SR Applied to Circular Currents

Horace Heffner July 2003

BACKGROUND AND ASSUMPTIONS

It is well known that special relativity predicts changes in the observed field of a particle due to the flattening of the field in the direction of motion. This flattening is due to application of the Lorentz contraction due to relative motion. This relativistic effect of flattening the apparent field is called the "pancaking" of the Coulombic field. It is the intent here to discuss the effects of pancaking with respect to planar circular direct currents.

On p.492 of *The Electromagnetic Field*, Albert Shadowitz provides the equation for relativistic (Coulombic) field pancaking as:

    E = Q/(4 Pi e0 r^2) (1 - (v^2/c^2))/(1 - (v^2/c^2) sin^2 theta)^(3/2)

If we let b = v^2/c^2 then we can interpret apparent charge Q' to be:

    Q' = Q (1 - b)/(1 - b sin^2 theta)^(3/2)

which can be interpreted to mean apparent charge is reduced to observers in line with the charge velocity vector and increased as the viewing angle is increased.

Note - it is not standard physics to interpret pancaking as a change in apparent charge (standard relativity assumes charge is invariant with velocity) but rather a change in observed field strength, but we should be able to interpret the pancaking equation for Q' either way.

Consider the Bohr model of the atom where the electrons whiz around a nucleus. Specific electrons present some degree of pancaking from any angle viewed. In some directions apparent charge is increased and some directions decreased. In a non-magnetic medium, the polar orientation of atom orbitals is mixed in a uniform way due to the orientation of atoms being mixed in a uniform way. Upon integration over 3D polar coordinates, one finds that the average net charge change, according to the pancaking equation, for randomly oriented atoms and orbitals, is zero. However, the conditions examined here differ from those of an atom not in the presence of ambient electromagnetic fields, as do the resulting forces.

ANALYSIS OF THE RELATIVISTIC PANCAKING EFFECT

If some set of orbitals are aligned, say by a magnetic field, or if we have the case of a planar circular current in a conductor, a neutral medium, then the average apparent charge (as viewed from a long enough distance to make the circle diameter insignificant) does not net out to zero, except at a specific viewing angle. As viewed within the plane, pancaking reduces the apparent charge of charges in motion, and increases the apparent charge of charges in circular motion as viewed from the poles of the circular motion.

The net apparent charge of a charge moving in a small circle relative to the distance of the viewer comes from integrating to find the average value of:

k(theta,v) = (1 - b)/(1 - b sin^2 theta)^(3/2)

for theta = 0 to 2Pi, where b = v^2/c^2, and then subtracting the average value from one to obtain the net charge change factor K(v), because if v = 0 then the observed (apparent) charge Q' is the same as the charge Q:

Q' = Q * 1

If the average value of k(theta,v) is non-zero, when integrated over all angles theta, for v not 0, then an average apparent net charge exists when v not 0.

The average value f_avg of any function f(x) is given by:

f_avg(x) = 1/(b - a) [integral from a to b][f(x) dx]

so the value of net charge change factor K(v) = 1 - [average over theta of k(theta,v)] is given by:

K(v) = 1 - 1/(2 Pi - 0) [integral from 0 to 2 Pi][k(theta) d theta]

which requires solving an elliptic integral of the second kind, and yields a net charge:

Q_net = K(v) Q

where K(v) can be approximately based on the average speed of the electrons.

Note that in the 3D situation the averaging integral equivalent to the above would be

[Integral from 0 to Pi] [k(theta) sin(theta) d theta]

because it is necessary to average over theta with a weight of sin(theta) to account for the surface area involved. This integral evaluates to one, thus K(v) evaluates to zero. However, in the planar version, K(v) does not average to zero.

NUMERICAL APPROXIMATION OF THE PANCAKING EFFECT

The average values k_avg(v) of k(theta,v) for random planar orientations as viewed from the plane were directly calculated by computer program, thus producing the incremental force factor:

$$K(v) = 1 - k_{avg}(v)$$

over a complete circle, for theta = 0 to 2 Pi. Results for various values of v/c are shown in Table 1:

v/c	K(v)
.999999	0.363371045179493
.5	6.57845423323069D-02
.1	2.50470713873419D-03
.01	2.5000468772296D-05
.001	2.50000048662713D-07
.0001	2.50000153911856D-09

Table 1 - Direct numerical estimation of K(v)

These factors indicate the possibility of huge apparent net charges, especially from electrons moving at the speed of k shell electrons (if such could be made to move in a planar orbit.). The innermost electrons of Fe have an ionization potential of 9277.69 eV, and Ni has 10775.40 eV. Using half the ionization potential of Ni as electron kinetic energy we obtain:

$$1/2\ m_e v^2 = (10775.4 \text{ eV})/2 = 8.63 \text{ J}$$

$$v = 4.35\text{x}10^7 \text{ m/s}$$

$$v = 0.145\ c$$

so more than 0.25 percent of the total charge for such electrons would appear as net apparent positive charge in the atom, if a sufficiently strong magnetic field could be applied so as to make K shell orbitals nearly flat (an astronomical magnitude magnetic field to be sure!)

ANALYTICAL SOLUTION USING MATHEMATICA

In order to obtain an exact form of the integral, Mathematica was used to integrate the pancake function obtaining a finite integral. Unfortunately a complete elliptic integral of the second kind appears in the solution.

The average value f_avg of any function f(x) is given by:

```
f_avg = 1/(b - a) [integral from a to b][ f(x) dx ]
```

so the value of net charge change factor K_incr(v) = 1 - k_avg is given by:

```
K_incr(v) = 1 - 1/(2 Pi - 0) [integral from 0 to 2 Pi][ k(theta) d theta ]
```

Mathematica says:

```
[integral from 0 to 2 Pi] [ (1 - b sin^2 theta)^(-3/2) d theta]
```

is given by:

```
-(EllipticE[x, b]/(-1 + b)) + (b*Sin[2*x])/(Sqrt[2]*(-1 + b)*
                  Sqrt[2 - b + b*Cos[2*x]])
```

which, when evaluated from 0 to 2 Pi, is

```
-4(EllipticE[b])/(b-1)
```

where EllipticE[b] is a complete elliptic integral of the second kind. So:

```
K(v)  = 1 - 1/(2 Pi - 0) [integral from 0 to 2 Pi][ k(theta) d theta ]

      = 1 - 1/(2 Pi) (1-b) [integral from 0 to 2 Pi]
                           [ (1 - b sin^2 theta)^(-3/2) d theta]

      =  1 - 1/(2 Pi) (1-b)  (-4(EllipticE[b])/(b-1))

      = 1 - 4/(2 Pi)  EllipticE[b]

K(v)  = 1 - 2  EllipticE[b]/Pi
```

or alternately:

```
K(v) = 1 - 2 EllipticE[v^2/c^2]/Pi
```

Through use of Mathematica, the following confirming values of K(v) were obtained:

v/c	K(v)	Mathematica evaluation of K(v) = 1 - 2 EllipticE[(v/c)^2]/Pi
.999999	0.363371045179493	0.363375
.5	6.57845423323069D-02	0.0657845
.1	2.50470713873419D-03	0.00250471
.01	2.5000468772296D-05	0.0000250005
.001	2.50000048662713D-07	2.5e-7
.0001	2.50000153911856D-09	2.5e-9

Table 2

Thus it appears there is some evidence for a predicted net apparent charge, when matter is viewed in a plane containing the matter and normal to the magnetic field, in both neutral condensed matter and plasmas, or even magnetron chambers, if a sufficient magnetic field is present. The fact that apparent charge does not manifest in condensed matter might be construed to confirm the QM view that the "electron is everywhere" in the wave function, or that it has no specific location until sampled. There is thus no radiation from atoms because the orbital electrons do not actually "move."

Plasma electrons are not so constrained by the QM boundaries as electrons in atoms though. The upper bound on the possible effect is less, due to lower velocities, but still significant for large astronomical bodies.

It should be noted that this speculation so far ignores the effects of charge acceleration and general relativity effects.

Now, to evaluate the integral giving k(b) for b = (v/c)^2, b small. Given the first few terms of EllipticE:

$$\text{EllipticE}[b] = \text{Pi}/2 - (\text{Pi}\ b^2)/8 - (3\ \text{Pi}\ b^2)/128 + \ \ldots$$

we can evaluate the integral giving k(b) for b = (v/c)^2, b small:

$$K(v) = 1 - 2\ \text{EllipticE}[b]/\text{Pi}$$

$$= 1 - 2\ \{1/2 - b/8 - 3\ b^2/128\}$$

$$K(v) = b/4 + (3/64)\ (b^2)$$

which is pretty good, and for many things

$$K(v) = b/4$$

works OK too, or the series

$$K(v) = (1/4)\, b + (3/64)\, (b^2) + (5/256)\, (b^3) + (175/16384)\, (b^4) + (441/131072)\, (b^5) + (4851/2097152)\, (b^6) + (14157/8388608)\, (b^7) + (2760615/2147483648)\, (b^8) + \ldots$$

can be used to compute to the degree of accuracy desired.

It is interesting though, that:

$$\text{EllipticE}[1] = 1$$

so, a limit to the effect is provided by:

$$K(c) = 1 - 2\, \text{EllipticE}[q]/\text{Pi}$$

$$= 1 - 2/\text{Pi} = 0.363380227632$$

EXAMINATION OF THE PANCAKING EFFECT

Let's assume uniform circular motion, i.e. DC current, in a charge balanced medium. It is commonly assumed there is then no induction. However, it is often stated that accelerating charges produce fields, so perhaps the uniform acceleration of charges about the circle produce a field that precisely cancels the pancake effect field computed above. This would be a very unusual field that uniform charge acceleration about the circle must produce if it exactly cancels the special relativistic (SR) Coulomb field of a circle current, which is non-conservative. Given the SR Coulombic field pancaking equation and $b = v^2/c^2$, we have:

$$k(\theta) = (1 - b)/(1 - b \sin^2 \theta)^{(3/2)}$$

At theta = 90 deg. we have:

$$k(\text{Pi}/2) = (1 - b)(1 - b)^{(-3/2)}$$

$$= (1 - b)^{(-1/2)} = \gamma(v)$$

which represents an apparent charge increase for every charge as viewed from a point on the major axis and distant from the circle. The charge motion, from the polar vantage point, is viewed from the "side" at approximately 90 degrees.

At theta = 0 deg. we have:

K(v) = b/2 + ...

which represents an apparent charge decrease. Using q' to designate the apparent charge observed for an actual current bearing charge q, this gives the following picture from the perspective of the velocity dependent SR field component:

```
          q' = q * gamma      (q' > q)


              (-)

               N
               |
               |
  (+)      o   |   x     (+)            q' = q * K(v)      (q' < q)
               |
               |
               S
            Magnetic
             Poles

              (-)


          o - current out of page (electrons into page)
          x - current into page (electrons out of page)
         (+) - positive net apparent charge
         (-) - negative net apparent charge
```

Fig. 1 - Diagram of SR based Coulombic field

Note that, because the proposed current is carried by electrons moving within a positive medium, that the field is positive to the sides. If the current were carried by positive charge, the SR Coulombic field would be reversed.

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RAMIFICATIONS THUS FAR

This analysis has been conducted from the very unconventional viewpoint of apparent charge, not field dynamics. However, the E observed at any point in space is proportional to the relative charge observed from that point, and is in fact the only way to observe a "relative charge" at all. Either way means of analysis provides a perfectly valid perspective, though the apparent charge method seems to easily and intuitively provide results.

Relativistic effects are thought of as only significant at speeds near c. However, charge density in conductors is so huge, that the minor speed difference between conduction band electrons and nuclei is enough to entirely account for magnetism. In numerous texts, including texts by Purcell and Feynman, this has been shown for long straight conductors . Here the analysis is simply carried one step further, to see what happens if the wire is circular. What happens is that the moving charges, as seen from the poles of the circle, all crunch their fields, thus are seen as having more charge. Electrons seen from the equatorial plane of a circular conduction path, have a net effect of reduced apparent charge. This is because electrons approaching or departing the viewer have a reduced charge, while those going sideways have an increased charge. When you average the net charge about the circle, a seen from a point in the equatorial plane, you end up with a net reduction in apparent charge for those charges moving around the circle.

Now, if the circle is a rotating conductor, then the motion of charges is relative. If the current i is in the direction of conductor rotation, then the electron motion is actually to the rear. The principle conduction then, as seen relativistic ally speaking, is by the nuclei. If the current is reversed, then the electrons are the faster charge carriers. The effect is non-linear with velocity. Therefore you get a big boost in the subject non-conservative field by rotating the conductor.

The non-conservative SR field, if sufficient in size, can be used to make a generator which require no power input.

Fig. 2, supplied below, shows in cross section an SR field generator coil and a secondary coil. The brushes supplying the primary coil are actually just slip rings. In the case of a superconducting primary coil, no brushes would be required. There can be two secondary coils, one to each side of the primary coil. The secondary coil, as shown in cross section, can be projected around the axis of the coil so as to make a quasi-toroidal coil, giving a mirror image triangle to the top of Fig. 2.

```
             ------------
             | Primary  |
             |  Coil    |
   axis    B==============B     -------------------
             |          |      |   Secondary    /
             |          |      |   (Stator)    /
             ------------      |   Coil       /
                               |             /
                               |            /
                               |           /
                               |          /
        B - bearings and       |         /
            brushes            |        /
        = - Axle               |       /
                               |      /
                               |     /
                               |    /
                               |   /
                               |  /
                               | /
                               |/
```

Fig. 2 - The relativistic field generator

The direction of the potential induced in the secondary is not dependent upon which way the primary coil spins, but is dependent on which way the current goes in the primary. Each turn of the stator loop should gain a fixed voltage because the field is not conservative. The charges in the coil look different from the side of the coil vs from the axis. The voltage generating segments are the bases of the stator triangle in Fig. 2. The hypotenuse is more rounded and is intended to follow a uni-potential line.

Given that K(v) <= b/4, we have that k(v) is proportional to v^2. There is a good prospect that detection of this field can be made, if it exists, if the secondary coil is a superconductor.

EFFECTS OF CHARGE ACCELERATION

Next, it is necessary to consider the special relativistic effects of acceleration. In *Classical Electromagnetism via Relativity,* Plenum Press, 1968, W. G. V. Rosser develops (p. 272 ff) a proof that the field from a closed circuit, ignoring radiation fields, is zero. Rosser utilizes the following SR based equations for his proof:

$$E = Ev + Ea$$

$$Ev = q/(4 \pi e0\, s^3)\, [r - r\, u/c][1 - v^2/c^2]$$

$$Ea = q/(4 \pi e0\, s^3 c^2)\, \{r \times ([r - r\, u/c] \times [a])\}$$

$$s = [r - (r \cdot u)/c]$$

where r, u, and a are vectors.

Earlier in the text (p. 252) Rosser credits the above equations to Frisch and Wilets (Amer. J. Phys. 24(1956) p.574.) The above equations are not approximations and are consistent with the Maxwell-Heaviside equations.

Rosser only actually proves his case for a specific circuit which has sharp bends, but assumes the bends are not significant because the accelerations involved are not large (apparently due to the fact the electron velocity is slow in wires) This seems to be a flawed approach and also as immaterial to high velocity situations, like those found in stars. Further, Rosser's proof has the glaring limitation that it only shows a netting to zero in the plane of his special circuit, which consists of two (radial from the point of observation) straight lines and two arcs centered on the point of observation.

Even if Rosser's proof is assumed to be correct in general, to the level of accuracy he produces, and even if the apparent charge is assumed to net to zero in the plane of the circuit, a non-conservative field appears when we look at the ramifications of the Ea equation in the polar regions of Fig. 1.

Rosser shows (p. 276) that the formula for Ea implies:

$$Ea \approx -q/(4 \pi e0\, c^2)\; [a_{perp}]/[r]$$

where $[a_{perp}]$ is the component vector of vector [a] that is perpendicular to vector [r]. Using scalar centripetal acceleration

$$a = v^2/r$$

to estimate the Coulombic field at points on the central polar axis distant from the current ring, we obtain:

$$Ea \approx -q/(4 \pi e0\, c^2)\; (v^2/r)/(r)$$

$$= -q/(4 \pi e0\, r^2)\; (v^2/c^2)$$

and we obtain an apparent charge factor of $-v^2/c^2 = -b$ due to the acceleration component of the polar Coulombic field. Now, clearly , -b does not exactly, at every v, offset the charge factor:

gamma(v) = (1-b)^(-1/2)

obtained using the standard SR field pancaking equation. We are left with an apparent net charge at the poles of:

q' = q [(1-b)^(-1/2) - b]

If this is true, then a field is predicted which is not energy conservative. A path from the polar region to a distant point on the plane of the circular current, to a near point on the plane, and back to the polar region, gains a fixed increment of energy.

Call [(1-b)^(-1/2) - b] the net relativistic polar apparent charge factor Fp(v). Table 1 provides a quick look at various evaluations of Fp(v).

	b	gamma(v)	Fp(v)	Incr., 1-Fp(v)
v/c	(v/c)^2	1/(1-b)^.5	1/(1-b)^.5-b	1-1/(1-b)^.5+b
0.0000	0	1	1	0
0.0001	0.00000001	1	0.99999999	1E-08
0.0010	0.000001	1	0.999999	9.99999E-07
0.0100	0.0001	1.000000005	0.999900005	9.9995E-05
0.1000	0.01	1.000050004	0.990050004	0.009949996
0.2000	0.04	1.000800961	0.960800961	0.039199039
0.5000	0.25	1.032795559	0.782795559	0.217204441
0.6000	0.36	1.071866157	0.711866157	0.288133843
0.7000	0.49	1.147154143	0.657154143	0.342845857
0.9000	0.81	1.70523372	0.89523372	0.10476628
0.9900	0.9801	5.037672145	4.057572145	-3.057572145
0.9990	0.998001	15.82325228	14.82525128	-13.82525128
0.9999	0.99980001	50.00375017	49.00395016	-48.00395016

Table 1 - Tabulation of Polar Apparent Charge Factors

Note that the slope of Fp(b) near b=0, is given by:

d/db Fp(b) = 1/(2(1-b)^(3/2)) - 1

which for b very small evaluates to roughly -1/2. Therefore, the incremental charge Q'(b) in a neutral planar circular conductor, for b very small is roughly:

$$Q'(b) = b/2\ Q$$

$$= Q\ [v^2/(2c^2)]$$

$$= [Q/(2c^2)]\ v^2.$$

This addition of an apparent charge, proportional to v^2, to a neutral circular planar conductor, implies that if that neutral conductor is spun about its major axis in the direction of current flow, that the net polar apparent charge will increase. If the drift velocity is v_{drift} and the rim velocity is v, then the two current net polar charge factor will be:

$$F_{net}(v,v_{drift}) = [1/(2c^2)]\ (v+v_{drift})^2 - [Q/(2c^2)]\ (v)^2$$

$$F_{net}(v,v_{drift}) = [2\ v\ v_{drift} + v_{drift}^2]/(2c^2)$$

and since v_{drift} is typically under 1 mm/sec, and v can be many meters per second, a gain in the polar charge of at least 4 orders of magnitude can obtained by rotating the current carrier about its axis.

SOME POTENTIAL CONSEQUENCES

It might be conjectured at this point that the Podkletnov antigravity experiment that NASA has been replicating, which uses a current carrying levitated spinning superconducting ring, does not show any artificial gravity because NASA is using a sensitive gravitometer. The field predicted looking at the pancake effect is electrostatic. Such a field might achieve the effect Podkletnov first noticed, namely that smoke rose above the spinning superconducting disk. It may be that the smoke particles were somewhat ionized. However, all the antigravity effects reported by Podkletnov can not be justified by the means discussed here, because the suggested electrostatic field would induce attracting charges on neutral objects. It is of interest that, due to the Faraday ice pail effect, shielding for the suggested force, which is electrostatic in nature, can not be easily achieved.

The numbers can be significant for current carrying masses spinning at very high velocities, and in cases where very strong magnetic fields are involved and thus affecting atomic structure and alignment, and might provide an explanation for polar jets observed for fast spinning astronomical objects. In addition, a net anti-gravitational force from flat galaxies, or more specifically from aligned spinning structures within them, is predicted by the proposed theory. It is of further interest that if the proposed potential exists then conservation of energy is violated, free energy devices can be made.

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A SMALL TEST CASE

Let's First look at a specific and mundane case readily tested by amateur means.

Copper density is 8.96 g/cm^3 at 300 K, and atomic weight is 63.546. Avogadro's number is 6.0221x10^23 atoms/mole. There is thus 8.96 * 6.0221x10^23 /63.546 = 8.49x10^22 atoms per cm^3 of copper. This is also the approximately number of conduction band electrons per cm^3.

If we assume a 7 cm radius disk spinning at 1800 rpm, or 30 rps, we obtain about a 13.2 m/s rim velocity. Assume the perimeter of the disk is wrapped with 140 turns, or 6160 cm of 0.02846 in, 0.0723 cm dia., No. 21 copper wire, carrying 1 amp DC. This wire has a cross sectional area of 0.0164 cm^2, or 1.64 mm^2. Total wire volume is (0.0164 cm^2)(6160 cm) = 101 cm^3. This wire has 13.05 ohms per 100 ft., or .428 ohms/meter. Total resistance is thus estimated at (.428 ohms/meter)(6160 cm) = 26.3 ohms, thus the wire is driven at 26.3 volts to achieve the 1 amp current.

The 101 cm^3 of wire has a total (8.49x10^22 atoms per cm^3)(101 cm^3) = 8.57x10^24 conduction band electrons. There are thus (8.57x10^24 electrons)/(6160 cm) = 1.39x10^21 electrons/cm of wire.

We have a current of 1.0 amps in the wire, or 1.0 coulomb/second. There is 1/q_e = 6.2415x10^18 electrons/coulomb, giving 6.2415x10^19 electrons/sec flowing in the wire. The electrons thus move at (6.24x10^19 electrons/sec)/{1.39x10^21 electrons/cm) = 0.0449 cm/sec, so:

    v_drift = 4.49x10^-4 m/sec

We have about 8.57x10^24 conduction band electrons carrying the current so at 6.24x10^18 electrons/coulomb we have:

    Q = 1.37 x 10^6 coulombs

carrying the current, so since:

    F_net(v,v_drift) = [2 v v_drift + v_drift^2]/(2c^2)

    Q' = Q [2 v v_drift + v_drift^2]/(2c^2)

    Q' = (1.37x10^6 coul.) [2 (13.2 m/s) (4.49x10^-4 m/sec) +

           (4.49x10^-4 m/sec)^2]/(1.8x10^17 m^2/s^2)]

      = (1.37x10^6 coul.)(6.59x10^-20)

$$Q' = 2.71\times10^{-14} \text{ coul.}$$

If we had a test charge of 1 coul. at a distance of 1 m from the spinning coil, and lying on its axis, we would have a force:

$$F = [1/(4 \pi \epsilon_0)]\, Q1\, Q2/r^2$$

$$= [1/(4 \pi (8.85\times10^{12} \text{ F/m})](1 \text{ coul.})(2.71\times10^{-14} \text{ coul.})/(1 \text{ m})^2$$

$$F = 2.44\times10^{-4} \text{ N}$$

giving a field strength of:

$$E = 2.44\times10^{-4} \text{ N/coul.}$$

$$= 2.44\times10^{-4} \text{ volts/meter}$$

which might be barely usable, but would be readily detected by use of a very low resistance loop.

In that the field is non-conservative, it may be of sufficient magnitude to be of some utility if used with a superconducting current loop, or big cross section copper loop, wrapped about a magnetic core, but the back emf of the magnetic field building in the conductor would prohibit much power from being extracted. The power to drive the device is about 26 watts, plus maybe another 20-180 watts to drive the motor. However, a spinning superconductor could be used for the primary, and that would take almost no power except cooling.

Suppose we could get 2 mV out of a 2 m triangular secondary current loop (the potential gain is higher near the rotating primary loop) and we have a copper conductor with a cross section of 144 cm^2, or 22.3 in^2. Copper has a conductivity of 4.01×10^6 ohm^{-1} cm^{-1}, so the conductor has conductivity of (144 cm^2)(4.01×10^6 ohm^{-1} cm^{-1}) = 5.77×10^8 cm ohm^1, or a resistance of 1.73×10^{-9} ohm/cm. Using 600 cm for a length we have a total resistance of (1.73×10^{-9} ohm/cm)(600 cm) = 1.03×10^{-6} ohm. We would thus have a current I = E/R of (.002 V)/(1.03×10^{-6} ohm) = 1940 amps, which is of course readily detectable. The heat output would be a mere (0.002 V)(1940 amps) = 3.88 watts.

A practical device might be made by using very high speed rotating superconductor(s) carrying lots of current. If a 2000 amp carrying superconductor rotating at 18000 rpm is used, then the power output jumps to 388 watts.

A variation is to drive the primary with A/C. The secondary would then be driven at (0.002 V) (1940 amps) = 3.88 watts A/C. It could be used to drive a transformer primary in order to drive a secondary at 3.88 watts and the voltage desired. Upping the rpms to 18,000 would produce about 38.8 watts, which would be above theoretical break-even if frictionless brushes and low friction bearings were used.

SCALING UP

By using supercooled aluminum wire, the conductivity can be increased by a factor of 10^5. This means the current can be increased by a factor of 10^(5/2) = 316 and still maintain the same I^2 R heat dissipation, and electron drift velocity v_drift can also be increased by a factor of 316. The drift velocity could be about (4.49x10^-4 m/s)(316) = 0.1419 m/s. Assuming a rim velocity of (60 rps)(1m)(Pi) = 188 m/s, the performance per turn can be compared to the small proof of concept experiment by:

```
   perf = F_net(188 m/s,0.1419 m/s) / F_net(188 m/s,4.49x10^-4 m/s)

        = [2 (188 m/s) (0.1419 m/s) + (0.1419 m/s)^2]  /

             [2 (13.2 m/s) (4.49x10^-4 m/sec) + (4.49x10^-4 m/s)^2]

        = (53.4 m^2/s^2)  / (.1186 m^2/s^2)

        = 450
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The coil cross section can be increased from about 1 in^2 to about 100 in^2, thus giving another 100 fold increase in number of turns, and a total ampere-turns multiplier of 100*316 = 31600. The computed field strength of about 2.44x10^-4 volts/meter for the experiment then becomes (2.44x10^-4 v/m) * 31600 * 450 = 347 v/m, spread out over an area of about 3 m^2. A special triangular coil of cross section 3 m can length 3m to a side can then gain about (347 + 1/4 (347) + 1/9(347)) V/turn = 472 volts/turn. Assuming 100 turns that is 47.2 kV output, with a conductor cross section of 3 m^2/100 = 300 cm^2. Assuming the secondary is driven at a mere 1000 A/cm^2, with half the cross section taken up by winding space and insulation, that is (300 cm^2)*(1000 A/cm^2) = 30 kamps at 47.2 kV, or 1.42 GW.

This indicates a very practical output. This is by far the most commercial idea, if proven feasible experimentally, even if it disappointingly does not result in the hoped for inertial drive.

The proof of principle experiment was to take 140 turns of 1 amp. The proposed practical device armature has 14000 turns at 316 A/turn, therefore has total amp turns of (14000 turns)(316 amps/turn) = 4.42 mega-amp-turns in a coil of radius 1 m, and a 10 inch by 10 inch cross section, or 25.4 cm square cross section. It may not be feasible to hold this together. However, major offsetting gains in performance can be had by supercooling the secondary coil, and by increasing the area of the rotating coil, which then permits a much larger secondary coil, both in area and acceleration length, and reduces the magnetic pressure on the rotating coil. The coil cross section can be made thinner and wider, so structural support can be beefed up around it. The coil would actually consist of a series of concentric coils with structural support and cooling conduits interlaced between them.

Using a seat of the pants number of about .7 N for 1000 amps. for the 1m radius coil hoop force, that force is increased by the square of the ratio of the amperages, (4.42x10^6/10^3)^2 or about 1.954x10^7, giving a force of 8.37x10^7 N, or 1.882x10^7 lbf, or about 9410 tons force between two halves of the proposed coil. Too much. At a 1m radius, or 6.28 m, that is about 75 inches perimeter giving a lateral force of about 213 tons/inch. Centrifugal force has to be added to that too.

An FEA simulation of the 1 m diameter coil (to the conductor cross section midline) with 23.4 cm square conductor carrying 4,420,000 amps was run. The half hoop force was 1.267x10^7 N, or 2.85x10^6 lbs, or 1424 tons. The field strength at the conductor midline was a modest 1.27 T, seemingly not out of the ordinary to contain, even rotating. However, the iLB force of 1.426 N/inch, or 32,000 lbs/in. This is difficult considering the need for cooling and the fact the coil also needs to rotate. There is considerable room for design adjustment, and at the anticipated power output, much leeway in cost.

Earlier, for the proof of principle experiment, it was assumed a secondary coil would reside only on one side of the rotating primary. However, a duplicate secondary (stator coil) can be placed on the other side of the rotating primary, thus doubling the output. Also, by adding another meter to the radius, the current and thus the power output of the secondary is quadrupled, or the primary current can be correspondingly reduced.

If feasible, superconducting wire would be useful for the spinning primary coil from a couple aspects. One is cooling would not be a function of current, and another would be that the insulation is actually metal, and thus much more resistant to stress than plastic or rubber at cryogenic temperatures. There is no apparent way that a back e.m.f can be generated, but superconducting wire must be tested to see if a back e.m.f. somehow is generated. Unfortunately, a couple meter diameter superconducting coil would cost fairly big dollars, but nothing like a nuclear plant.

Unless there is a significant mistake, and provided the basic principle stands the experimental test, it should be feasible to put a GW plant in a box about 10 meters to a side.

SR Applied to Circular Currents

Horace Heffner July 2003

TEST RESULTS

This work was just one diversion in a protracted investigation and discussion of various apparent electromagnetic anomalies by the author, Frank Stenger and Scott Little. A test using copper conductors was conducted by Frank Stenger in 2001. The results were negative. It appears one likely source of the problem is that the formula extensions due to acceleration are incorrect. A thorough test of principle, however, requires use of a superconducting secondary coil. In such a case a spontaneously increasing magnetic field in the superconductor would be evidence for the expected field.