Richard Hull's Mysterious Motor

Horace Heffner   August 2003

Richard Hull, on his web site:

<http://rhull.home.infionline.net/highenergy017.htm>,

poses the question: "What's up Doc?!" in regard to the principles of operation of a novel DC motor.   Fig, 1 and Fig, 2 are photos of a Marinov style DC motor created by Tim Raney, who copied a motor that Richard Hull made. Fig. 1 and Fig. 2 are copied here from Richard Hull's above web site by permission of Richard Hull.

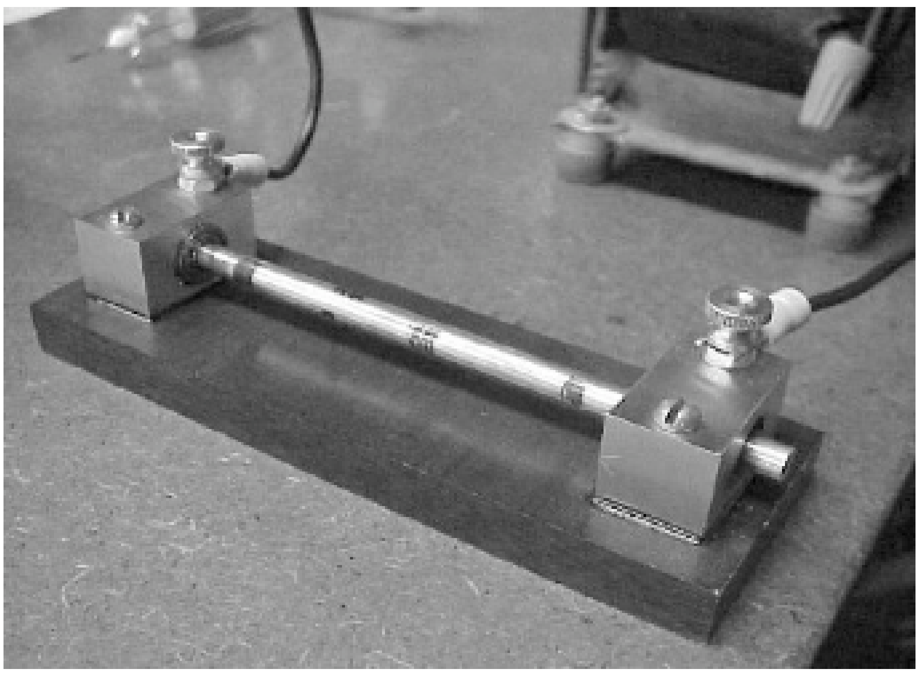

Fig. 1 - Photo of motor constructed by Tim Raney

The motor consists of a conductive shaft held by two ball bearings at the ends. DC current is fed through the bearings into and through the central metal shaft.

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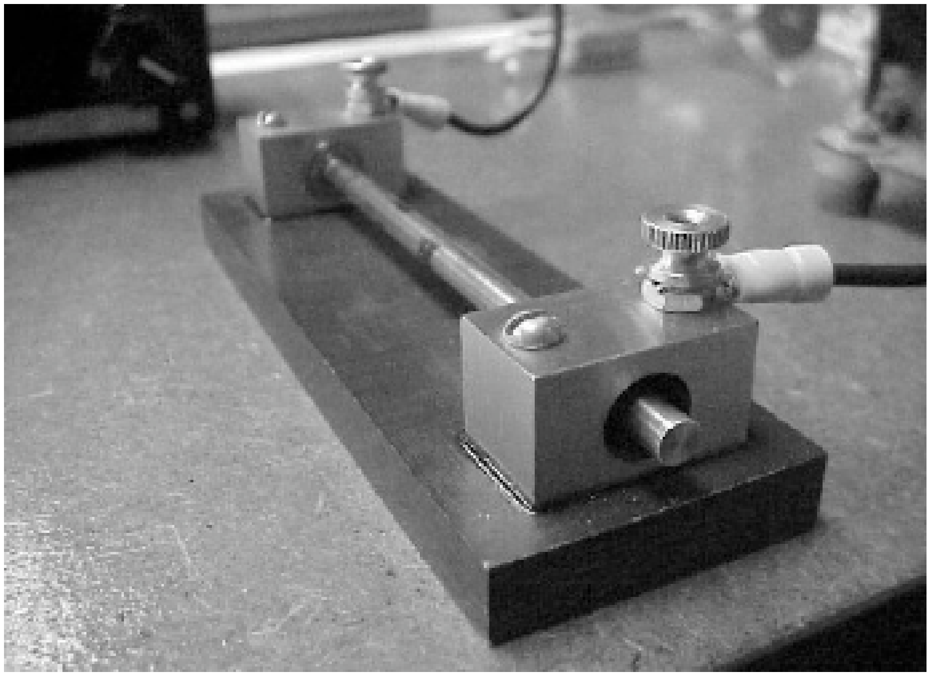

Fig. 2 - End view of motor by Tim Raney

Here is my guess (hypothesis) as to how the motor works: the torque occurs as a result of hysteresis in the ball bearing races. Fig. 3 below shows the H field around the current through the ball bearing races at the surfaces. The current in Fig. 3 is shown as vertical but it is really from the inside rim to the outside rim here, so the orientation of current i is not important. That orientation is reversed, going from outside to inside on the opposed bearing, but, by symmetry, that doesn't matter either. The relative orientations of i and H and thus i and M are what is important.

```
         (-)
          ^
  O O     .    X X   Race
--------.--------------               Static outer race
          .
          . i through ball bearing
          .
--------.--------------               ====> Inner race motion
  O O     .    X X   Race
         (+)


    O - Field H out of page
    X - Field H into page
  ..> - Current i


Fig. 3 - Field H from the current in the races
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Assuming the race motion shown in Fig. 3, the ball bearing is rotating counterclockwise. The magnetic field M in the race remains for a short duration too while the ball moves forward (to the right). The motion is such that the current i conducts directly through the residual fields M lingering in the ball bearing and races as shown in Fig. 4 below.

```
       (-)
        ^
O O    X.X     Race
--------.-------------             Static outer race
       o.o              <---F1
        . i through ball bearing
       x.x              F2--->
--------.-------------             ====> Inner race motion
       O.O    X X  Race
       (+)


    O - Field M out of page
    X - Field M into page
    o - Field M imposed on bearing is out of page
    x - Field M imposed on bearing into page
  ..> - Current i


Fig. 4 - Field M residuals in ball bearing races
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The races do not fully contain the residual field M. It goes out into space and wraps around the races. In the volume between the races the field directions are reversed, as is shown by the small x's and o's in Fig. 4. These small x's and o's are imposed on the ball bearing itself (not shown), through which the current i flows. The iL x B forces F1 and F2 occurring at the top and bottom of the ball bearing respectively in Fig. 4, cause a counterclockwise torque upon the ball bearing. This reinforces the counterclockwise motion of the ball bearing and thus drives the motor. The *other* forces inside the ball bearing are self-forces that net to zero. The field lines of M inside the ball bearing generated by i within the ball bearing, are closed within the ball bearing, they do not significantly affect anything outside the ball bearings. However, the fields M generated by i within the ball bearings oppose the fields o and x generated in the bearings by the residual M. For this reason, the device should work best if the balls in the bearings are of low permeability.

This hypothesis is easily checked. The motor will work well with low permeability ball bearings like stainless steel or even copper or aluminum. The motor will not work without at least one magnetic material race exhibiting hysteresis. The more hysteresis in the races the better the motor works. Two high permeability ball races should give about twice the torque as one highly permeable race. Thinner races (in the axial direction) should work better than thick ones. In other words ball bearings should work better than roller races where the rollers are longer than their diameters, due to the need for the external field to be projected out of the race and into the bearing. (Note, however, that roller bearings that are thinner than their diameters should work better than ball bearings however, because more roller material is located where the effective fields M are.) Ordinary brushes or slip ring brushes should not work at all.

Update 9/2009:

Figure 4 has an error. The forces F1 and F2 are in the opposite directions from that shown in Fig. 4. The explanation above is therefore erroneous. Experimental work continues.   See:

http://www.mtaonline.net/~hheffner/HullMotorA.pdf

http://www.mtaonline.net/~hheffner/HullMotor2.pdf