BOW DRIVE
Converting an Oscillating Motion into Unidirectional Shaft Rotation

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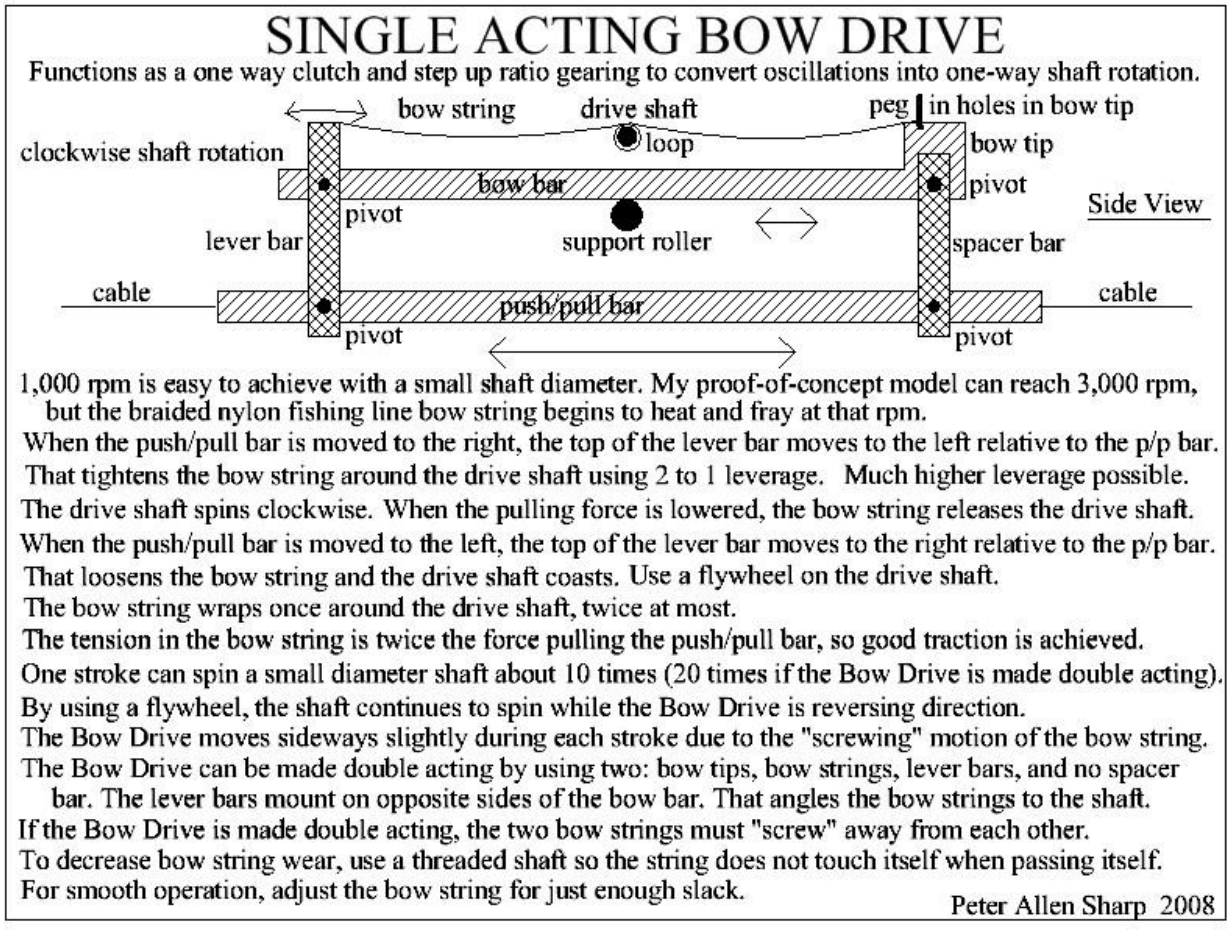
Here is a video of a double acting Bow Drive being used to spin a small diameter shaft (about 1/16") at about 1,500 rpm to light an LED:
http://www.youtube.com/watch?v=p0vPwN7A9gU

The Bow Drive is a low-tech device that can be made from sticks and sting. It can produce high rpm, unidirectional shaft rotation using a slow, oscillating input if the shaft has a small diameter. It can also produce slow, unidirectional shaft rotation with high torque if the shaft has a large diameter.



The Bow Drive could be used with an array of Bird Windmills to spin a common shaft. It can also be used for such things as:

-- spinning yarn
-- driving a propeller pump
-- spinning a generator shaft
-- rotating standard drill bits in a hand drill
-- spinning a wood lathe

Explanation of the Bow Drive

The Bow Drive is counter-intuitive, due to its relative motions, so some explanation is helpful for understanding it.
When the push-pull bar is moved to the right, the bow-bar will not accelerate quite as quickly due to inertia.
So when the push-pull bar moves to the right, the bow bar moves left relative to the push-pull bar.
When the bow bar moves to the right following the push-pull bar, the upper tip of the lever bar moves left relative to the bow bar.
That tightens the bow string.
Once the bow string is tight, the system is locked and almost no further relative motions occur between the parts: the whole unit moves to the right together.
The lever bar increases the tension in the cord and grips the shaft especially tightly.
The leverage as shown is about 2 to 1.
So if the push-pull bar is pulled to the right with a force of, say, 1 pound, the lever bar tightens the string with a force of 2 pounds.
That leverage allows the string to grip the shaft very tightly to create traction.
The tension in the bow string can be greatly increased by increasing the leverage of the lever bar.
That can be done by attaching the string to the lever bar closer to the upper pivot of the lever bar.
To get as close to the pivot as possible, the string should pass itself on the underside of the shaft so that the shaft will not touch the bow bar.
To further increase the leverage, the distance between the pivots of the lever bar and the spacer bar can be increased.
The only practical leverage limit is the strength of the bow string.

The reason for using only one loop of string around the shaft is so that the string will completely release the shaft when the tension on the string is eliminated.
If a string is wound many times around a shaft, it gets harder to eliminate all of the friction when the string is supposed to release the shaft.

The point of wear is where the bow string passes itself on the shaft. That wear could be mostly eliminated by using a shaft with threads that matched the diameter of the bow string.
When under tension, the bow string would lie within the threads and not touch itself as it passed itself.

The bow string should have a slight angle to the shaft in order to minimize contact where the bow string passes itself.
The bow string assumes an angle like the threads on a screw, so the bow string's angle should be at least that angle or more.
As the bow string "screws" around the shaft, the bow string "screws" itself along the shaft.
That sideways movement of the bow string limits how many rotations of the shaft can occur during one stroke.
Otherwise, the string will run up against the shaft bearing and bind on itself.
Once the bow string is loosened, it easily moves back to its original starting position.
That return movement occurs during the recovery stroke of the Bow Drive.

The bow string needs to be adjusted so that it is not too tight and does not have too much slack. If the bow string stretches, then it needs to be readjusted.

To adjust the length of the bow string, it is best to use a device such as a boat cleat that allows quick attachment without any slippage.

The Bow Drive can be made double-acting, but it then requires more careful adjustment. So it would be easier to use two separate Bow Drive, one for the pull stroke and one for the push stroke.
They could be fastened together or used separately.

There is a lot of force applied to the small shaft, so the bearings must be reasonably good. For this model, I used brass beads for the bearings, and the shaft is spring steel (music wire).
The brass beads have very little surface area in contact with the shaft, and the beads are self-aligning.
I then add a drop of oil.
Brass beads make nice bearings because they are self-aligning.

The distance between the bearings should be as small as possible so as to avoid excess bending of the small diameter shaft.
So if two, single-acting Bow Drives are used side by side, the shaft should have a bearing between the two bow strings if possible.
