ABSTRACT

Improvements in articulated waterwheels in which their open-ended, pivoted buckets are counteracted so that a bucket in the thrusting position against the hub forces its adjacent buckets into positions extended from the hub and thereby increases the thrusting period, reduces energy losses from backwash and carryover, and improves the efficiency of waterwheels in low speed applications.

7 Claims, 4 Drawing Figures
COUNTERACTUATED ARTICULATED WATERWHEELS

OBJECT OF THE INVENTION

Articulated waterwheels of the free-swinging-bucket type are most efficient in high speed boats, but not as efficient in low speed boats. In low speed boats the wheel must be turned at surface speeds greater than the speed of the boat in order to reach rotational accelerations that are great enough to produce the required thrust. When turned at such speeds, free-swinging buckets do not release properly when they exit the water. They carry water with them across the top of the return cycle of rotation, with a corresponding dissipation of energy. If they can be forced to discharge their water and simultaneously forced to produce thrust for a longer period, they can be made to perform more efficiently at low speeds.

In high speed boats, articulated waterwheels rotate at surface speeds equivalent to the speed of the boat, or with little or no slip. Their rotational speed is great enough to generate very large accelerations from the point of bucket entry to the point of deepest penetration. These accelerations are large enough to produce the required thrust with relatively small masses of water contained in the thrusting buckets. In slow moving boats, the masses of water and the size of the buckets would have to be excessively large to produce the same result, or the rotational speed of the waterwheel would have to be increased. If the rotational speed of the waterwheel is increased, its thrusting buckets will be moving faster than the surrounding water, and when they pass the point of maximum penetration and maximum thrust they will drag in the water and will not swing free of the water, but will carry their charge of water up and forward in the return cycle at a considerable cost of energy. The geometry of an articulated waterwheel with an even number of buckets is such that this condition can be obviated by connecting the buckets to each other so that a thrusting bucket forces an exiting bucket into a favorable exiting position. Since in its geometry a favorable exiting position corresponds to a favorable entering position, an articulated waterwheel can be made to place a bucket in the entering position at the same time a bucket is in the exiting position. Then the buckets can be interconnected so that a thrusting bucket forces its adjacent buckets on either side into favorable entering and exiting positions; or more correctly, the buckets can be counterconnected so that a thrusting bucket moving against the hub of the waterwheel counteracts its adjacent buckets into favorable entering and exiting positions extended from the hub.

When its buckets are counterconnected in this manner, an articulated waterwheel operates more efficiently at slow speeds than a wheel with free-swinging buckets, but at the same time it is subject to energy losses that are not inherent in free-swinging buckets. The counterconnected buckets adjacent to extended entering and exiting buckets are nested against the hub in thrusting positions. This means that one or more buckets in the return cycle of rotation are in the thrusting position as well as the thrusting bucket in the water. The energy required to overcome centrifugal force and pull these buckets against the hub is wasted energy. In addition to this, a counterconnected thrusting bucket is only momentarily nested against the hub and closed at its after end. During most of its thrusting period it is held away from its nested position by the counterconnection and it allows thrusted water to escape from its partially open after end with a corresponding loss of thrust. These losses can be minimized by using flexible means of counterconnection or other means of counteractuation as will be shown in the drawings and the description that follows.

Minimizing these losses and applying the principles of my invention will make articulated waterwheels operate with efficiencies comparable to screw propellers in low speed boats. Being comparable in efficiency, waterwheels will then have an advantage over screw propellers in that they can operate in shallower water and are less subject to damage by waterborne debris.

Therefore, it is the object of my invention to improve the operation of articulated waterwheels at slower speeds by counterconnections the pivoted buckets so that a thrusting bucket forces adjacent buckets into favorable entering and exiting positions.

It is also the object of my invention to provide slow moving boats with efficient waterwheels of simple construction that are not costly to manufacture and that can operate in shallow water over long periods of time with a minimum of damage from foreign objects in the water.

These and related objects of my invention will be demonstrated in the following specification in conjunction with the drawings in which:

FIG. 1 is an elevation of an articulated waterwheel with counterconnected, pivoted, openedended buckets shown in one position of its rotational cycle.

FIG. 2 is a schematic drawing showing a series of positions of one bucket as it is counteractuated through one cycle of rotation of the waterwheel.

FIG. 3 is an elevation of an articulated waterwheel whose pivoted buckets are counteractuated by means of springs attached to the hub.

FIG. 4 is an elevation of an articulated waterwheel whose pivoted buckets are counteractuated by means of a pneumatic bladder mounted on the hub.

DESCRIPTION

Basically, a counteractuated articulated waterwheel consists of a hub which is driven above the surface of the water by a conventional power source, and to which are pivoted four or more even numbers of counteractuated, openedended buckets. The buckets are equipped with crank arms which are counterconnected by connecting rods or counteracted by other means. The hub is equipped with nests which close the open, after ends of the buckets, and which act as stops to restrict the pivoted motion of the buckets in both extremes of their oscillation. The buckets are also tapered to partially restrict the flow of water through them.

FIG. 1 is an elevation of a six-bucket, counteractuated, articulated waterwheel which consists of a hub driven counter-clockwise by a shaft S above the surface of the water W, buckets B pivoted to it at pivot points p, nests N on the hub which restrict the pivoted motion of the buckets, and connecting rods R which counteractuate the buckets. The buckets are equipped with crank arms which terminate at crank pins a and b, and which are interconnected alternately a to b and b to a by connecting rods R. The bucket cavities are opened-end and tapered with their after openings smaller than their forward openings. The figure shows
bucket B₂ held against its nest by the reaction of the water to its thrusting force. In that position its after end is closed by the nest, it is producing maximum thrust, and, by means of the connecting rods, it has forced bucket B₁ into an extended entering position and bucket B₃ into an extended exiting position. Buckets B₁ and B₄ being likewise interconnected are also drawn into nested positions, and bucket B₃ is held in an extended position, all by the reaction of the water to the thrusting force of bucket B₂. Spring loaded, shock absorbing struts R can be used in place of connecting rods R to modify the counteractuation of the buckets when conditions indicate such modification.

FIG. 2 shows a series of positions a to x of one counterclockwise bucket as it enters and leaves the water during one revolution of the waterwheel. The broken lines joining the bucket's crank pins indicate the interrelationship with other buckets on the waterwheel. At position a, the bucket is about to enter the water vertically. It is held in that position by another bucket which is thrusting in position c. At position b the bucket has entered the water and has begun to thrust even though it has not closed against its nest. Its position corresponds to the position of bucket B₁ in FIG. 1 where it can be seen that its nest is above the water and behind it. It is held in position b away from its nest, by another bucket in position f which corresponds to the position of bucket B₂ in FIG. 1 and which is closed against its nest and thrusting with a greater force. At position c, d, and e, the bucket is still held away from its nest by another bucket in positions g, h, and i, but it is drawing closer to its nest and it is thrusting by virtue of the reaction of the water passing through its tapered cavity and its open end. At position f, the bucket is closed against its nest and is producing its maximum thrust. At position g, the bucket is being forced away from its nest and deeper into the water by the thrusting force of another bucket in position c. It is still thrusting in this position, even though it is spilling water from its after end, because it is still accelerating and the spilled water is being reaccelerated by its nest which is close behind it. At positions h, i, and j, the bucket has decelerated and ceased to produce thrust. It is being forced to swing out and discharge its water by another bucket in positions d, e, and f. At positions k through x the bucket is in its return cycle during which it is forced by thrusting buckets to nest and extend twice. These motions are extraneous to the function of the waterwheel, but, since the bucket has been forced to effectively discharge its water, relatively small amounts of energy are dissipated. The advantage of the greatly extended thrusting period of the counterclocked buckets overrides the small disadvantage of the extraneous motions.

FIGS. 3 and 4 show how these extraneous motions can be eliminated entirely at some sacrifice of the extended thrusting period.

FIG. 3 shows a counteractuated articulated waterwheel whose buckets have crank arms which are actuated by springs attached to the hub. The springs yield to allow a thrusting bucket to nest against the hub and at the same time force adjacent buckets into extended positions to augment their thrust and to assist their discharge of water. Having thus described the several aspects of my invention, I claim:

1. A counteractuated articulated waterwheel, driven by a conventional power source, and consisting of a hub which rotates above the surface of the water and open-ended buckets pivoted about its periphery which enter and exit the water as the hub rotates and swing about their pivots between a thrusting position against the hub and an extended position away from the hub, said hub being equipped with nests which close the open ends of the buckets when they are in the thrusting position and act as stops which restrict the swing of the buckets at their thrusting position and at their extended position, and which buckets are counteractuated so that, as thrusting buckets are forced into their thrusting position against the hub by the thrusting action, the buckets adjacent to the thrusting buckets are forced into extended positions away from the hub.

2. A counteractuated articulated waterwheel, driven by a conventional power source, and consisting of a hub which rotates above the surface of the water and open-ended buckets pivoted about its periphery which enter and exit the water as the hub rotates and swing about their pivots between a thrusting position against the hub and an extended position away from the hub, said hub being equipped with nests which close the open ends of the buckets when they are in the thrusting position and act as stops which restrict the swing of the buckets at their thrusting position and at their extended position, and each of which buckets is equipped with two opposite crank arms which are interconnected to the opposite crank arms of adjacent buckets by connecting rods, and by means of which counterconnection thrusting buckets, that have been forced into their thrusting position against the hub by the thrusting action, force their adjacent buckets into extended positions away from the hub.

3. A counteractuated articulated waterwheel, driven by a conventional power source, and consisting of a hub which rotates above the surface of the water and open-ended buckets pivoted about its periphery which enter and exit the water as the hub rotates and swing about their pivots between a thrusting position against the hub and an extended position away from the hub, said hub being equipped with nests which close the open ends of the buckets when they are in the thrusting position and act as stops which restrict the swing of the buckets at their thrusting position and at their extended position, and which buckets are counteractuated so that, as thrusting buckets are forced into their thrusting position against the hub by the thrusting action, the buckets adjacent to the thrusting buckets are forced into extended positions away from the hub.
open ends of the buckets when they are in the thrusting position and act as stops which restrict the swing of the buckets at their thrusting position and at their extended position, and which buckets are equipped with crank arms which are connected to the hub by springs, and which springs are so tensioned that they will yield and allow thrusting buckets to be forced into their thrusting position against the hub by the thrusting action and, at the same time, counteractuate the buckets adjacent to the thrusting buckets into extended positions away from the hub.

5. A counteractuated articulated waterwheel, driven by a conventional power source, and consisting of a hub which rotates above the surface of the water, and open-ended buckets pivoted about its periphery which enter and exit the water as the hub rotates and swing about their pivots between a thrusting position against the hub and an extended position away from the hub, said hub being equipped with nests which close the open ends of the buckets when they are in the thrusting position and act as stops which restrict the swing of the buckets at their thrusting position and at their extended position, which buckets are provided with a means of counteractuation, and which means of counteractuation yields and allows thrusting buckets to be forced into their thrusting position against the hub by the thrusting action and, at the same time, counteractuates the buckets adjacent to the thrusting buckets into extended positions away from the hub.

6. A counteractuated articulated waterwheel, driven by a conventional power source, and consisting of a hub which rotates above the surface of the water, and open-ended buckets pivoted about its periphery which enter and exit the water as the hub rotates and swing about their pivots between a thrusting position against the hub and an extended position away from the hub, said hub being equipped with nests which close the open ends of the buckets when they are in the thrusting position and act as stops which restrict the swing of the buckets at their thrusting position and at their extended position, said buckets being counteractuated so that, as thrusting buckets are forced into their thrusting position against the hub by the thrusting action, the buckets adjacent to the thrusting buckets are forced into extended positions away from the hub, and which open-ended buckets are so configured that their after openings are smaller than their forward openings.

* * * * *