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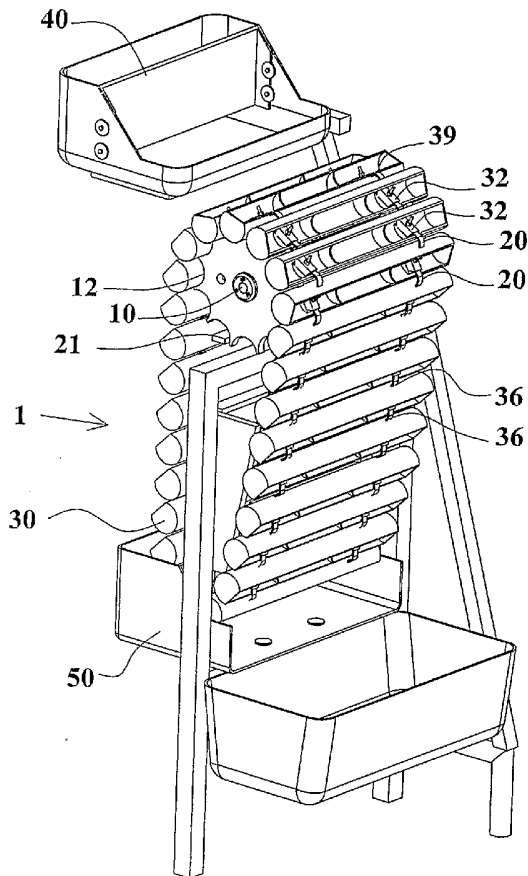
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[Continued on next page]

(54) Title: IMPROVEMENTS IN AND RELATING TO GRAVITY TYPE WATER WHEELS



(57) Abstract: A water wheel (1) in which a plurality of water receptacles (30) are coupled to a belt (20), the belt (20) arranged to freely depend from a rotatable shaft (10). The water receptacles (30) are fixed to the belt (20) such that the water receptacles (30) are maintained in a substantially upright position as the water receptacles (30) descend with rotation of the belt (20) and shaft (10). The water receptacles (30) are upturned more rapidly and at a lower position than is possible with e.g. breast type water wheels, to offering increased efficiency in energy recovery.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## Improvements In and Relating to Water Wheels

### Field of the Invention

5 The present invention relates to water wheels.

### Background to the Invention

A wide range of hydraulic machines for exchanging energy  
10 between a fluid medium and mechanical system are known.  
One particularly simple class of devices for harnessing  
power from flowing water is gravity type water wheels, in  
which the weight of water in buckets on one side of a  
wheel or belt creates an unbalance causing the wheel or  
15 belt to turn.

Three well-known gravity water wheels are shown in Figure  
1A-1C.

20 Figure 1A shows an overshot type water wheel. A  
disadvantage of the overshot water wheel design is that as  
the wheel rotates some water is emptied from the buckets  
before they reach their lowest point. This means that not  
all the energy available from the input flow can be  
25 recovered.

Figure 1B shows a shrouded or breast type water wheel,  
which reduces the problem of premature emptying compared  
to the overshot wheel, but has a disadvantage in that any  
30 solid material drawn into the wheel may cause a blockage  
between the buckets and the shroud, or alternatively be  
chopped up by the rotation of the wheel.

Figure 1C shows a chain type water wheel, which functions over the vertical portion as an elongated breast wheel. Chain type water wheels can be used in situations when the drop between the input and output flows is so great that a single wheel would be excessively large. However, the chain type wheel is mechanically complex compared to overshot and breast wheels, and also requires two shafts and their associated bearing and support structures.

It is an aim of preferred embodiments of the present invention to address one or more of the disadvantages of the prior art, whether identified herein or otherwise.

#### Summary of the Invention

According to a first aspect of the present invention there is provided a water wheel comprising a shaft and a belt; the belt carrying a plurality of water receptacles and arranged to freely depend from the shaft as the shaft rotates.

Although the word "water" is used in this document, it should be clear that any liquid or other heavier than air fluid medium could be used to power the water wheel by filling the receptacles.

Suitably, each receptacle comprises a fixing means to hold the receptacle in place on the belt. Suitably, each receptacle is held in place on the belt by the fixing means such that as the shaft rotates descending receptacles assume a substantially upright position by the engagement of the belt with the receptacles and the weight of the receptacles and water contained therein.

Suitably, each receptacle is held in place on the belt by the fixing means such that as the shaft rotates descending receptacles approaching the lowest point of the belt move  
5 from the substantially upright position to an inverted position by the engagement of the belt with the receptacles.

Suitably, each receptacle is held in place on the belt by  
10 the fixing means such that as the shaft rotates ascending receptacles assume a substantially inverted position by the engagement of the belt with the receptacles and the weight of the receptacles.

15 Suitably, ascending receptacles approaching the highest point of the belt move from the inverted position to the upright position by engagement of the belt with the receptacles and/or by engagement of the receptacles with the shaft.

20 Suitably, the fixing means engages the belt at a plurality of points along the belt. Suitably, the fixing means comprises a clamping member arranged to hold a portion of the belt against two spaced apart clamping points.

25 Suitably, the fixing means is provided within the receptacle. Suitably, the clamping points comprise parts of a projection extending from an inner surface of the receptacle.

30 Suitably, the belt is arranged to pass from the fixing means of a first receptacle to the fixing means of an adjacent, second receptacle over an edge of the first

receptacle. Suitably, the belt is arranged to pass from the fixing means of a second receptacle to the fixing means of an adjacent, first receptacle through a wall of the second receptacle.

5

Suitably, as the shaft rotates the first receptacle descends below the second receptacle.

Alternatively, the fixing means may be provided at the  
10 ends of the receptacle, preferably mounted on an end cap of the receptacle. In this configuration the belt passes from the fixing means of adjacent first and second receptacles to the side of the receptacles.

15 Suitably, the receptacles comprise a cut out portion in which the belt locates as it passes from the fixing means over the edge of the first receptacle.

Suitably, the receptacles are substantially identical.  
20 Suitably, the receptacles are troughs. Suitably the receptacles are of substantially constant cross section along their length. Suitably, in cross section the receptacles comprise one of: a triangle, a major segment of a circle, a minor segment of a circle, a segment of an  
25 ellipse.

Suitably the shaft comprises a plurality of teeth arranged to receive and engage the receptacles therebetween in turn as the shaft rotates. Suitably, the spaces between the  
30 teeth are of complementary shape to the receptacle cross section. The receptacles may rotate between the teeth as the shaft rotates.

Alternatively, the receptacles may comprise shoes mounted thereon to engage the shaft. Suitably, the fixing means comprises part of the shoes.

5 Suitably, the water wheel comprises a plurality of belts to carry the receptacles. Suitably, the receptacles comprise fixing means for each belt. Preferably the water wheel comprises two belts spaced apart along or at the ends of the receptacles to stabilise the receptacles as  
10 they rotate.

Suitably the belt and the receptacles comprise a plastics material.

15 Suitably, a water impermeable membrane is connected between each receptacle.

Suitably the water wheel comprises a generator coupled to or formed integrally with the shaft to produce electricity  
20 as the shaft rotates. Suitably the water wheel comprises an inlet sluice and an outlet race.

Suitably, the water receptacles are movable between a substantially upright position and a substantially  
25 inverted position independently of their position on the belt. Suitably, the water receptacles are rotatable independently of belt rotation.

#### Brief Introduction to the Drawings

30

For a better understanding of the invention, and to show how embodiments of the same may be carried into effect,

reference will now be made, by way of example, to the accompanying diagrammatic drawings in which:

Figures 1A-1C show three prior art gravity type water  
5 wheels;

Figure 2 shows a side perspective view of a water wheel according to a first preferred embodiment of the invention;

10 Figure 3 shows a side view of the water wheel of Figure 2;

Figure 4 shows a front perspective view of the water wheel of Figure 2 without an inlet sluice and an outlet race;

15 Figure 5 shows a side perspective view of an upper portion of the water wheel of Figure 2;

Figures 6A-6C show an alternative arrangement by which  
20 troughs can engage a shaft in preferred embodiments of the invention; and

Figure 7 shows a side perspective view of an alternative  
25 arrangement of troughs and belts for use with another preferred embodiment of the invention.

#### Description of Preferred Embodiments

Figures 2, 3 and 5 show a water wheel 1 comprising a shaft  
30 10, and belts 20 that carry twenty four receptacles in the form of troughs 30. The water wheel 1 further comprises an inlet sluice 40 and an outlet race 50.



The belts 20 freely depend from the shaft 10, and are arranged to carry the troughs 30 around as the shaft 10 rotates.

5 By allowing the belts 20 to freely depend from the shaft 10 a mechanically simplified version of the chain type water wheel is provided. Furthermore, as described below removal of the lower shaft offers increased efficiency over the prior art breast type wheel as the emptying  
10 troughs are not forced to move around the lower shaft in a circular fashion.

Each trough 30 comprises a fixing means 32 to it in place on the belts 20. The belts 20, troughs 30 and fixing  
15 means 32 are arranged so that as the shaft 10 rotates under the weight of water contained in some of the troughs 30, descending troughs 30 assume a substantially upright position by the engagement of the belts 20 with the troughs 30 and the weight of the descending troughs 30 and  
20 the water contained therein.

As seen in Figures 2,3 and 5 the shaft 10 is arranged to rotate anticlockwise, with descending troughs 30 on the left hand side of the water wheel 1 fed by water from the  
25 inlet sluice 40. The water wheel 1 shown in the Figures is empty of water, and the lack of water in the troughs 30 on the left hand side of the water wheel 1 means that the troughs 30 are in a slightly less upright position than when in normal use.

30

By designing the fixing means 32, troughs 30 and belt 20 to keep the descending troughs 30 substantially upright and therefore mostly full on the way down a high

proportion of the energy obtainable from the water is harnessed.

As the shaft 10 rotates (anticlockwise in Figures 2,3 and 5), descending troughs 30 approaching the lowest point of the belts 20 move from the substantially upright position to an inverted position. The belts 20 acting through the fixing means 32 and the weight of the troughs 30 acts to upturn the troughs 30 and discharge their contents into the outlet race 50. Correct arrangement of the fixing means allows the troughs 30 to be upturned later and more rapidly than is possible in the known breast type wheel where the troughs are upturned as they move in a circular path around a lower shaft.

15

The troughs 30 shown in Figures 2-5 have wooden battens 21 attached to their convex surface. These battens 21 act as a counterweight in the embodiment shown to aid the transition between guided troughs 30 held in place on the shaft 10 and the upright configuration of the troughs as they descend. In other embodiments the positioning of the fixing means and the weight of water and trough can be arranged such that the counterweight provided by the battens 21 is not required.

25

Ascending troughs 30 on the right hand side of the water wheel 1 in Figures 2,3 and 5 remain in the substantially inverted position as they hang from their fixing means 32 and belts 20.

30

To achieve the desired positioning of the troughs 30 at all points along the belts 20 as the shaft 10 rotates the

fixing means 32 is arranged to engage the belts 20 at a plurality of points along each belt 20.

Each fixing means 32 is located within a trough 30 and  
5 comprises a clamping member in the form of a clamp plate  
33 arranged to hold a portion of one of the belts 20  
against a support including two spaced apart clamping  
points 34. The support comprises a projection 35  
extending from an inner surface of the trough 30.

10

The belt 20 is arranged to pass from the fixing means 32  
of a first trough 30A to the fixing means of an adjacent,  
second trough 30B over a cut out portion 39 at an edge of  
the first trough 30A. In Figures 2, 3 and 5 the second  
15 trough 30B lies one position clockwise along the belt of  
the first trough 30A.

The connection between each trough 30B and the adjacent  
trough 30A lying one position anticlockwise on the belt 20  
20 is such that the belt 20 passes from the fixing means 32  
of the trough 30B to the fixing means 32 of the adjacent  
trough 30A through an aperture 36 in wall of the trough  
30B.

25 By providing the spaced apart clamping points 34 and the  
belt-cut out and belt-aperture interfaces, tension in the  
belt can act to apply twisting forces to the troughs 30  
and cause them to adopt a desired orientation. Careful  
selection of the spacing of the clamping points 34, the  
30 depth of the cut out 39 and the position of the aperture  
36 can provide the desired orientation of the troughs 30  
around the belt 20.

In cross section the troughs 30 comprise a major segment of a circle, and are arranged to engage with the shaft 10 between teeth 12 on the shaft 10. There are twelve teeth 12 on the shaft 12 which pull the troughs 30 up and around  
5 as the water wheel 1 rotates. In addition to the wholesale rotation of the water wheel 1 the troughs 30 rotate between the teeth 12 as the shaft 10 rotates to assume the correct upright position for filling.

10 In other embodiments the troughs 30 may comprise alternative cross sections, and may be shaped so that no rotation is possible in the spaces between complementary teeth 12 on the shaft 10.

15 Figures 6A-6C show an alternative arrangement by which troughs 300 can engage a shaft 100. The troughs 300 comprise end caps 301 at both ends which comprise a shoe 302 including a fixing means 320 to secure the troughs 300 to a belt 200. The shoe 302 includes a recess, preferably  
20 a truncated V-groove 303 as shown in Figure 6B arranged to engage a tapering edge 304 of the shaft 100. As shown by the dashed lines of the side view of Figure 6C the V-groove is curved in the direction of the belt 200 to match the curvature of the shaft 100.

25 The large contact area between the V-groove 303 and the tapering edge 304 reduces slippage at the interface between the shaft 100 and shoes 302. In use both ends of a trough 300 will periodically engage the shaft 100 in  
30 this way, and at any given time more than one trough 300 will be in engagement with the shaft.

Figure 7 shows an alternative arrangement of troughs 301 and belt 201 for use in water wheels according to the embodiments of the present invention. In Figure 7, troughs 301 are coupled to one another by a belt 201 made up from a plurality of pivotable links 202. Each trough 201 comprises a pivotable link 202. The troughs 201 engage a toothed shaft (not shown) in a similar manner to that described in relation to the embodiment of Figures 1-5. The fixing means for holding the troughs to the belt are also provided by the pivotable links 202. In this embodiment interaction between troughs 301 as well as the influence of the belt 201 and gravity determines the orientation of the troughs 301 as the belt 201 rotates.

In Figure 7 the belt 201 is intended to rotate clockwise. The generally diamond-shaped cross section of the troughs 301 is chosen to maximise the collection of water in each trough as the belt 201 rotates, and to facilitate the subsequent emptying of the troughs 301 as they approach their lowermost position. In preferred embodiments of troughs 301 the angle of the open portion of the troughs 301 to the base portion of the troughs 301 is greater than the angle of the closed portion to the base portion. In the particularly preferred embodiment shown in Figure 7 the angles of the open portion and the closed portion are approximately  $45^\circ$  and  $30^\circ$  respectively.

As with the embodiment of Figures 1-5, the arrangements of belt and the fixing means shown in Figures 6 and 7, mean that as the trough leaves the shaft the tension in the belt and the weight of the water and trough causes the trough 300 to adopt an upright configuration as it

descends, and to quickly invert at a predetermined lower position.

Although the preferred embodiments shown herein comprise  
5 two belts 20, 200 any suitable number of belts can be used  
to carry the troughs. At least two belts spaced apart  
along the troughs is preferred to stabilise the troughs as  
they rotate.

10 In preferred embodiments each trough is further joined to  
adjacent troughs by a loose, water impermeable sheet.  
This prevents water passing between the troughs, allowing  
a greater proportion of the energy of the input flow to be  
recovered. Preferably the water impermeable sheet has a  
15 water shedding surface to encourage water thereon to form  
droplets and run from the sheet into a lower trough.

The water wheel 1 is shown in Figure 4 without the input  
sluice 40 and the outlet race 50. The water wheel 1 is  
20 primarily intended to harness energy for electricity  
generation, and therefore comprises a generator (not  
shown) coupled to the shaft 10 to produce electricity as  
the shaft rotates 10. In alternative embodiments a  
generator may be built into the shaft and/or formed as one  
25 piece with the shaft.

Gravity type water wheels as described above are  
particularly suitable for low head installations, with a  
fall in the region of 1 metre or less. It is envisaged  
30 that the embodiment shown in the accompanying Figures will  
have an operational power output of approximately 150-  
250W.

The embodiment shown in Figures 1-5 is approximately 145cm high by 40cm wide by 60cm deep. Each of the troughs 30 is approximately 37cm wide by 5cm high, with a capacity of approximately 400ml. The shaft 10 has a diameter of approximately 25cm.

With the inlet sluice 40 arranged as shown in Figures 2, 3 and 5 to provide overshot operating conditions the water wheel 1 has a no-load speed of approximately 62 revolutions per minute and a load speed of 35-40 revolutions per minute. Measured maximum power output is approximately 260W, with overall operating efficiency approaching 80% when the water wheel is running at 170W output.

If increased generating capacity is required at a particular location a battery of the water wheels described herein can be used, or the trough length extended.

The battery may comprises a plurality of water wheels mechanically and/or electrically coupled to one another, and the water wheels making up the battery may be arranged adjacent across a water flow, and/or in series down stream from one another. Alternatively multiple belts and troughs could be arranged side by side on a single shaft. Embodiments of the present invention can be designed to offer efficient energy recovery with input heads as low as 15cm. Embodiments of present invention can also be designed to offer efficient energy recovery at larger heads, e.g. 2m. Other design variables to consider include the number of troughs, and the position of the input sluice relative to the belt drop.

In the embodiment of Figures 2, 3, and 5 the inlet sluice 40 can be positioned to feed the troughs 30 any point on the descending side of the water wheel 1, as determined by inlet flow rate and desired power output. If the inlet sluice 40 is positioned to feed the troughs 30 as they descend vertically past the inlet sluice 40 the water wheel 1 operates in a similar way to the prior art breast wheel. By positioning the inlet sluice 40 very low down in the path of the troughs 30 the water wheel 1 operates almost in an undershot configuration.

As an alternative to using a battery, the length of the belt 20 and the number of troughs 30 making up the water wheel 1 can be increased to accommodate a larger drop. It is envisaged that the belt and troughs could be supplied as standard lengths coupleable modularly as required.

There are a very large number of locations suitable for the installation of low head water wheels to provide electricity generation, and low head "run of river" hydro-electric installations provide a clean and renewable energy source. Embodiments of the present invention are of simple construction, and can operate at relatively high efficiency when running within their design parameters.

Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.



All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, 5 except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be 10 replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

15

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any 20 accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

**Claims:**

1. A water wheel comprising a shaft and a belt; the belt carrying a plurality of water receptacles and arranged to  
5 freely depend from the shaft as the shaft rotates.

2. A water wheel according to claim 1, wherein each receptacle comprises a fixing means to hold the receptacle in place on the belt, and wherein each receptacle is held  
10 in place on the belt by the fixing means such that as the shaft rotates descending receptacles assume a substantially upright position by the engagement of the belt with the receptacles and the weight of the receptacles and water contained therein.

15

3. A water wheel according to claim 2, wherein each receptacle is held in place on the belt by the fixing means such that as the shaft rotates descending receptacles approaching the lowest point of the belt move  
20 from the substantially upright position to an inverted position by the engagement of the belt with the receptacles.

4. A water wheel according to claim 2 or 3, wherein each  
25 receptacle is held in place on the belt by the fixing means such that as the shaft rotates ascending receptacles assume a substantially inverted position by the engagement of the belt with the receptacles and the weight of the receptacles.

30

5. A water wheel according to claim 2, 3 or 4, wherein ascending receptacles approaching the highest point of the belt move from the inverted position to the upright

position by engagement of the belt with the receptacles and/or by engagement of the receptacles with the shaft.

6. A water wheel according to any one of claims 2-5, wherein the fixing means engages the belt at a plurality of points along the belt.

7. A water wheel according to claim 6, wherein the fixing means comprises a clamping member arranged to hold a portion of the belt against two spaced apart clamping points.

8. A water wheel according to claim 7, wherein the clamping points comprise parts of a projection extending from an inner surface of the receptacle:

9. A water wheel according to claim 7 or 8, wherein the fixing means is provided within the receptacle.

10. A water wheel according to claim 7, 8 or 9, wherein the belt is arranged to pass from the fixing means of a first receptacle to the fixing means of an adjacent, second receptacle over an edge of the first receptacle.

11. A water wheel according to claim 7, 8, 9 or 10, wherein the belt is arranged to pass from the fixing means of a second receptacle to the fixing means of an adjacent, first receptacle through a wall of the second receptacle.

12. A water wheel according to claim 10 or 11, wherein as the shaft rotates the first receptacle descends below the second receptacle.

13. A water wheel according to any one of claims 2-7,  
wherein the fixing means is provided at the ends of the  
receptacle, such that the belt passes from the fixing  
means of first and second receptacles to the side of the  
5 first and second receptacles.

14. A water wheel according to any preceding claim,  
wherein the receptacles are substantially identical in  
shape to one another.

10

15. A water wheel according to any preceding claim,  
wherein the receptacles are of substantially constant  
cross section along their length.

15 16. A water wheel according to any preceding claim,  
wherein the shaft comprises a plurality of teeth arranged  
to receive and engage the receptacles therebetween in turn  
as the shaft rotates.

20 17. A water wheel according to claim 16, wherein the  
spaces between the teeth are of complementary shape to the  
cross section of the receptacles.

25 18. A water wheel according to claim 16 or 17, wherein the  
receptacles are arranged to rotate between the teeth as  
the shaft rotates.

30 19. A water wheel according to any preceding claim,  
wherein the receptacles comprise shoes mounted thereon to  
engage the shaft.

20. A water wheel according to any preceding claims wherein the water wheel comprises a plurality of belts to carry the receptacles.

5 21. A water wheel according to any preceding claim, comprising a water impermeable membrane connected between receptacles.

10 22. A water wheel according to any preceding claim, further comprising one or more of: (a) a generator coupled to or formed integrally with the shaft to produce electricity as the shaft rotates; (b) an inlet sluice; and (c) an outlet race.

15 23. A water wheel substantially as herein described, with particular reference to the accompanying drawings.

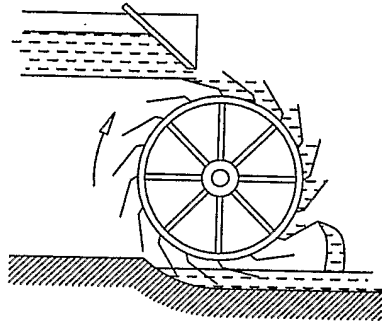


FIG. 1A  
(Prior Art)

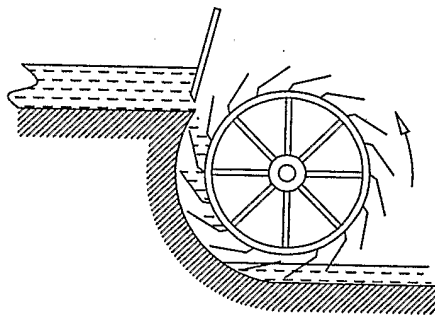


FIG. 1B  
(Prior Art)

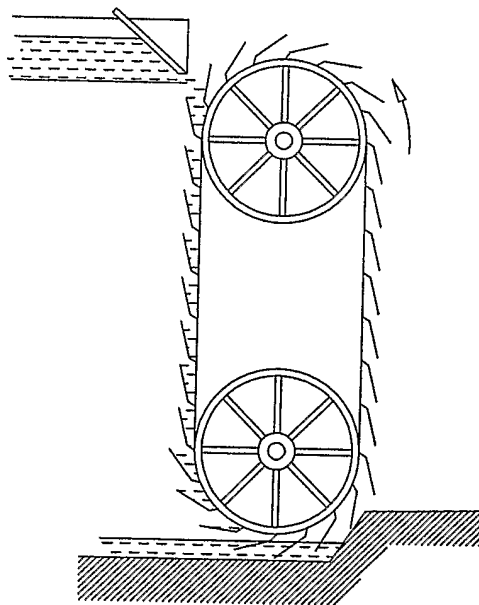
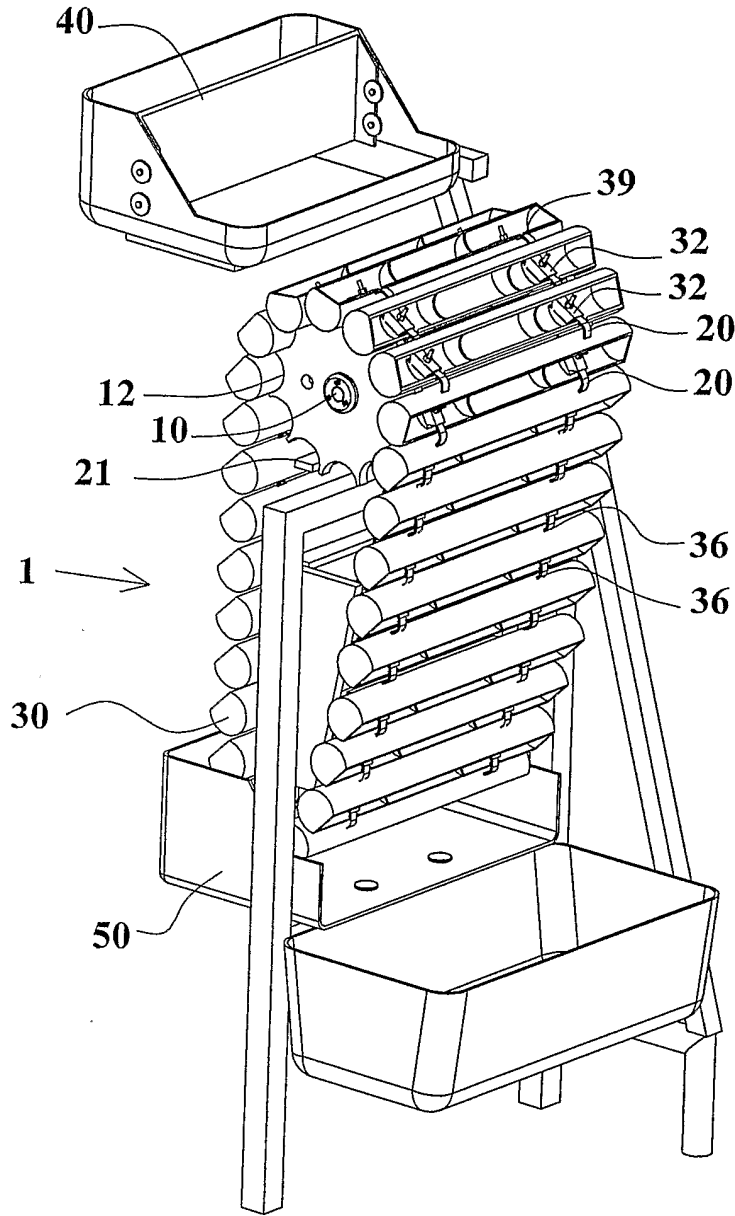
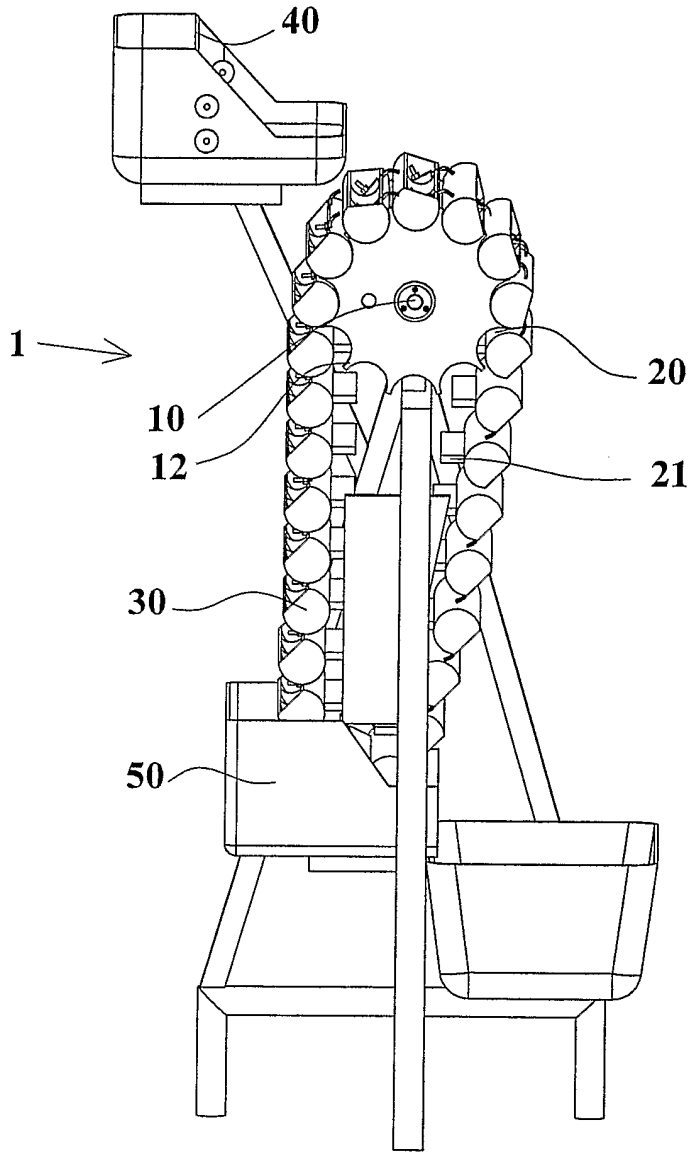


FIG. 1C  
(Prior Art)

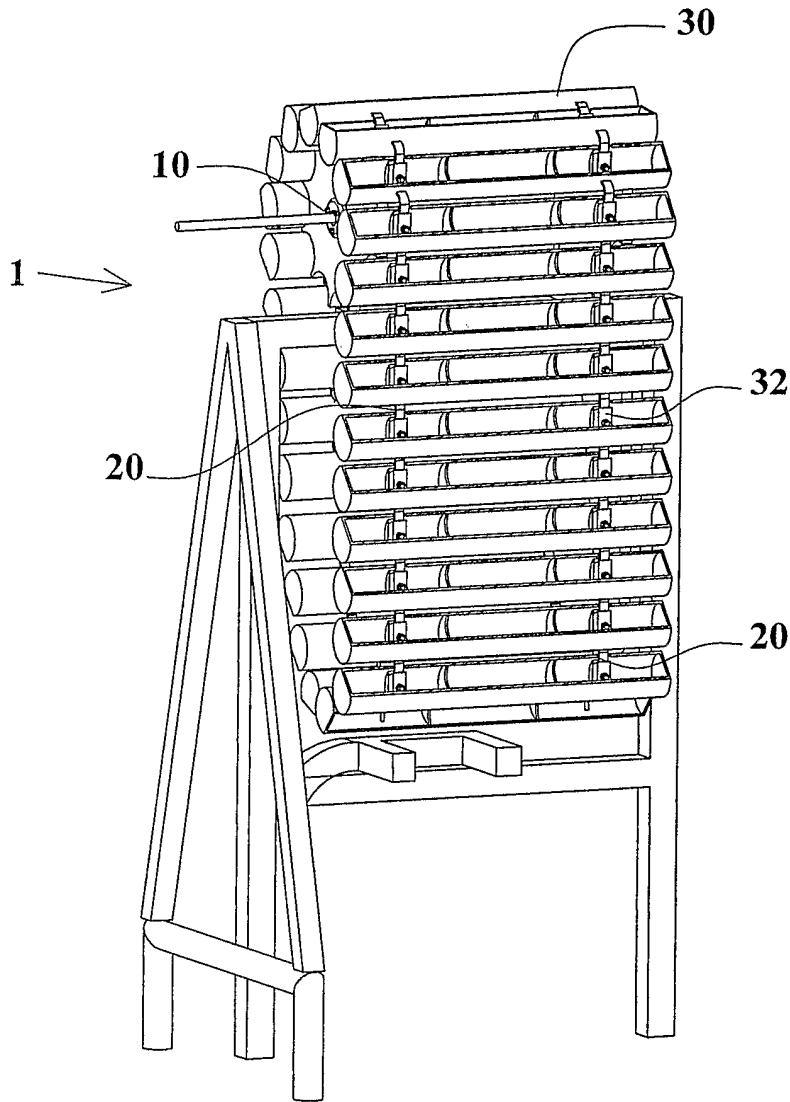


**Fig 2**



**Fig 3**





**Fig 4**

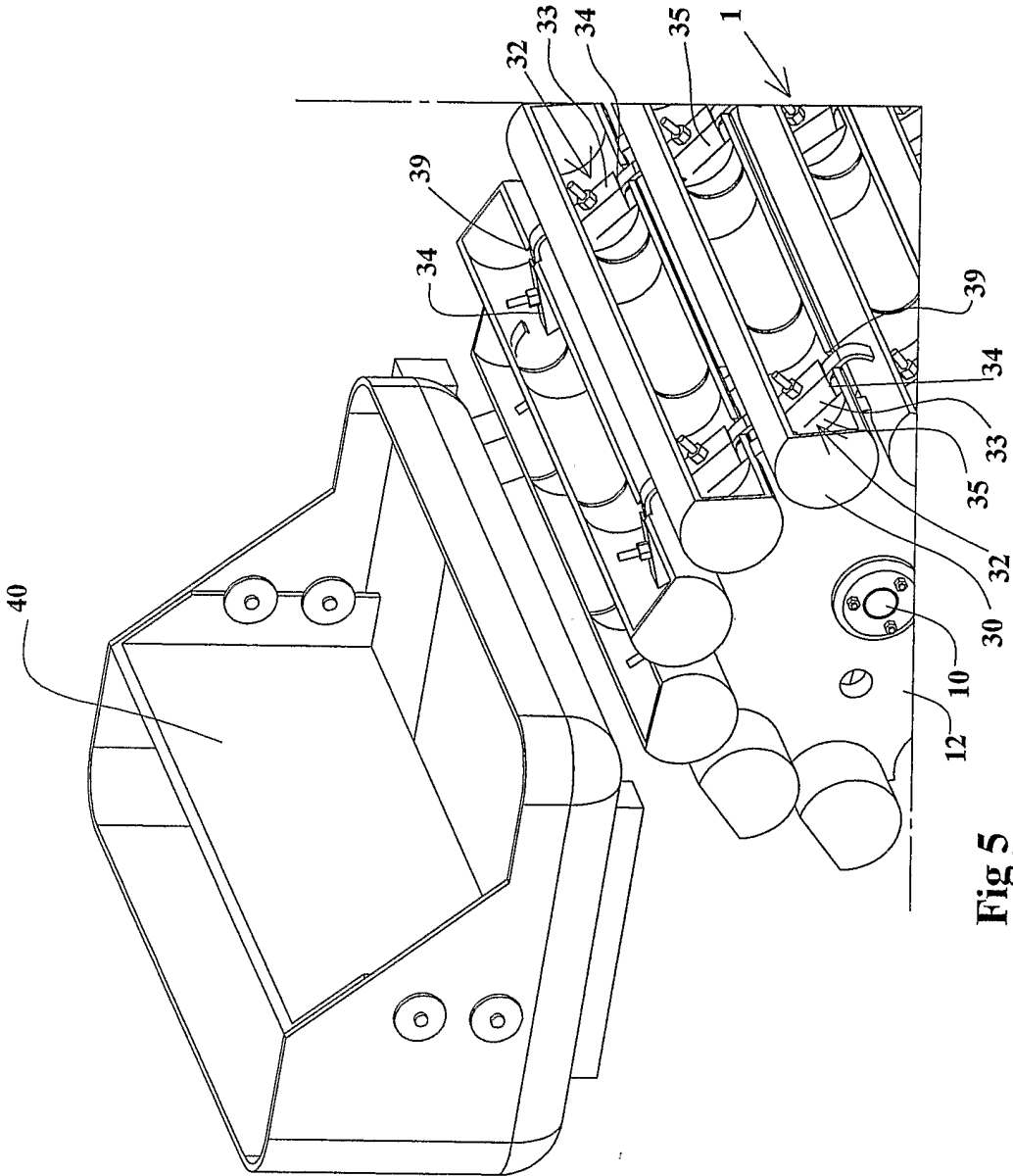


Fig 5

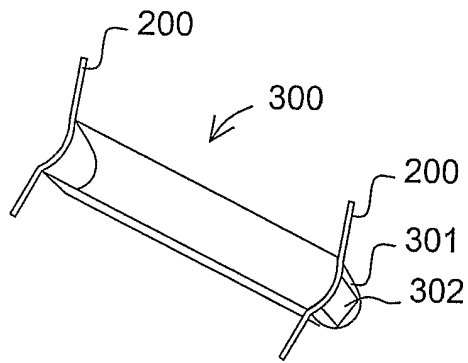


FIG. 6A

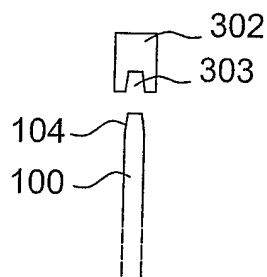


FIG. 6B

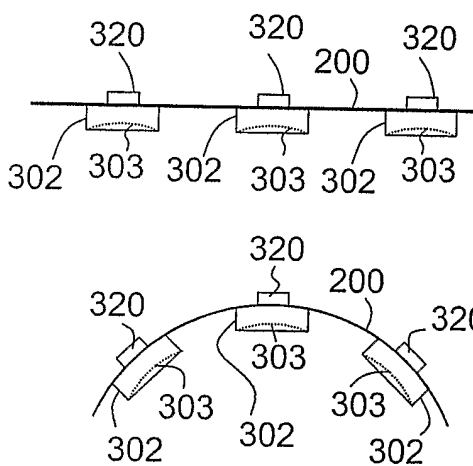


FIG. 6C

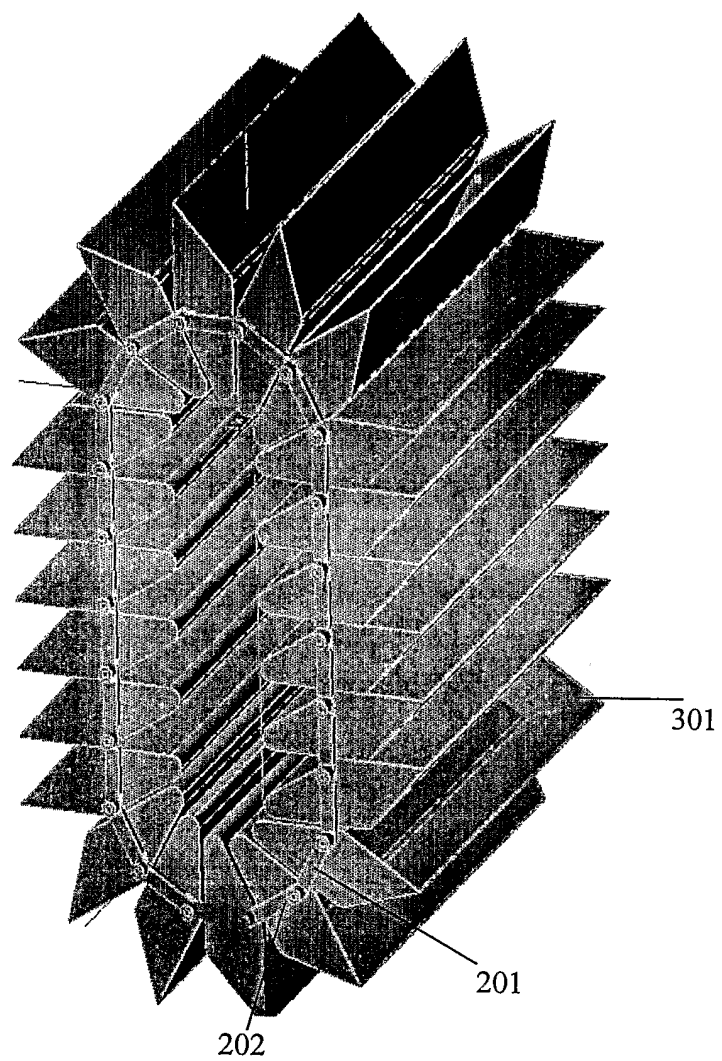


FIGURE 7

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference DHC/RSL/Y7359	<b>FOR FURTHER ACTION</b>		see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/GB2006/000351	International filing date (day/month/year) 02/02/2006	(Earliest) Priority Date (day/month/year) 02/02/2005	
Applicant  BECK MICKLE HYDRO LIMITED			

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of:

- the international application in the language in which it was filed  
 a translation of the international application into \_\_\_\_\_, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b.  With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2.  **Certain claims were found unsearchable** (See Box No. II)

3.  **Unity of invention is lacking** (see Box No III)

4. With regard to the **title**,

- the text is approved as submitted by the applicant  
 the text has been established by this Authority to read as follows:

IMPROVEMENTS IN AND RELATING TO GRAVITY TYPE WATER WHEELS

5. With regard to the **abstract**,

- the text is approved as submitted by the applicant  
 the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings**,

- a. the figure of the **drawings** to be published with the abstract is Figure No. 2  
 as suggested by the applicant  
 as selected by this Authority, because the applicant failed to suggest a figure  
 as selected by this Authority, because this figure better characterizes the invention
- b.  none of the figures is to be published with the abstract

**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/GB2006/000351

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> INV. F03B9/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols) F03B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data, PAJ		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 890 850 A (M. GUEVEL) 18 February 1944 (1944-02-18)  page 1, line 55 - page 2, line 49 page 2, line 60 - line 68 page 2, line 74 - line 90 -----	1-5, 10-12, 14-20,22
X	DE 22 21 605 A1 (RIZZA,PIETRO LA; LORENZ,PAUL) 8 November 1973 (1973-11-08)  page 1, paragraph 5 - paragraph 6 page 1, paragraph 8; figures -----	1-7, 9-12, 14, 16-19,22
A	DE 361 082 C (RICHARD KOECHER; WILLY RITTER) 10 October 1922 (1922-10-10) the whole document -----	1-23
<input type="checkbox"/> Further documents are listed in the continuation of Box C.		
<input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family	
Date of the actual completion of the international search  <p align="center">11 April 2006</p>	Date of mailing of the international search report  <p align="center">12/05/2006</p>	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer  <p align="center">de Rooij, M</p>	

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2006/000351

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
FR 890850	A	18-02-1944	NONE	
DE 2221605	A1	08-11-1973	NONE	
DE 361082	C	10-10-1922	NONE	