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USING STREAM ENERGY TO PUMP LIVESTOCK WATER

This factsheet looks at using gravity energy in the form of a flowing stream to move water in the low volumes usually required for livestock use. Pumps discussed include the Coil (*Sling*) Pump and "Water Wheel" Pump.

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Introduction

Livestock water pumping options are selected with pump-driving energy as the limiting factor, especially remote systems. Where grid-supplied electricity is not available, gravity is usually the first energy option to consider. In this Factsheet, using gravity energy in the form of a flowing stream is considered.

Like most livestock water pumping systems, the site plays a big part in the energy choice. For a stream-powered pump to be viable, the sites stream and terrain must be favorable, having

- a water supply deep enough to properly submerge the pump, and
- a gradient sufficient to generate the water velocity required

Pumping water using water flow has similarities to pumping using wind. For small systems, the higher density of water and continuous 24-hour flow offer significant advantages. (For larger systems, wind power may be the choice.) For all such pumps, in-stream debris is a concern and may limit their use.

Coil Pump

This pump is commonly known by its commercial name of *Sling Pump*. It is based on a principle similar to the Archimedean screw, except it operates in a horizontal position with coiled pipe, rather than a sloped and open screw. The basic coil pump is illustrated in Figure 1, below.

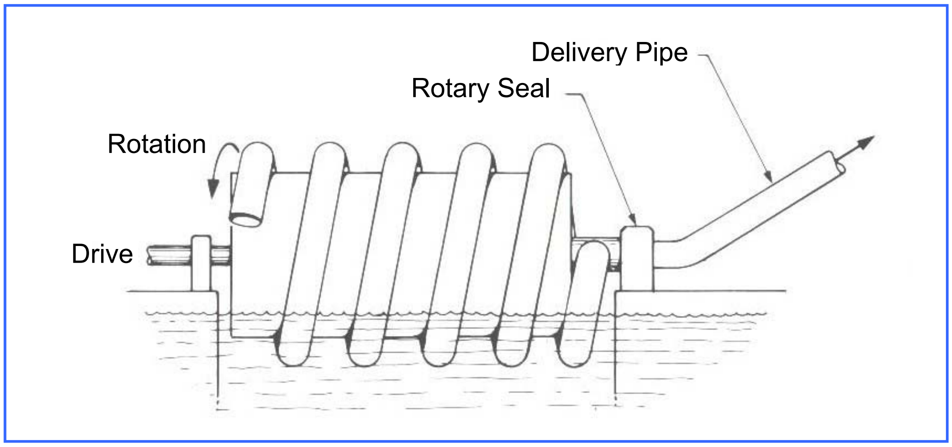

Figure 1 Coil Pump From: Water Pumping Devices by Peter Fraenkel, 1995

Coil Pump Operation. One end of the coiled pipe is open and dips into the stream taking a "gulp" of water with each revolution, sufficient to fill the lower part of a coil, while trapping air in the coil. With each revolution, this water moves along the coil and a new "gulp" of water is taken. As long as the delivery pipe height is no higher than the specified maximum elevation, water (and air) go in with each revolution and water (and air) comes out.

This design is limited in available water lift and volume, but is a very simple device, as well as being portable and easy to set up. The one wearing part is the rotary seal in the delivery line (allowing the pumping pipe to rotate while the delivery pipe is stationary).

Sling Pump

The *Sling Pump* is a commercial adaptation of the coil pump principle. It has a casing around the coiled pipe and the drive is via a propeller facing into the stream current, as shown in Figures 2 to 4, below. The pump rotates slowly.

Figure 2 Sling Pump Operating in a Stream

Various water lifts and volumes are possible with different sized coiled pipe. The *Sling Pump* shown above has 32mm (1.25 inch) polyethylene pipe for the internal coil. It will pump 15,000 litres (4,000 USgal) per day up 6.1m (20 ft).

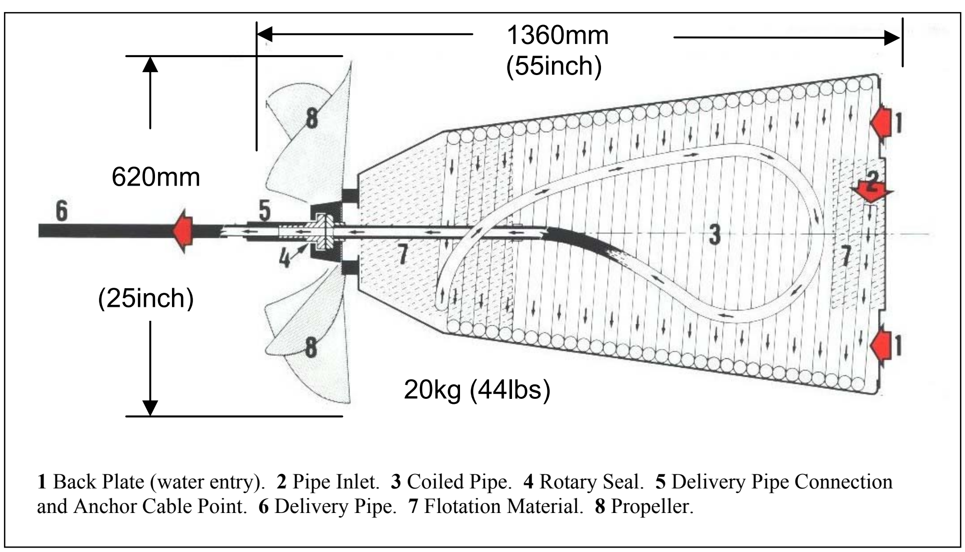

Figure 3 Sling Pump Cutaway Sketch from Canadian Industrial Pumps Ltd

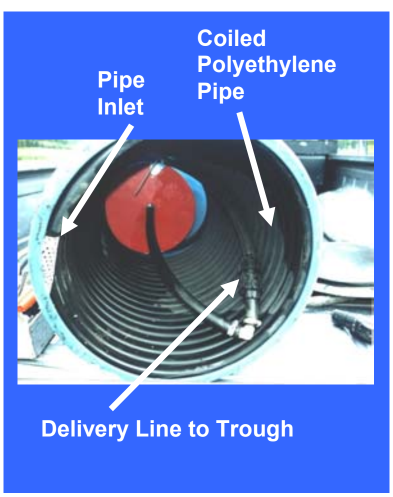

Figure 4 *Sling Pump* with the Back Removed

Figure 5
Sling Pump
Installation Options

5a Anchored to a Bridge

5b Anchored to a Streamside Post

5c Current Moves Pump into Stream, away from Bank

5d Adjustable Streambank Arm

5e Adjustable Streambank Arm

5f Streambank Arm Detail

Sling Pump Installation.

Like all such pumps, the *Sling Pump* requires specific conditions to operate:

- a depth of water sufficient to submerge the pump
  - the pump must be half submerged, as shown in Figure 2, page 2
  - 400mm (16 inches) minimum water depth required
- a water velocity sufficient to power the pump
  - 0.6 m/sec (2 ft/sec) to obtain the design output
  - visually, this is not a "lazy" stream flow but an "active" one

As well, installation must ensure the pump is kept in the "active" portion of the stream to maximize rotational energy. The pump reacts to the force on the propeller by moving sideways. The stream current must flow in such a way not to allow the pump to move out of the "active" portion, or to move to shallow water areas, to maintain rotation, as shown in Figures 5b and 5c.

Various installation possibilities include setting the anchor cable:

- to a bridge (allows multiple stream positions), Figure 5a
- to streambank post (a typical method), Figure 5b
  - the stream current is turning away from the bank, Figure 5c
- to a streambank arm, Figure 5d, 5e and 5f
  - the pump can be set in multiple stream positions to catch the current
  - note steel pin to limit extension of arm
  - also note round "roller" for ease of movement
  - driven posts maintain arm position by resisting stream current

Sling Pump Plumbing.

The water delivery is continuous 24 hours a day, but livestock use is not. Oversized water troughs are a good idea to allow a short time, high rate use that may be greater than the pump output. The trough can be drawn down at such times and be refilled by the pump later. However, sooner or later the trough(s) will be filled. To avoid spillage, excess water must be handled.

Environmentally, trough locations are set well back from the stream so excess water would require a second (overflow) pipe back to the stream. In place of this pipe, a pressure relief valve that opens at a low pressure (5 psi or so) can be teed into the delivery pipe at the pump, as shown in Figure 6, below.

When the water trough float valve closes on filling, pressure will build and this relief valve will open, spilling water back into the stream.

When livestock use the trough water, the float valve will open. Delivery pressure is then reduced, the relief valve will close, and pump delivery water goes to the trough, until filled.

With this system, when the trough float is closed, "head" is added to the pump. The total head must not exceed the specified amount or the pump will stall.

Figure 6 Pressure Relief Valve

Water Wheel Pump Horizontal-Axis

This device directly uses the energy of a flowing stream and could be called a "sternwheeler-in-reverse". Rather than the engine-powered stern wheel moving a boat, a frame (anchored to the shore) has a stream-driven wheel that operates a pump. The wheel shaft is on a horizontal axis.

The width and depth the wheel is immersed into the stream can be varied to operate different sized pumps. This pump may operate in less water depth than the *Sling Pump* (e.g. wide wheel in shallow water), but would need the combination of wheel and stream width sufficient to pump the same amount of water.

This device may be built to pump larger volumes than the *Sling Pump* but like it, specific operating conditions are required:

- a depth of water sufficient to submerge the wheel
  - this will vary with the depth adjustment of the wheel
- a water velocity sufficient to rotate the wheel
  - this flow may be a "lazy" flow as the wheel can be wide to capture a large portion of stream flow for pumping energy

Various types of pumps could be connected to the drive. They would be matched to the amount of energy produced by the rotating wheel and the volume and lift needed for the livestock being watered.

Water Wheel Pump Vertical-Axis

This device could be thought of a as "water windmill". The axis of the rotating wheel shaft is vertical, extending down into the flowing stream. The top end of the shaft (above water) drives a pump. The in-stream wheel on the shaft is formed to capture the stream energy. One prototype uses a turbine similar to the Darrieus windmill; a commercial unit (*Tyson Turbine*) uses a propeller-type shape.

As for wind systems, the energy available in a stream is proportional to the density of the drive material (water) and the cube of the stream velocity. As water has a much higher density than air (windmills), similar levels of energy are available in a stream with about 1/9th the velocity of air.

Other Information

The following provide more detailed information on stream-powered pumps:

- *Water-Pumping Devices – A Handbook for Users and Choosers*
  Peter Fraenkel, Intermediate Technology Publications, 1995
  London, UK http://www.developmentbookshop.com/detail.aspx?ID=489
- the *Sling Pump* – contact the BC supplier at 604-882-8752
  or at Kjell@uniserve.com
- the water wheel pump – refer to *Cattlemen* magazine issues August 2001 and November 2002 for articles on a producer-built pump
- the *Tyson Turbine* http://www.theramcompany.com/index.html

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RESOURCE MANAGEMENT BRANCH
Ministry of Agriculture and Lands
1767 Angus Campbell Road
Abbotsford, BC V3G 2M3 Phone: (604) 556-3100

WRITTEN BY
Lance Brown
Engineering Technologist
Kamloops Office