water Wheel Company of America* manual and *the Pelton Water Wheel Company*.

These nozzles were so designed to allow three quarter inch water pipe sections to pass through adjustable swivel balls, which in turn allow the nozzles to be critically aimed at the buckets to achieve maximum pressure on the wheel.

Because this unit will be operating as a tourist attraction, an external separate water pump unit supplies the pressure required to turn the wheel.

Inside the nozzle housing casting, provision has been made to connect the pipes from the nozzles to flexible hoses which in turn are connected to a water supply manifold. It is expected that the wheel, when complete will turn at a slow pace to allow viewers to see the principal workings of the wheel.

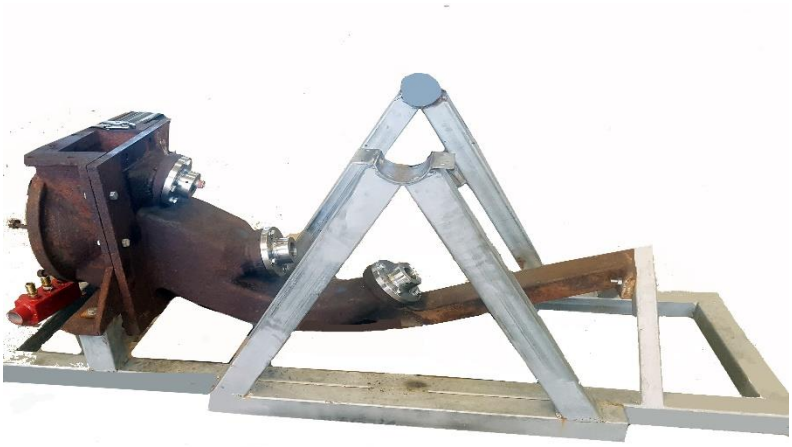
Locally manufactured adjustable nozzle

Locally manufactured water manifold showing one intake connection to a water supply hose and pump at the bottom, and three outlet fittings to connect with a ¾" hose connected to each nozzle

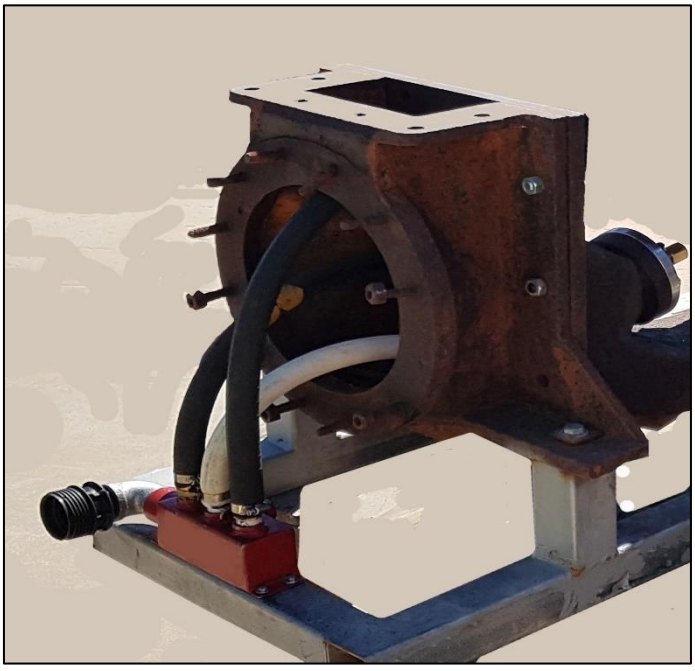
THE NOZZLES (cont)

Bench testing the nozzles and manifold using a portable fire fighting unit
Showing the flow through a 3/8 (bottom) and 3/4 inch diameter oriface

Fitting the nozzles to the nozzle housing



The frame with nozzles fitted



The completed intake manifold (red) with hoses connected to the nozzles
A nozzle is shown on the far right

THE GATE VALVE

The Gate Valve

Note: this gate valve serves no purpose than to give a display

THE PUMP UNIT

The pump unit (2 Views)

(Cemented into ground next to Wheel)

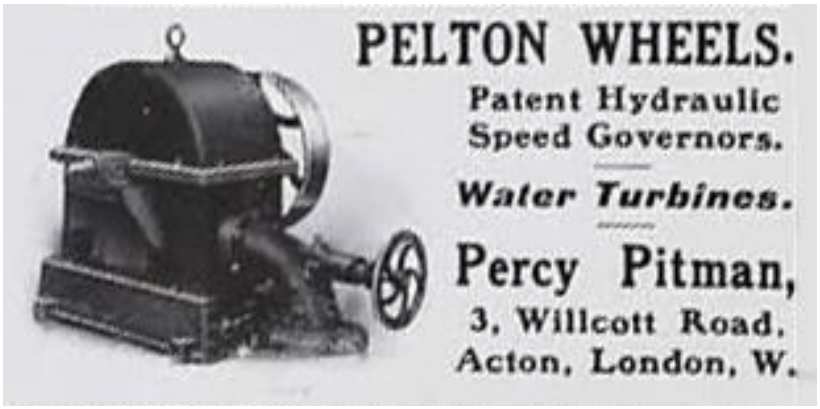
Pump assembly showing horizontal perforated water pick-up pipe
(See page 16)

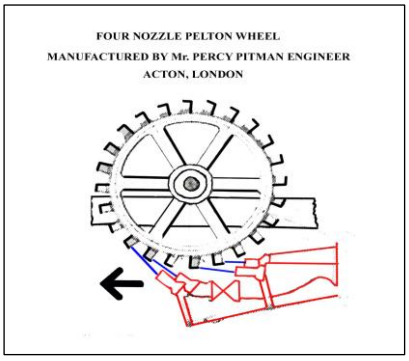
Initial start-up with the wheel assembly still on a forklift
Note: In this photo, the wheel is making its first revolutions for the first time in many years. Using water pressure from a portable fire-fighting water pump. Note the input hose on the right-hand side of the photo (red) with unguarded water coming off the wheel

Paroo Shire staff looking at the initial start-up (turning) of the wheel (Ian Itter Collection)

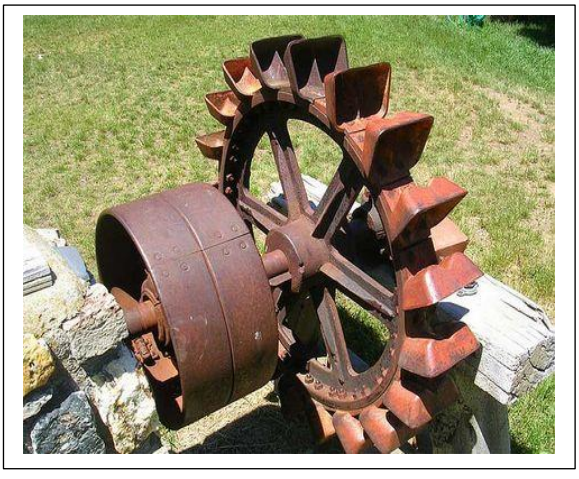
APPENDICES

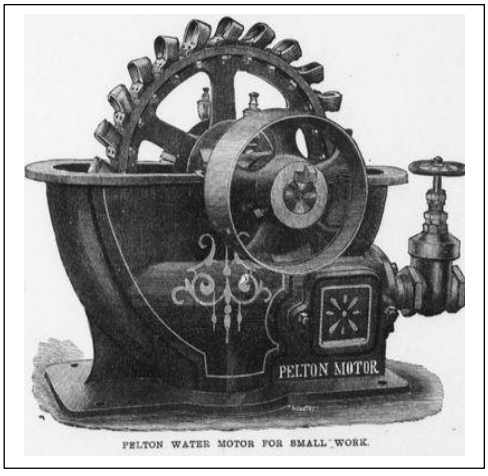
APPENDIX 1
RELEVANT OTHER APPLICATIONS





The diagram on the left shows a four nozzle design manufactured in England. The lines in blue indicate the water paths from the nozzles, while the red lines indicate the indicate the casting structure that supports the nozzles





APPENDIX 2
THE PELTON WEEL AT QUIPIE (Edited)

(An (undated article)

No matter how long a dry period is experienced, Cunnamulla does not have occasion in being fortunate enough to be situated over water may we had for the sinking of a bore.

The sinking of a bore is a costly procedure. The contractors charge by the foot and the rates increase with the depth of the bore, 14 shillings per foot up to 800 feet. 18 shillings per foot for the next 200. 20 shillings per foot for the next 500, 25 shillings per foot for the next 1000 feet and 40 shillings per foot for the rest.

The Quilpie bore is one of the finest in the west. It is 2900feet deep, has a flow of 1,500.000 gallons a day with a pressure of 178 pounds per square inch and the temperature of the water is 189 degrees at the bore head, only a few degrees from boiling point. A six inch main pipe leads from the bore to supply the town, and it was found that the pipes could not withstand the pressure.

To correct this a bigger pipe was introduced at the bore head, through which thousands of gallons of water gushed daily to waste. The amount of water that goes to waste is of no consideration at all. It is a common practice with people at the far end of the town to leave taps running day and night so that the water shall not be in the pipes long enough to be cooled off.

At several points around the town one-inch pipes run without even a tap to turn the water off and on. A stream of water is fed into the drains to ensure that the water does not contain brine or become stagnant so mosquitoes are deprived of what would otherwise be flourishing breeding ground.

Practically every house has hot and cold showers and the only apparatus that has to be installed, is a small tank with a moat.

One holder has a life-long service that requires neither attention nor fuel since the advent of the bore, lawns are as common in Quilpie as in Un.,-j btine.

Previously the allotments were carpeted with myriads of small red stones. A volunteer fire brigade was been organised and owing to the temperature of the water, the firemen have to wear leather gloves.

Despite this handicap they have been responsible for some great saves. One resident of Quilpie, a hotel proprietor, could not bear to see the water gushing from the 4 inch pipe at the bore head, without regretting that it could not be used. His fertile brain evolved a scheme for harnessing it and now it drives his own hydro-electric plant.

The plant consists of a Pelton Wheel driven at 1000 revolutions per minute by the waste water forced through a one inch nozzle at a pressure of 125 pounds per

square inch. The wheel in turn drives two generators. The Pelton wheel was wholly made in Brisbane, and is similar to the old-fashioned water-wheel with the exception that it is all encased. The generators had to be imported and were specially made for the job. They are compound wound and are located where the water escapes after passing through the Pelton Wheel.

The Pelton wheel does away with the necessity of storage batteries. They have an automatic cut-out to deal with the excess current. It does not matter how much you use, whether one light or a hundred lights are burning, it lets just the required amount of current through.

The plant only cost £1200 to install, and costs about 6 shillings and eight pence a week to run.

When it is taken into consideration that there are 250 lights. Four refrigerating compressors, and 7 fans presently supplied and still there is a sufficient margin of current for a considerably heavier load, it can readily be seen what a wonderful proposition it really is. All these facts outlined are made possible by a man-made gusher of one million gallons of water that comes daily to the surface in the middle of this arid country

QUESTIONS RAISED

What year was it made ?
When did it come to Australia ?
Who purchased it
Was it indeed manufactured in the USA ?
What Horse-power- is it ?
Is it a genuine Pelton Wheel or maybe a American Leffel or other manufacturers machine ?
Why are the Buckets on the main wheel staggered ?
Why are the bucket? cast into the wheel instead of bolt ons.

WORK IN PROGRESS

Both Bucket Wheel and Nozzle Housing have been installed on a 4 inch square tube frame.
Three adjustable nozzles have been made by following designs of similar turbines of the time, these nozzles allow a hose connection to be made within the nozzle housing.
A visit was made to the Butlin Archives in Canberra University to view the Station records of Ularunda and Elmina Stations, where the records are archived. After going through a large collection of records, we failed to find any record of the acquisition of any wheel.
We have found so far, the predominant manufacture of these turbines in the Cunnamulla and Nebine districts are those produced in Brisbane by the Henderson Company. All wheels so far inspected are Henderson manufacture. The Elmina turbine is quite a different and more substantial structure to the Henderson models.

Elmina	American Manufacture
Possibly the Pelton	Company
Charleville model	Henderson Manufacture (2 Wheels)
Warambah plant	Henderson Manufacture Brisbane
Murwah plant	Henderson Manufacture Brisbane
Boorara	Unknown at present
Claverton	Unknown at present
Bedena	Unknown at present
Eularunda	Unknown at present. tThought to be the same type as the Elmina unit
Thargomindah	English Manufacture

CUNNAMULLA - RESTORING THE ELMINA STATION PELTON WHEEL
ISBN ??????????????????