Rotating Magnetic Field using 4 coils wrapped around a ferrite toroid
Replication of Nikola Tesla's Patent 390,721, Dynamo-Electric Machine
Version 1
7/19/2011

This is a rough draft that is lacking highly specific details. However there is plenty of information for the experimenter to replicate this project.

Warning: This project involves spinning magnets at very high speeds and should not be undertaken without proper precautions. I am just an electronics hobbyist, so everything here should be treated as unreliable information which could kill you. I am not responsible for any resulting injury or death.

Scope of Project: To build a circuit to energize coils with sine waves 90 degrees out of phase from 10 to 10kHz. When said coils are appropriately placed around a ferrite toroid and energized, a rotating magnetic field is created. Additionally, a spherical magnet placed in the center of toroid is caused to rotate at high speeds. This idea was first proposed by Nikola Tesla in his 1888 patent number 390,721.

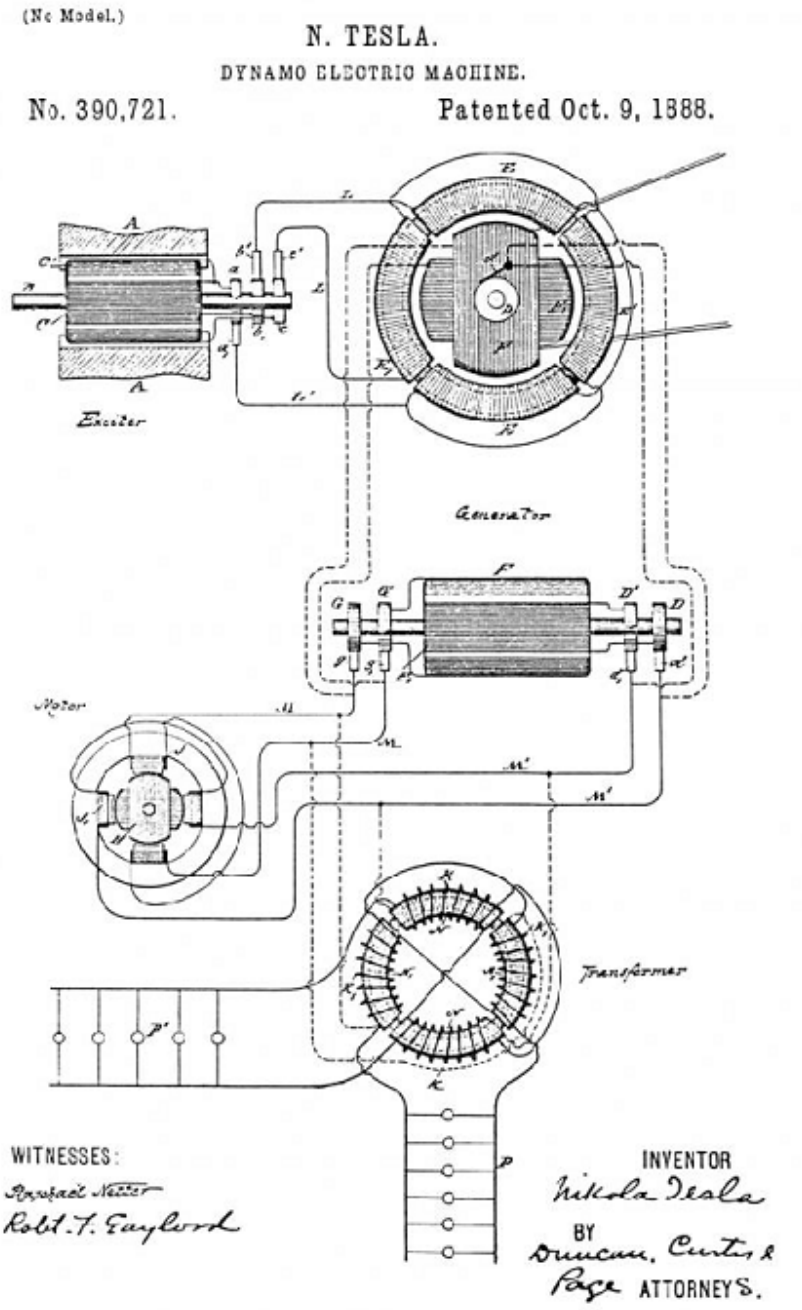


Figure 1.
Tesla's patent 390,721 for a Dynamo Electric Machine. For entire patent see Reference 2 in the Reference section

This patent uses a rotating "exciter" to generate the 90 degrees phased sine waves which are then fed into coils

wrapped around a ferrous toroid, creating a rotating magnetic field. The purpose of this article is to give specific instructions for generating 90 degrees phased sine waves using solid state circuitry. The circuit is quite simple for anyone familiar with electronics.

Main Index for each aspect of the project

1. Signal Generator

The Elenco GF-8026
Frequency: 0.02 Hz to 2 MHz
Output Voltage: 20 Volt peak to peak into open load.
Output impedence: 50 and 600 ohm

Figure 2.
Photo of Elenco GF-8026

2. Differential Audio Phase Shifter circuit

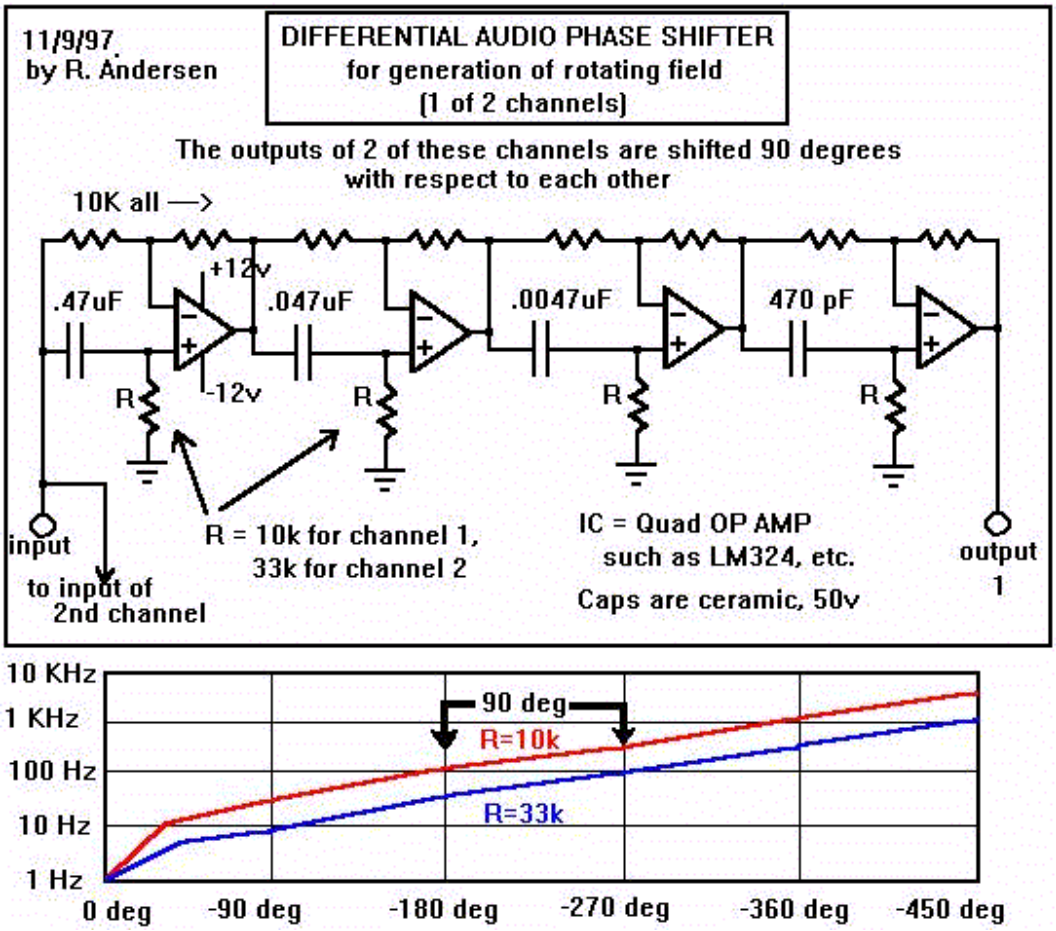


Figure 3.
Circuit diagram. This is actually only ½ the circuit. The other half is identical except for the values of R.

This analog circuit takes a sine wave input and outputs two sine waves at 90 degrees to eachother. This circuit is the heart of the project. It takes the place of the "exciter" part of the Tesla patent. For additional information about this circuit see the "Reference 1" under the reference section at the bottom of this paper or visit this link: http://electropub.wordpress.com/2011/05/11/rick-andersen-quadrature-op-amp-circuit/

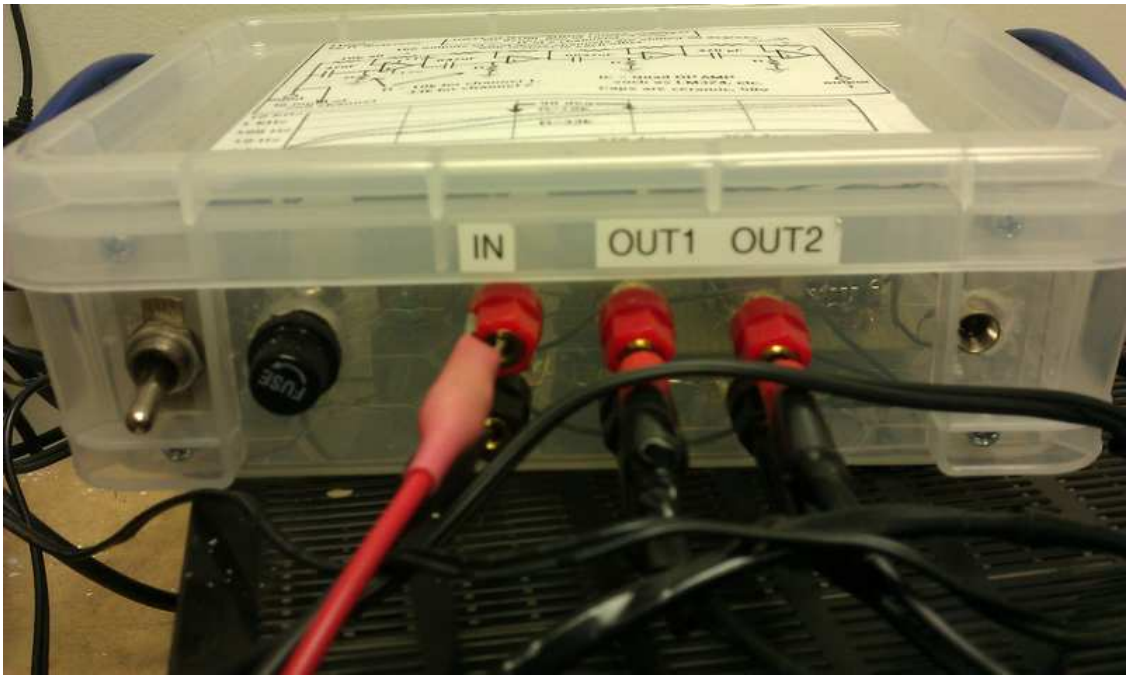


Figure 4a.
Front of completed circuit in enclosure.

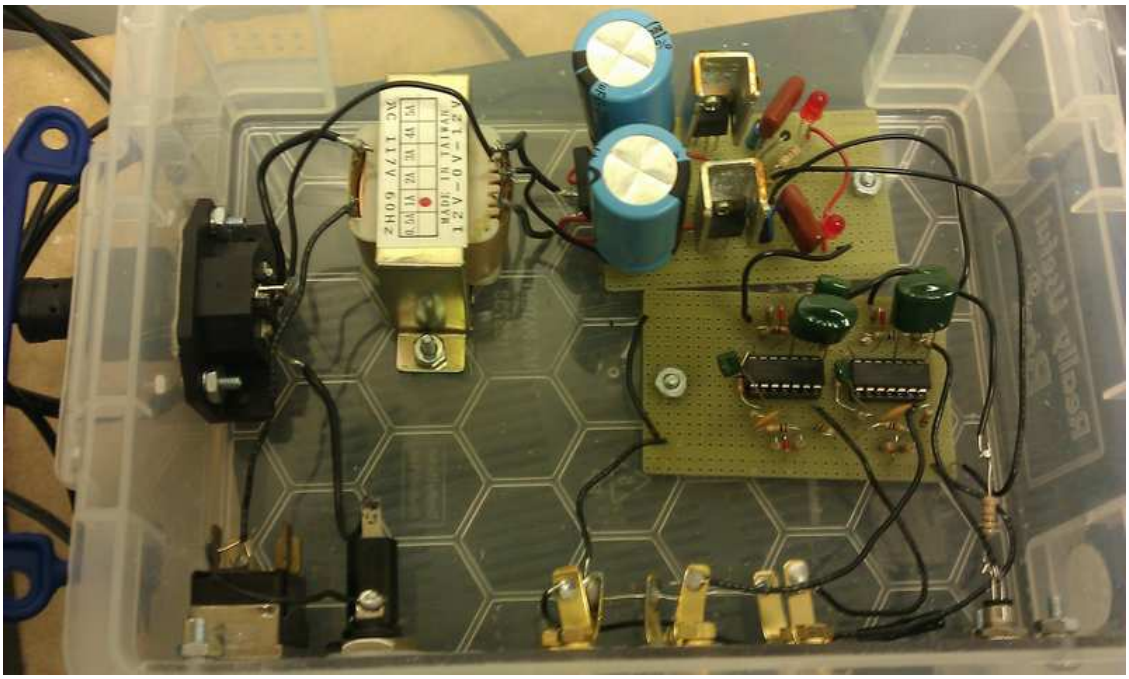


Figure 4b.
Inside view of completed circuit.

3. Stereo Amplifier
JVC RX-750V
Output: 2 channels
Output power: approximately 100W per channel into a 4 ohm load. Cannot find exact specs.

The stereo amplifer is used to amplify the current output of the Differential Audio Phase shifter circuit, thus making it suitably strong to power the coils wrapped around the toroid.

Figure 5.
Photo of JVC RX-750V Stereo Receiver/Amplifier.

4. Input/Output box for Stereo Amplifier
The purpose of the input/output box is to make it simple to use banana plug wires with this circuit. It also houses the current limiting resistors (see next section) It takes the output of the Differential Audio Phase shifter circuit and feeds the two output sine waves into the Left and Right Auxillary inputs on the amplifier. Then the left and right 4 ohm speaker outputs return into the Input/Output box and

are connected to banana plug jacks and 200W series resistor for current limiting.

5. Current Limiting Resistors (part of the Input/Output box)

The two current limiting resistors are 200W units and are used to prevent the stereo amplifier circuitry from overloading. I used part 019-025 from parts-express.com. They are non-inductive dummy loads used for testing audio equipment. Before I used this my amplifier would shutdown due to overload

They are located inside the Input/Output box to right before the main Output, which is used to drive the coils on the toroid.

I also included a small 12v PC cooling fan, powered by a 12V AC/DC adapter. I'm not sure if it is necessary, but it is a good idea to keep air moving, particularly to prevent the plastic enclosure from melting.

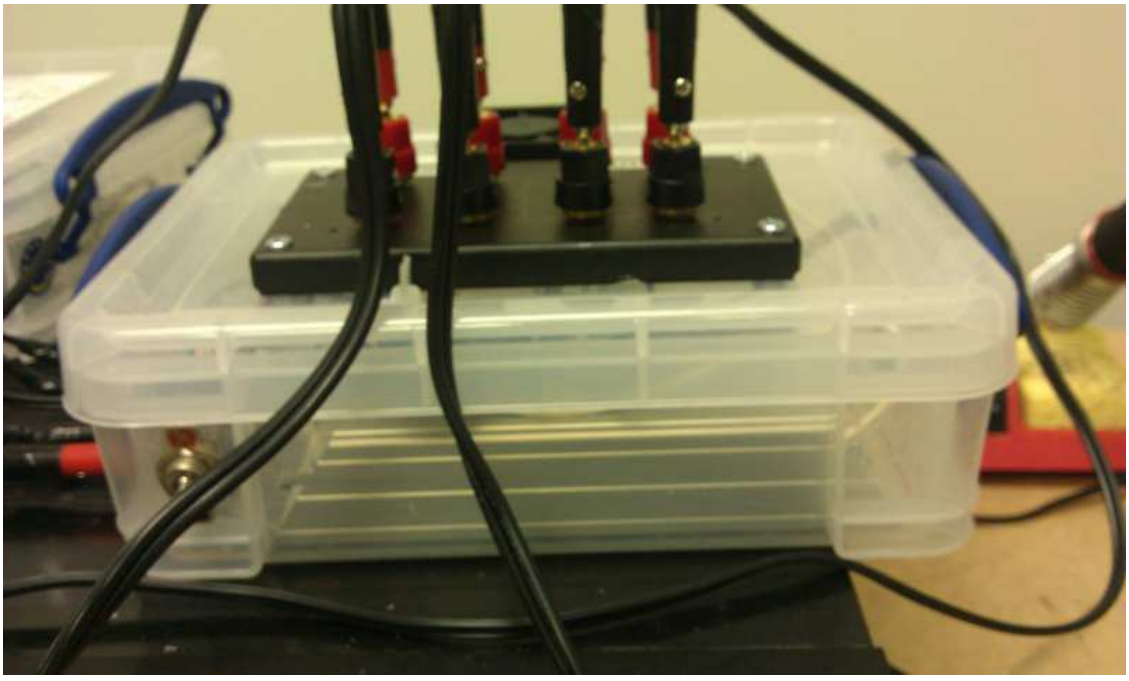


Figure 6a
A switch on the front of the in/out box controls the fan.

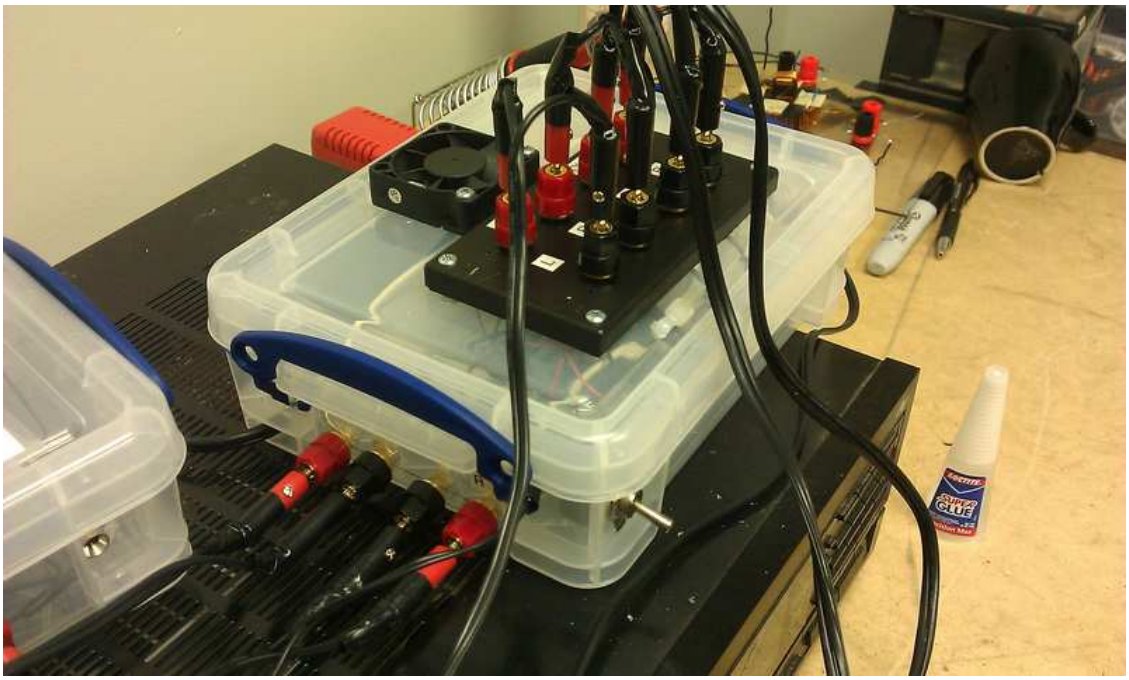


Figure 6b

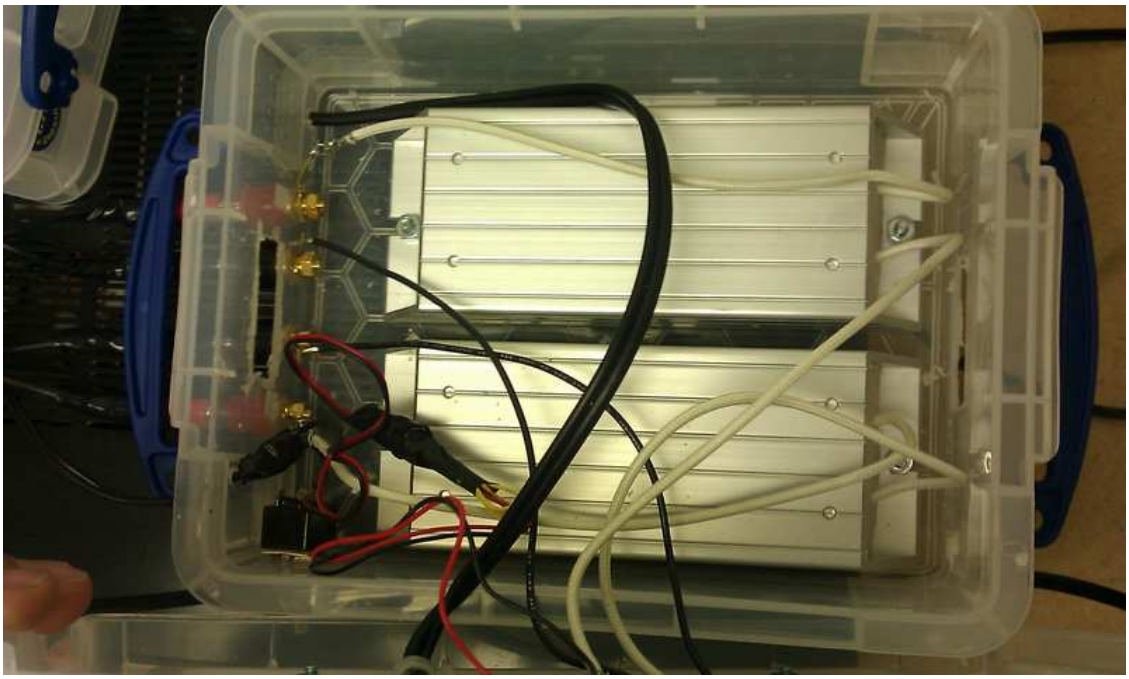


Figure 6c

Figures 6a, 6b, 6c
Pictures of the finished Input/Output box.

6. Ferrite toroid with single layer coil

This is the tricky part of the circuit. It appears in the patent that the toroid is would with a single coil, then the coil is divided into 4 equal coils, and finally the coils are connected as in the diagram. However, the trick is that diametrically opposed coils E and E' are wound in the opposite direction as other coils labeled E and E`. If one were to connect the coils as shown in the Tesla patent, then the diametrically opposing coils would have to be wound in the opposite sense (direction) in order to create the rotating magnetic field.

So if one winds a single coil, and divides it into 4 equal coils, care must be taken to connect the coils E and E` opposite to what is shown in the patent. Only then will the coils be energized correctly to setup a rotating magnetic field. To visualize this, first picture only coils E and E being energized. In order for a "north pole" to be created diametrically opposite a "south pole" the coils must be energized so that they are opposing eachother. Each resultant pole is created between the ends of the coils.

The coil is would on an Amidon FT240-77 core and is 24 AWG magnet wire, approximately 120 total turns. Each coil is about 30 turns.

The coils are then connected to the Input/Output box, using the Tesla patent as a reference for the connections.

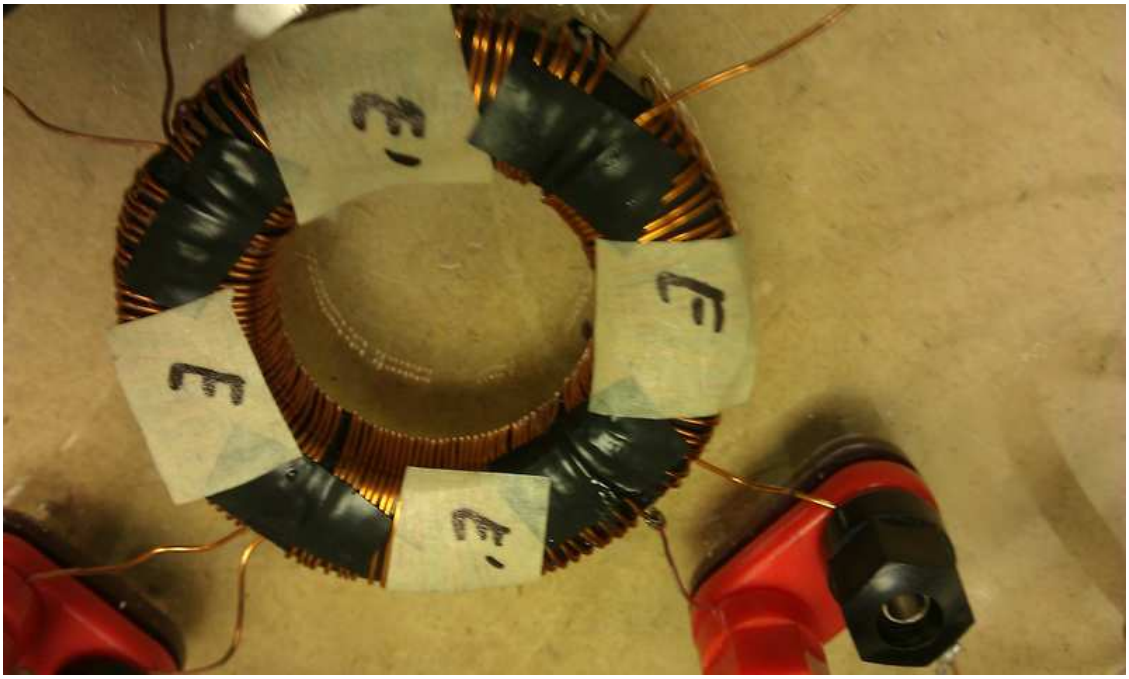


Figure 7
Picture of toroid coil with single layer winding and labeling.

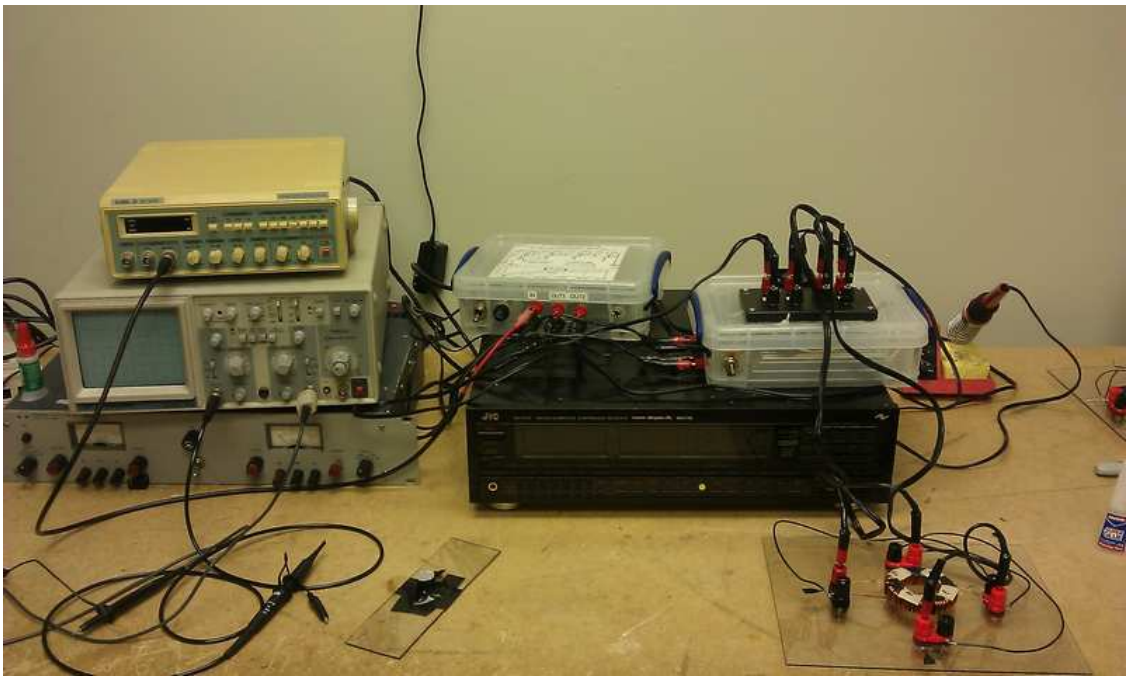


Figure 8
Pictures of final setup.

Experiments

1. Rotating a spherical magnet inside the toroid.

- I created a ½ inch diameter tube (actually a tiny bit larger to reduce friction) out of paper and electric tape, and placed it on a small rectangle of plexiglass. I then placed a ½ diameter spherical magnet in the tube, resting on the plexiglass. This was centered on top of the toroid. Energizing the circuit caused the magnet to spin. The magnet cannot easily be seen spinning because it is an isotropic shape (a sphere), but it does emit an audible frequency due to its contact with the plexiglass. A strobe light could be employed here, or an oscilloscope with a pickup coil to detect the magnetic field of the rotating magnet. So far I have had it up to 400 Hz (24,000 RPM). I am afraid to raise the frequency without first taking precautions in case the magnet becomes a projectile. It could happen if part of the circuit fails.

- I found that the current and frequency must be adjusted, starting at a low frequency of around 10 Hz and slowly increased in order to reach the higher frequency of rotation.

2. Rotating a smaller spherical magnet in the toroid.

- In the same tube mentioned above, I placed a smaller 1/8 inch spherical magnet. At about 10Hz it would rotate around the perimeter of the tube, following the moving pole. Increasing the frequency beyond about 10 Hz is not a good idea since it will eventually wear through the tube and fly off. This could be used as the basis of a novel rail gun.

3. Placing two coils, would at 90 degrees to eachother inside the toroid to detect the presence of the rotating field.

- First I removed the magnet assembly mentioned above. I then placed a coil, which I used in a previous experiment, inside the toroid. It consists of two coils wound on a square form at 90 degrees to eachother. With the coils positioned along the same vertical axis, that axis being perpendiclar to the round surface of the toroid, they picked up the magnetic field and showed it on the oscilloscope screen. The output of each coil was a sine wave and each output was 90 degrees from eachother. This definitively shows the presense of the rotating magnetic field. It does so without the use of magnets, so it is much safer, too.
- It would be better to energize the detection coils, so they interect with the fields within the toroid. This would result in a varying current in the detection coils. In Tesla's patent he says that the rotor can be made of ferrous material or of energized coils.

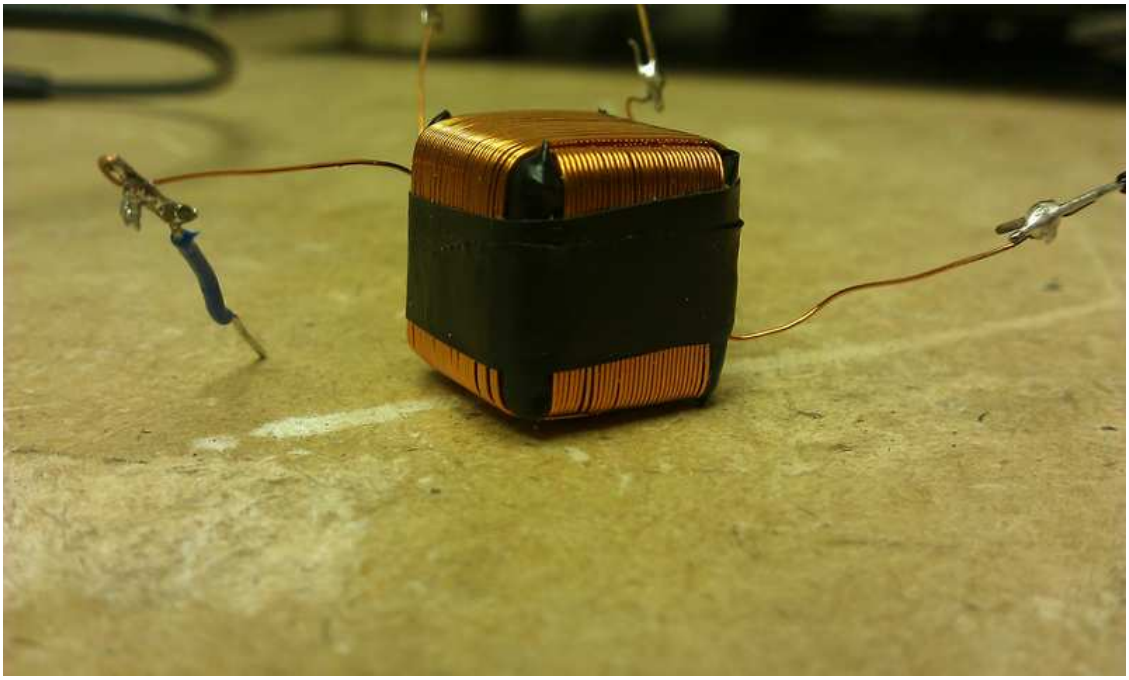


Figure 9
Photo of detection coil with two coils wound at 90 degrees

Final thoughts

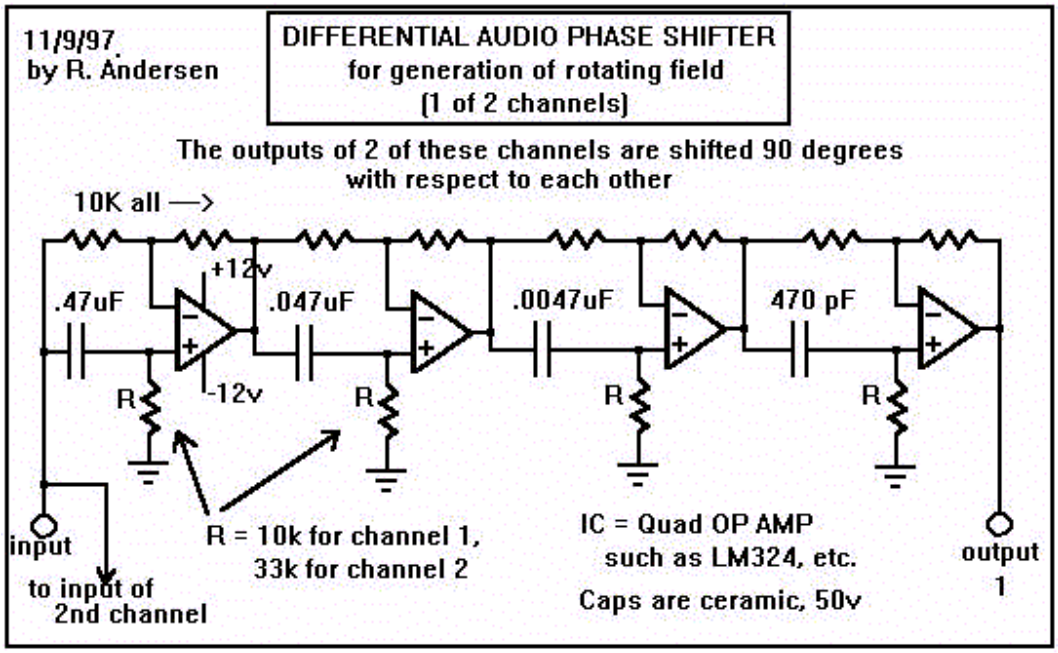
There is still work to be done to enable improvements to this system. However, this easy to build system gives one a test bed to give calculations some real world meaning.

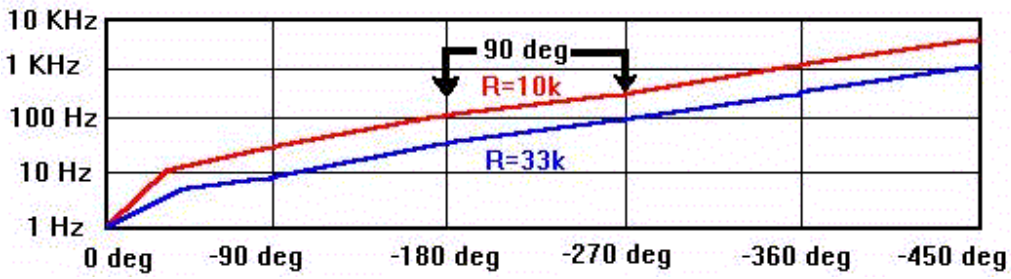
Reference Section

Reference 1

How to generate a Rotating Field

11/9/97 by Rick Andersen





Many of the sources in the alt-sci underground relate that Philadelphia Experiment-type setups rely on a rotating (usually magnetic) field as the key mechanism for producing spacetime shifts. We should be able to accomplish this without the need for bulky, expensive 1940's electromechanical equipment such

as synchro-motors and generators. Indeed, it can be done quite simply (at least the basic waveform control) using today's fast digital signal processing chips and software. For you hobbyists, however, there's also a relatively simple way to do it using analog circuitry built from readily-available parts.

First, we need an oscillator or wave function generator, which can be built using a few parts that you can buy from Radio Shack. (We are assuming audio frequencies in this discussion, up to about 10 KHz maximum.)

1) Using the example of the simplest periodic wave, the **sine wave**, the first step is to generate both the sine wave itself, and simultaneously, a **cosine wave** (a sine wave shifted in *time*by +/- 90 degrees with respect to the sine wave) at the same frequency.

2) These two waveforms must then be transmitted into an area together, with a *90 degree **spatial** separation*between the antennas/coils/speakers/transducers. In other words, they're perpendicular or "orthogonal" to one another.

3) Across from *each* of the above, at the opposite side of the central focal point for all this transmitted wave energy, we need another transducer whose waveform is *inverted*or phase shifted 180 degrees from our sine and cosine waves, above.

Thus our 4 transducers' outputs form a "cross" with one transducer at each point of the cross, or "compass," in a horizontal plane:

the "North" one projects the *reference sine wave*;

the "South" projects an *inverted sine wave*;

the "East" projects a *cosine wave*;

the "West" projects an *inverted cosine wave*.

All four transducers are aimed at the central focal point which they surround.

Now what you must understand is that the above will only work if you have complete control over that 90 degree phase separation at each and every frequency of interest. If you decide to change the reference oscillator frequency, the cosine wave must "track" and maintain the quadrature (90 degree time-) relationship. If you want to do this with more complex waveforms, such as sawtooth or square or even white noise, this can be very problematic. Why? Well, how did you generate the cosine wave from the sine wave in the first place? Ah, there's the rub: If you didn't use a **quadrature oscillator** (which automatically does this for you), then you must have used a **phase-shift circuit** to do it. The problem with that is that phase-shifters do not and *cannot shift each and every frequency across the audio spectrum by the same amount*. It's just mathematically impossible, since the phase shift offered to any particular frequency is a function of capacitive reactance vs. resistance in the phaser: the good old electronics technician's formula Xc = 1/(2 PI F C), where R = Xc at the quadrature frequency. By definition, only ONE frequency will be shifted by 90 degrees for a given RC combination. So what do we do now?

The answer is to use a **differential phase-shifter**, which is actually *two* separate phase-shifters, each of which are inputted with a copy of the audio signal we're interested in making quadrature. Yup, each of them suffers from the same problem as outlined above, BUT– if we carefully tailor the values of the capacitors and resistors in them, we can engineer things such that the

difference in phase shift between channel 1 and channel 2 will always be about 90 degrees! (This is very fortunate; Murphy must have been sleeping one day and somebody came up with this technique when he wasn't watching.)
In other words, it doesn't matter that channel 1 of my phaser shifts 1 KHz waves by 270 degrees (-90) but only shifts 2 KHz waves by 225; channel 2 will shift the 2 KHz frequency by 315 or by 135 degrees– the point is that the *difference* between 225 and 135 is 90 degrees, and that's what we want, a **quadrature** separation.

A Differential Audio Phase Shifter for Rotating Field Generation

Below I present a schematic diagram of 1 of two identical channels of a differential phase-shifter built with commonly-available quad op amps such as the LM324, the TL074, etc. It can also be built using 2 LM358 dual op amps per channel, or you can use 4 single 741′s if necessary. Nothing is too critical here. Notice that below the schematic I've included a graph of frequency vs. phase shift (data from electronic simulation of my circuit), and that, above 10 Hz, the difference between channels is almost exactly 90 degrees on up to near 10 KHz. (Above and below those extremes the error increases unacceptably.
bit with a rolloff around 5 KHz, so it would really be "pink" noise– as our signal source. Transmitting this type of noise in quadrature would mean that the central focal point would be surrounded by a rotating, multi-frequency standing wave, containing every frequency and amplitude (varying randomly) from 10 Hz to 5000 Hz. This might have application to measuring and quantifying absorption/reflection characteristics of, say, a human body standing at the focus or "zero-point" of the rotating "wave-cloud". Kind of like a rotating version of the frequency-rich **Lakhovsky Multiwave Oscillator**.
Or, how about generating a series of frequencies related by ratios of PHI, the Golden Ratio? Would this particular series cause a type of spiralling that would bring a tear of joy to Dan Winter'seye?

But which way does it spin?

You have complete control over that; simply **reverse the phases** of the cosine wave and its inverted twin, while leaving the sine wave as it was, and you will have reversed the direction of field rotation.
As more food for thought, how about setting up a "static" DC magnetic field around the outside horizontal perimeter of your rotating field, as was suggested by the mysterious Air Force Colonel in another file found on this site. He suggests that this makes your setup into a poor man's version of a **nuclear magnetic resonance** setup, which, supposedly, can take any amount of power into its field that you can afford to provide. Will you succeed in the creation of the "electric sheet" that the Colonel described as being able, when dense enough, to *refract light* like a mirage???

Reference 2

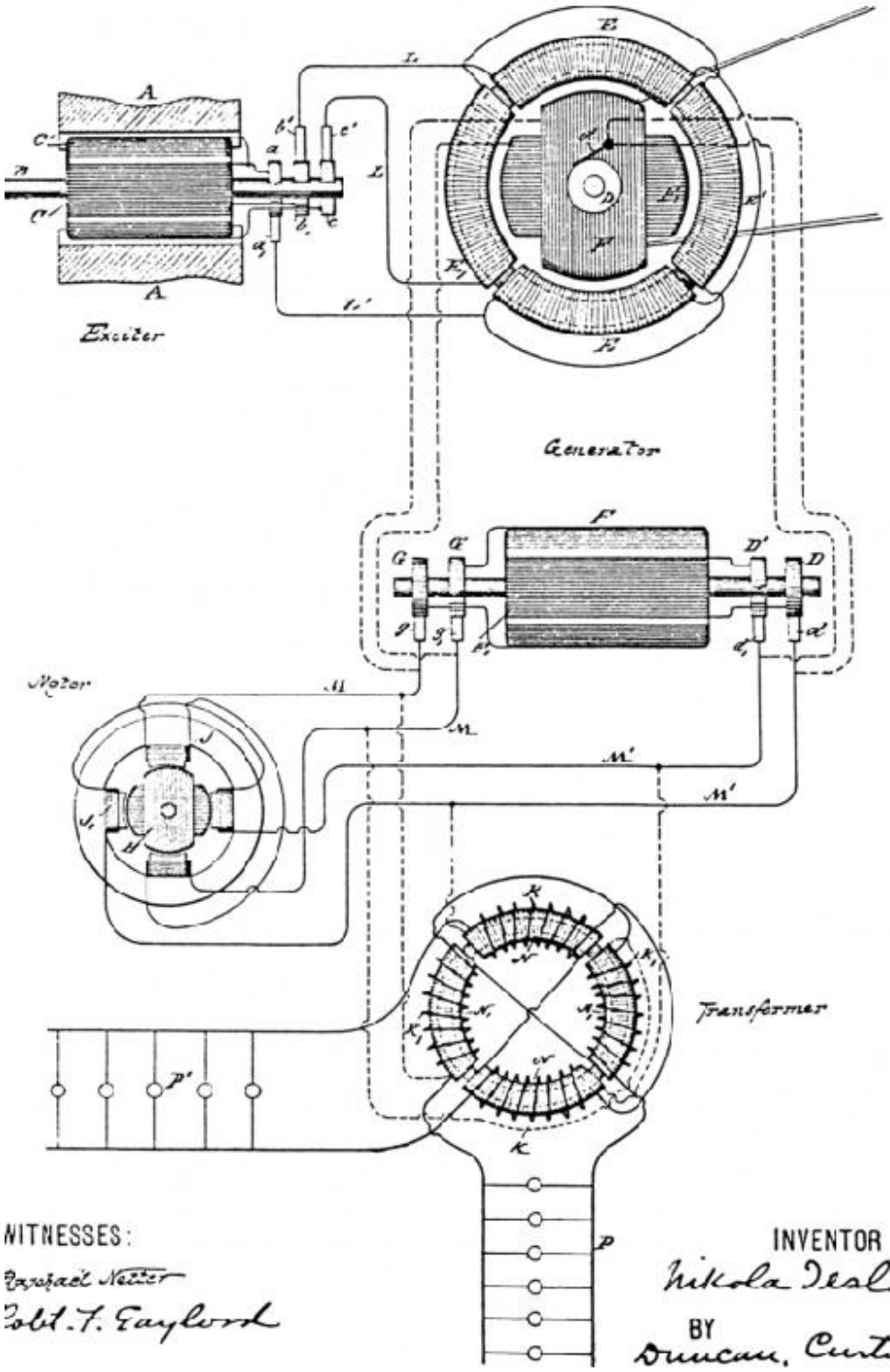
TESLA PATENT 390,721 DYNAMO-ELECTRIC MACHINE.

(No Model.)

N. TESLA.

DYNAMO ELECTRIC MACHINE.

No. 390,721. Patented Oct. 9, 1888.



WITNESSES:

Raphael Netter

Robt. F. Gaylord

INVENTOR

Nikola Tesla

BY

Duncan, Curtis & Co.

SPECIFICATION forming part of Letters Patent No. 390,721 dated October 9, 1888.
Application filed April 28, 1888. Serial No. 272,153. (No model.)

To all whom it may concern:

Be it known that I, NIKOLA TESLA, a subject of the Emperor of Austria, from Smiljan, Lika, border country of Austria-Hungary, now residing at New York, in the county and State of New York, have invented certain new and useful Improvements in Electric Generators, of which the following is a specification, reference being had to the drawings accompanying and forming a part of the same.

My present invention relates, chiefly, to the alternating-current system invented by me and described in prior patents, notably Nos. 381,968 and 382,280, of May 1, 1888, in which the motors or transformers, or generally the converters, are operated by a progressive shifting or movement of their magnetic poles produced by the co-operative action of independent magnetizing-coils through which pass alternating currents in proper order and direction. In my said system, as I have heretofore shown, I employed a generator of alternating currents in which there were independent induced or generating coils corresponding to the energizing-coils of the converter, and the relations of the generator and converters were generally such that the speed of rotation of the magnetic poles of the converter equaled that of the armature of the generator.

To secure the greatest efficiency, it is necessary to run the machines at a high speed, and this is true not only of those generators and motors which are particularly adapted for use in my system, but of others. The practicability of running at very high speeds, however, particularly in the case of large generators, is limited by mechanical conditions, in seeking to avoid which I have devised various plans for operating the system under efficient conditions, although running the generator at a comparatively low rate of speed.

My present invention consists of another way of accomplishing this result, which in certain respects presents many advantages. According to the invention, in lieu of driving the armature of the generator at a high rate of speed, I produce a rotation of the magnetic poles of one element of the generator and drive the other at a different speed, by which similar results are obtained to those secured by a rapid rotation of one of the elements.

I shall describe this invention by reference to the diagram drawing hereto annexed.

The generator which supplies the current for operating the motors or transformers consists in this instance of a subdivided ring or annular core wound with four diametrically-opposite coils, E E'. Within the ring is mounted a cylindrical armature-core wound longitudinally with two independent coils, F F', the ends of which lead, respectively, to two pairs of insulated contact or collecting-rings, D D' G G', on the armature-shaft. Collecting-brushes *d d' g g'* bear upon these rings, respectively, and convey the currents through the two independent line-circuits M M'. In the main-line there may be included one or more motors or transformers,

or both. If motors be used, they are constructed in accordance with my invention with independent coils or sets of coils J J', included, respectively, in the circuits M M'. These energizing-coils are wound on a ring or annular field or on pole-pieces thereon, and produce by the action of the alternating currents passing through them a progressive shifting of the magnetism from pole to pole. The cylindrical armature H of the motor is wound with two coils at right angles, which form independent closed circuits.

If transformers be employed, I connect one set of the primary coils, as N N, wound on a ring or annular core, to one circuit, as M', and the other primary coils, N' N', to the circuit M. The secondary coils K K' may then be utilized for running groups of incandescent lamps P P'.

With the generator I employ an exciter. This consists of two poles, A A, of steel permanently magnetized, or of iron excited by a battery or other generator of continuous currents, and a cylindrical armature-core mounted on a shaft, B, and wound with two longitudinal coils, C C'. One end of each of these coils is connected to the collecting-rings *b c*, respectively, while the other ends are both connected to a ring, *a*. Collecting-brushes, *b' c'* bear on the rings *b c*, respectively, and conductors L L convey the currents therefrom through the coils E and E' of the generator. L' is a common return-wire to brush *a'*. Two independent circuits are thus formed, one including coils C of the exciter and E E of the generator, the other coils C' of the exciter and E' E' of the generator. It results from this that the operation of the exciter produces a progressive movement of the magnetic poles of the annular field-core of the generator, the shifting or rotary movement of said poles being synchronous with the rotation of the exciter-armature. Considering the operative conditions of a system thus established, it will be found that when the exciter is driven so as to energize the field of the generator the armature of the latter, if left free to turn, would rotate at a speed practically the same as that of the exciter. If under such conditions the coils F F', of the generator-armature be closed upon themselves or short-circuited, no currents, at least theoretically, will be generated in the said armature-coils. In practice I have observed the presence of slight currents, the existence of which is attributable to more or less pronounced fluctuations in the intensity of the magnetic poles of the generator-ring. So, if the armature-coils F F' be closed through the motor, the latter will not be turned as long as the movement of the generator-armature is synchronous with that of the exciter or of the magnetic poles of its field. If, on the contrary, the speed of the generator-armature be in any way checked, so that the shifting or rotation of the poles of the field becomes relatively more rapid, currents will be induced in the armature-coils. This obviously follows from the passing of the lines of force across the armature-conductors. The greater the speed of rotation of the magnetic poles relatively to that of the armature the more rapidly the currents developed in the coils of the latter will follow one another, and the more rapidly the motor will revolve in response thereto, and this continues until the armature-generator is stopped entirely, as by a brake, when the motor, if properly constructed, runs at the same speed with which the magnetic poles of the generator rotate.

The effective strength of the currents developed in the armature-coils of the generator is dependent upon the strength of the currents energizing the generator and upon the number of rotations per unit of time of the magnetic poles of the generator; hence the speed of the motor-armature will depend in all cases upon the relative speeds of the armature of the generator and of its magnetic poles. For example, if the poles are turned two thousand times per unit of time and the armature is turned eight hundred, the motor will turn twelve hundred times, or nearly so. Very slight differences of speed may be indicated by a delicately-balanced motor.

Let it now be assumed that power is applied to the generator-armature to turn it in a direction opposite to that in which its magnetic poles rotate. In such case the result would be similar to that produced by a generator the armature and field-magnets of which are rotated in opposite directions, and by reason of these conditions the motor-armature will turn at a rate of speed equal to the sum of the speeds of the armature and magnetic poles of the generator, so that a comparatively low speed of the generator-armature will produce a high speed in the motor.

It will be observed in connection with this system that on diminishing the resistance of the external circuit of the generator-armature by checking the speed of the motor or by adding translating devices in multiple arc in the secondary circuit or circuits of the transformer the strength of the current in the armature-circuit is greatly increased. This is due to two causes: first, to the great differences in the speeds of the motor and generator, and, secondly, to the fact that the apparatus follows the analogy of a transformer, for, in proportion as the resistance of the armature or secondary circuits is reduced, the strength of the currents in the field or primary circuits of the generator is increased and the currents in the armature augmented correspondingly. For similar reasons the currents in the armature-coils of the generator increase very rapidly when the speed of the armature is reduced when running in the same direction as the magnetic poles or conversely.

It will be understood from the above description that the generator-armature may be run in the direction of the shifting of the magnetic poles, but more rapidly, and that in such case the speed of the motor will be equal to the difference between the two rates.

In many applications to electrical conversion and distribution this system possesses great advantages both in economy, efficiency, and practicability.

What I claim is—

1. The combination, with an alternating-current generator having independent energizing or field and independent induced or armature coils, of an alternating-current exciter having generating or induced coils corresponding to and connected with the energizing-coils of the generator, as set forth.

2. In an alternating-current generator, the combination of the elements named and cooperatively associated in the following manner: a field-magnet wound with independent coils each connected with a source of alternating currents, whereby the magnetic poles produced by said coils will be progressively shifted or moved through the field, and an armature-core wound with independent coils, each

having terminals from which currents are delivered to the independent external circuits.

3. The system of electrical distribution consisting of the combination, with an alternating-current generator having independent energizing-coils and an armature wound with independent induced coils, of an alternating-current exciter having induced coils corresponding to and connected with the energizing-coils of the generator, and one or more electrical converters having independent inducing or energizing coils connected with the corresponding armature coils of the generator, as herein set forth.

4. The combination, with an alternating-current generator having a field-magnet wound with independent energizing-coils and an armature adapted to be rotated within the field produced by said magnet, of an exciter having induced or generating coils corresponding to and connected with the energizing-coils of the generator, as set forth.

NIKOLA TESLA.

Witnesses:

ROBT. F. GAYLORD,

PARKER W. PAGE.