While the brilliant dual-toroid technique of Thane Heins is very effective, it is not the only way of achieving spectacular performance from a transformer as can be seen here:

The High-power Motionless Generator of Clemente Figuera

Clemente Figuera of the Canary Islands died in 1908. He was a highly respected individual, an Engineer and University Professor. He was awarded several patents and was known to Nikola Tesla. The following information comes from a man who wishes to remain anonymous. On 30th October 2012, he made the following comments about his repair to a Figuera patent which was missing some of the content. He says:

RE-INVENTING THE WHEEL:
CLEMENTE FIGUERA AND HIS INFINITE ENERGY MACHINE

A year ago, I was working on a concept for an over-unity transformer. There were several designs which I wanted to test. Because it was my belief that the extra energy must come from somewhere, I favoured the use of permanent magnets. I modified an existing transformer and added permanent magnets, and I was disappointed. It did not work as I had expected. I took a second look at the permanent magnet design and was planning to try the experiment again with some modifications. However, more than sixteen months have now elapsed and I still have not had the time to go back to test my theory.

I heard of Clemente Figuera for the first time from one of the Tesla articles. In 1902 the Daily Mail announced that Mr. Figueras (with an "s"), a Forestry Engineer in the Canary Islands, and for many years Professor of Physics at St. Augustine's College, Las Palmas, had invented a generator which required no fuel. The newspaper article says that "He claims to have invented a generator which can collect the electric fluid, to be able to store it and apply it to infinite purposes, for instance, in connection with shops, railways and manufacturers. He will not give the key to his invention, but declares that the only extraordinary point about it is that it has taken so long to discover a simple scientific fact. Señor Figueras has constructed a rough apparatus by which, in spite of it's small size and it's defects, he obtains 550 volts, which he utilises in his own house for lighting purposes and for driving a 20 horse-power motor. Señor Figueras is shortly coming to London, not with models or sketches, but with a working apparatus. His inventions comprise a generator, a motor, and a sort of governor or regulator, and the whole apparatus is so simple that a child could work it." [Taken from "Perpetual Motion – A History of an Obsession"].

I was in one of the forums when someone mentioned Clemente Figuera and provided some links to documents referring to his work [1]. In one of the documents, I found what looks to be the only page showing sketches from one of his patents. After restoring the faint lines which show the wire connections, I was very surprised to see the similarities between the embodiment of Mr. Figuera's drawing and one of my own for over-unity transformers.

I was very eager to read any information about Mr Figuera's work and the operation of his 'Infinite Energy Machine'. It looks very suspicious that the pages describing the most important part of the machine have been 'lost'. I then decided to just figure this machine out for myself. It really did not take me that long since I was able to solve the mystery relatively easily. This paper is my explanation of how the "Infinite Energy Machine" of Mr. Figuera, works:

Before I go into the details of how this machine operates, it is essential to understand the basic operation of existing transformers. I know that many of you may laugh when you hear this, but the majority of engineers and technicians today, do not really understand how transformers work. The reason for this lack of knowledge is because it is not found in either technical or college text books. The reaction of some PhD. Professors, who taught me electromagnetic wave theory in college, was just flat denial. Their attitude is that of a closed mind – a mind which is limited to only whatever is shown in the text books. Whenever I presented this theory to these scholars, none of them had any logical arguments against it. At one time, the Chief Electrical Engineer of the Engineering Department which I work for, stated that the Faraday Induction Law does not apply to transformers. This is the reason why in this paper I expend so much effort in explaining this theory.

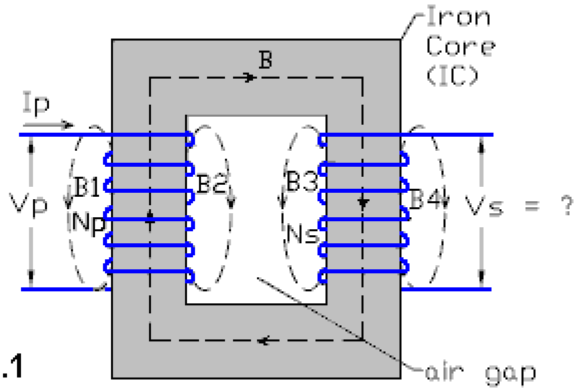


Fig.1

Figure 1 is a typical transformer model shown in all technical publications. This figure shows a primary winding with Np turns and a secondary winding having Ns turns, both of them wound around a common iron core. This model shows most of the magnetic field **B** flowing inside the iron core and the magnetic field losses are indicated by **B1**, **B2**, **B3**, and **B4** which are responsible for the reactance components. These reactance components have great influence in the voltage regulation of the transformers. An alternating voltage source **Vp** is applied to the primary coil generating a primary current equal to **Ip**. Can you tell me what the value of the secondary voltage **Vs** is? Many of you will rush to use the known turns ratio formula but the truth is that for such a transformer model the voltage at the secondary coil is zero (**Vs** = 0).

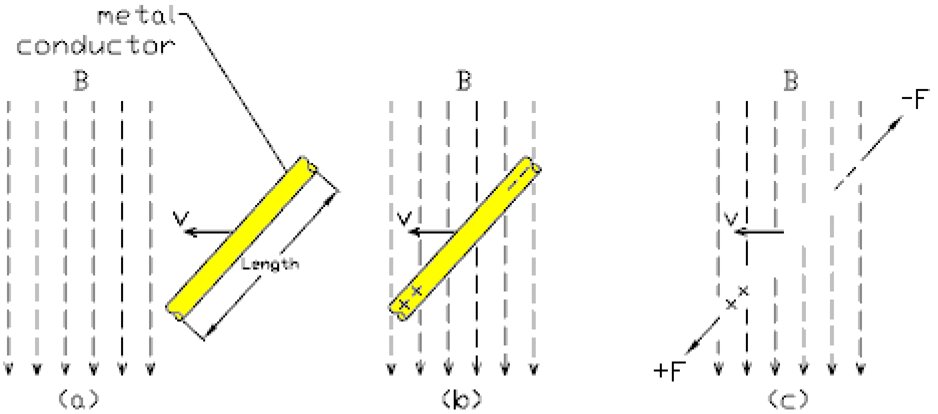


Fig.2

I will provide two reasons why the secondary voltage is null. First, I want to turn your attention to Figure 2 (a), (b), and (c). In physics courses, we were told that if a conductor does not interact with a magnetic field **B** there would be no voltage induced in it - as shown in figure 2a. As soon as the magnetic field **B** flows and cuts the conductor, a voltage is induced as shown in figure 2b. However, the electromagnetic theory tells us that the applied magnetic field **B** and the electric field **E** of the free charges do not interact with each other. Then, how is a voltage induced in the conductor?

The theory also says that when electric charges move, a magnetic field is created around those charges. Therefore when a conductor moves in a magnetic field **B**, the free charges of the metal conductor create a magnetic field on their own, which field, in turn interacts with the applied magnetic field **B**. The forces exerted on the electric charges are perpendicular to the plane formed by the magnetic field **B** and the speed **v** of the moving conductor. Mathematically, this law can be written in vector form as **F** = q(**v** x **B**). Note that for the positive charges, this formula follows Fleming's right-hand rule and for the negative charges it follows Fleming's left-hand rule. In other words, the free positive charges in the conductor will receive a force in one direction while the free negative charges will receive a force in the opposite direction as shown in figure 2c.

This effect moves the free positive and negative charges apart from each other resulting in an induced voltage in the conductor as shown in figure 2b. And in addition, the electromagnetic theory states that the magnetic flux lines are always closed loops. The magnetic lines do not have a beginning or end as is the case for the electric field. Therefore, it is not possible for a magnetic line to start in the primary coil, flow around within the iron core, and back again to the primary as suggested in figure 1. Instead, a magnetic loop will start in a turn of the primary coil and will grow in a fashion similar to stretching a rubber band. This will be explained in more detail later in this paper.

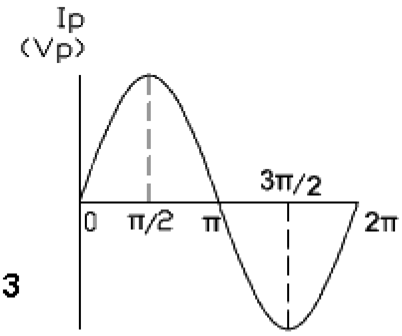


Fig.3

Figure 3 shows a typical sinusoidal waveform of the voltage source Vp applied to the primary coil and the current Ip flowing through the primary coil. When the voltage Vp is applied to the air core coil shown in figure 4, the magnetic flux will be evenly distributed along the space surrounding the coil.

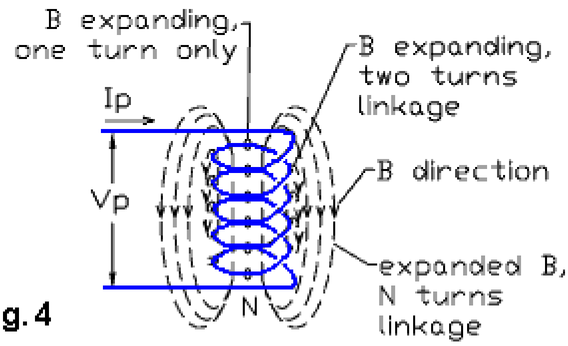


Fig.4

The magnetic field B is weak and so is the self-inductance. The self-induction is the induced voltage in each turn due to the magnetic interaction with it's neighbours. The magnetic field originating from a turn will cut through the other turns of the same coil inducing a voltage with a polarity which is opposite to the applied voltage Vp. This action is also known as "reactance". The direction of the magnetic field will depend upon the polarity of the voltage Vp. If, for the positive half of the cycle, the magnetic field **B** points downwards, then, it will point upwards for the negative half of the cycle. The direction of the magnetic field **B** can be determined by Fleming's right-hand rule.

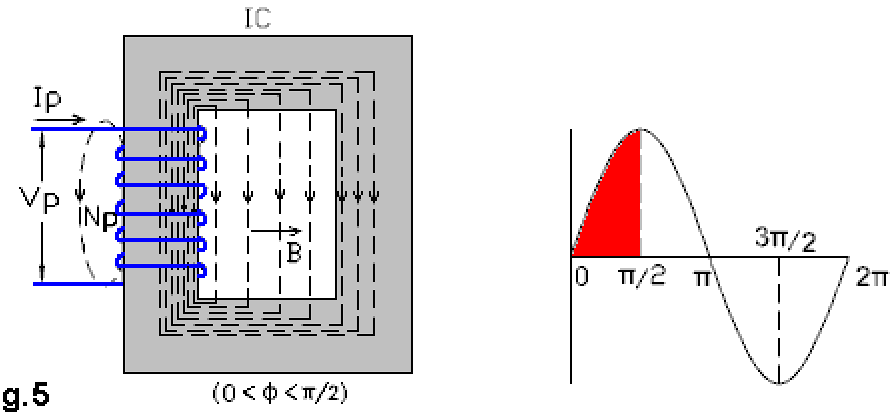


Fig.5

Figure 5 illustrates what happens to the magnetic field **B** of the coil when an iron core is added. Because the iron core has a much lower reluctance than air, the majority of the magnetic field **B** will move into the iron core. The reluctance is the unit that measures how much a given material opposes the flow of magnetic flux Ø. Reluctance is to the magnetic flux, what resistance is to electric current. If two paths present different reluctances, a higher magnetic field will flow through the material which has the lower reluctance. The function of the iron core **'IC'** is to act as a magnetic guide, concentrating the magnetic flux into a smaller space and increasing the magnitude of the magnetic field **B** very considerably. It is very important to note that the magnetic field **B** moves across the air gap formed by the window of the iron core.

When the voltage Vp is applied to a coil, the following dynamics occur:

1) When the voltage waveform angle theta is zero ($\theta = 0$), then the magnitude of both the primary current **Ip** and the magnetic field **B** are both zero.

2) As the angle θ moves from 0 to π/2 (Pi is 180 degrees) the magnitude of the primary current **Ip** and the magnetic field **B** both increase. In addition, the magnetic field **B** moves to the right across the air gap. The direction of the magnetic field **B** is determined by Fleming's right-hand rule, and so, the North Pole is located at the bottom of the primary coil as shown in figure 5 above.

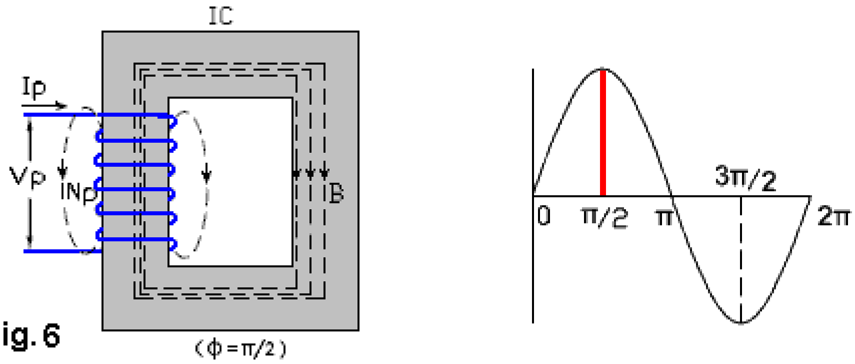


Fig. 6

3) When the waveform angle θ reaches π/2 (90 degrees), the magnitude of the primary current **Ip** and the magnetic field **B** are at their maximum values. The majority of the magnetic field **B** has moved into the right-hand column of the iron core **IC** as shown in figure 6.

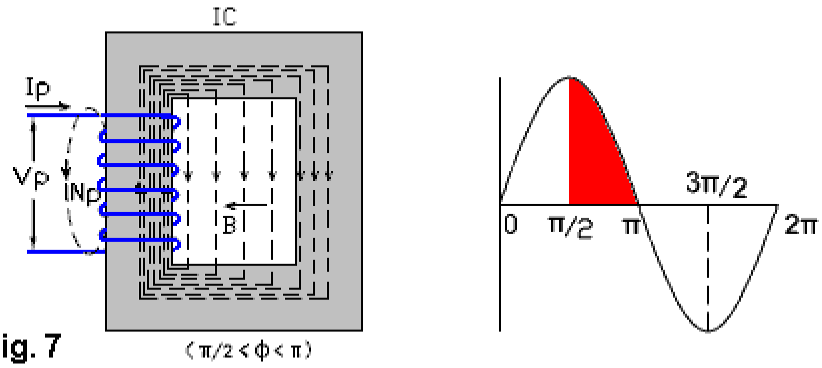
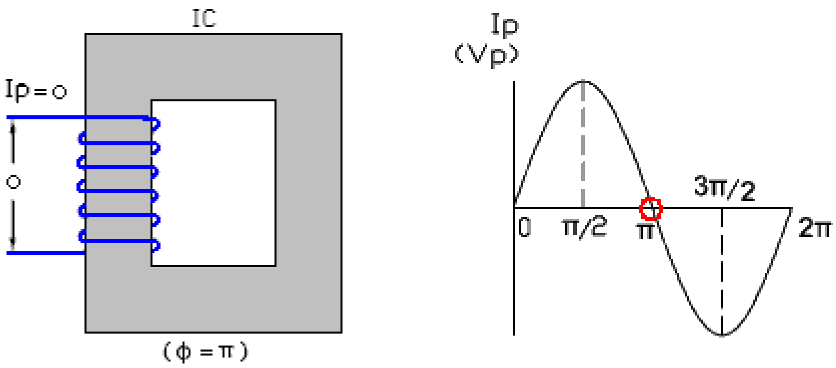


Fig. 7

4) As the waveform angle θ moves from π/2 to π (90 degrees to 180 degrees), the magnitude of both the primary current **Ip** and magnetic field **B** is decreasing, and in addition, the magnetic field **B** also moves progressively to the left across the air gap as shown in figure 7.



5) When the angle θ is equal to π (180 degrees), the magnitude of the primary current **Ip** and the magnetic field **B** are both zero.

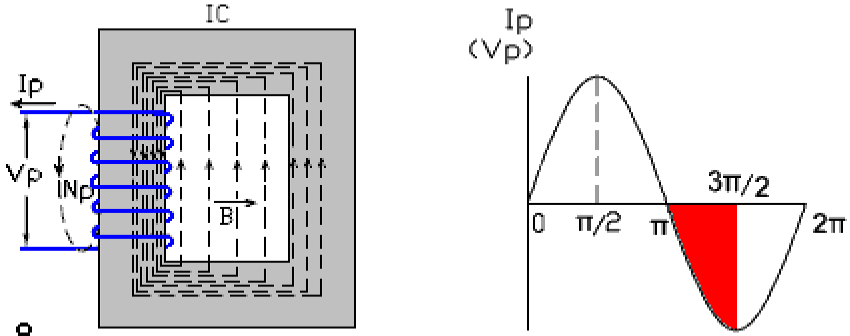


Fig. 8 (π < ϕ < 3π/2)

6) As the waveform angle θ moves from π to 3 π/2 (180 degrees to 270 degrees) the magnitudes of both the primary current **Ip** and the magnetic field **B** are increasing. In addition, the magnetic field **B** moves to the right across the air gap. The direction of the magnetic field **B** is determined by Fleming's right-hand rule; the north Pole is now located at the bottom of the primary coil. Refer to figure 8.

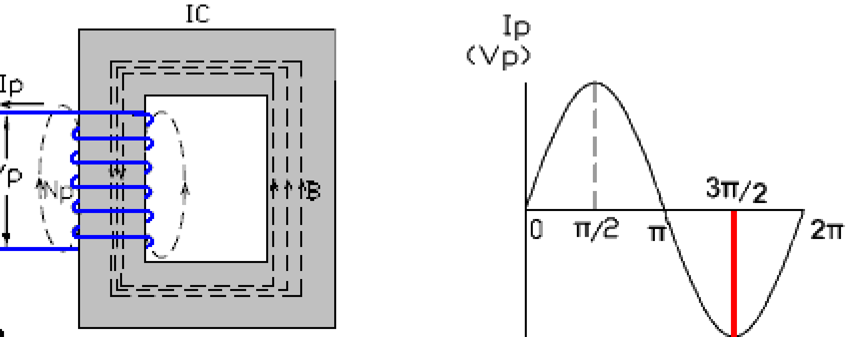


Fig. 9 (ϕ = 3π/2)

7) At θ = 3π/2 (270 degrees) the magnitude of the primary current **Ip** and magnetic field **B** have reached their maximum values. The majority of the magnetic field **B** has moved into the right-hand column of the iron core as shown in figure 9

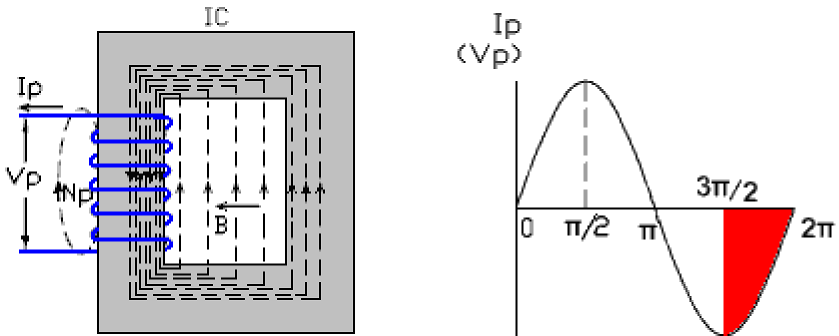


Fig.10 (3π/2 < ϕ < 2π)

8) As the waveform angle θ moves from 3π/2 to 2π (270 degrees to 360 degrees) the magnitudes of both the primary current **Ip** and the magnetic field **B** are decreasing. In addition, the magnetic field **B** also moves to the left across the air gap as shown in figure 10.

9) At θ = 2π the magnitude of the primary current **Ip** and magnetic field **B** are both zero again.

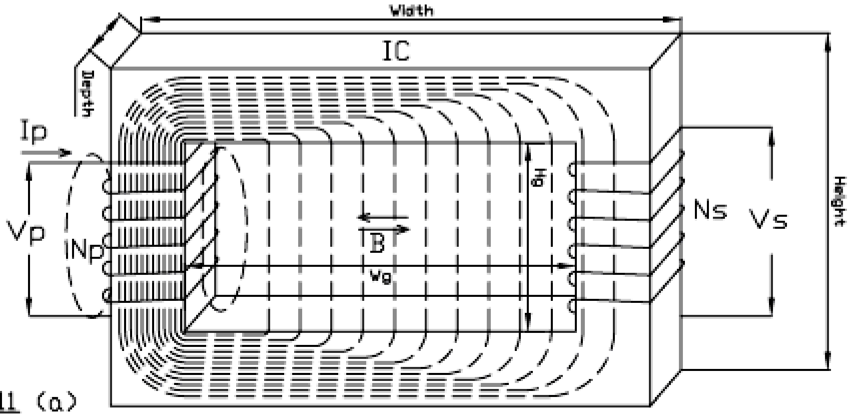


FIG. 11 (a)

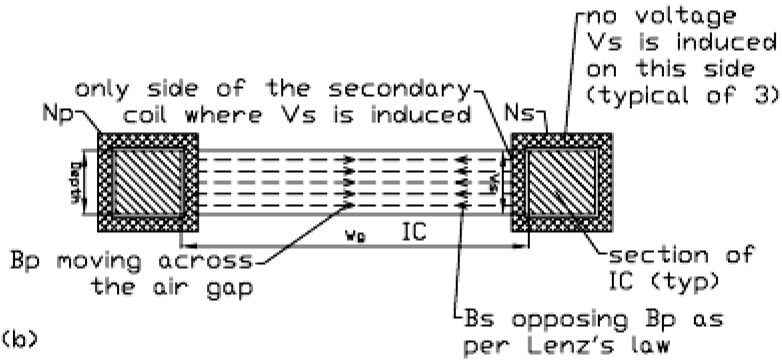


FIG. 11 (b)

Now, let us add a secondary coil to the iron core as shown in figures 11 and 12. The dimension of the air gap is Wg (width) x D (depth) x Hg (height). Np and Ns represent the number of turns in the primary and secondary coils, respectively. As shown in figure 11b, the primary and secondary magnetic fields **Bp** and **Bs** are confined within the same air gap space and iron core IC. In addition, the voltage Vs is induced only in a section of the secondary coil that is inside the air gap. The sections of the secondary turns located outside of the air gap do not interact with the primary magnetic field **Bp**, and therefore, no voltage is induced. In other words, only a quarter of each turn of the secondary coil interacts with the primary magnetic field **Bp** and so contributes their induced voltages. Figure 11b also shows the induced magnetic field **Bs** counteracting the primary magnetic field **Bp** within the same magnetic path. The interaction of the magnetic field in the air gap is not as well defined as shown in figure 11b. The repulsion of the magnetic fields **Bp** and **Bs** creates scattering effects outside the air gap space. The magnetic flux lines bend outwards leaving the air gap which is the space inside the core window.

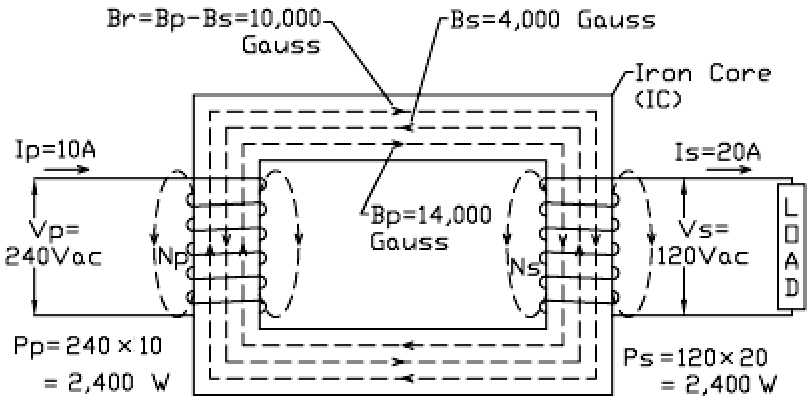


FIG. 12

Figure 12 shows what happens in a transformer when a load is connected to the secondary coil. The primary current **Ip** creates a magnetic field **Bp** which will cycle continuously through the iron core and air gap as explained in the steps 1 to 9 above. For argument sake, let us assume that Vp = 240Vac 60Hz, Ip = 0.25A, and that the magnitude of the generated magnetic field Bp = 10,000 Gauss. Let us also assume that the voltage induced in the secondary coil is Vs = 120Vac. The voltage induced in the secondary coil can be estimated from the Faraday's induction law, *Vs:*

$$Vs = -Ns\left(\frac{dBp}{dt}\right).\,\mathrm{As}$$

As seen from this formula, the voltage induced in the secondary coil is a function of the number of the secondary turns Ns and the rate of change of the magnetic field **Bp** cutting the secondary coil. The magnetic field interacting with the secondary coil is also known as the ‘magnetic linkage’. The negative sign is introduced in the formula to account for the effects of Lenz’s law and is of great significance because it is the element which makes all conventional symmetrical transformers inefficient. Simply stated, Lenz’s law says that the polarity of the induced voltage **Vs** induced in the secondary coil will generate a current **Is** which produces a magnetic field **Bs** which opposes the magnetic field **Bp** that created the current **Is** in the first place. Fleming’s right-hand rule can be used to determine the polarity of the secondary induced voltage **Vs**.

Assume that a current **Is** of 20 Amps flows in the secondary coil when a load is connected to it, and that this current generates a magnetic field **Bs** of 4,000 Gauss. For the sake of simplicity, disregard the Eddy and Joule losses, that is, assume for argument’s sake, that the transformer does not heat up. In accordance with Lenz’s law and as shown in figure 12, the polarity of the induced magnetic field **Bs** must oppose the magnetic field **Bp** which creates it. The magnitude of the resulting magnetic field **Br** is given by **Br** = **Bp** – **Bs** which is 10,000 – 4,000 = 6,000 Gauss. Because of this, there is now a lower magnetic field whose lines cut the turns of the primary coil. Therefore, the self-inductance of the primary coil decreases, which in turn decreases the (self-induced) voltage which opposes the applied voltage source **Vp**. A lower self-induced voltage is equivalent to lower impedance as seen by the voltage source **Vp**. The result is an increase in the primary current **Ip** until the resultant magnetic field **Br** is again 10,000 Gauss. That is, the primary current **Ip** needs to produce a magnetic field **Bp** = 14,000 Gauss such that the magnetic field **Br** = 14,000 - 4,000 which is 10,000 Gauss. Assume that the new **Bp** is obtained by increasing the primary current **Ip** from 0.25 to 10A.

This process is also known as transformer auto-regulation or self-regulation, since the only variable in the Faraday’s formula is the magnitude of the changing magnetic field. If the magnetic field **Br** starts to change, then, the induced secondary voltage would no longer be a constant value of 120Vac. ***For the secondary voltage Vs to stay at a constant value of 120Vac the magnetic field Br must be 10,000 Gauss. It does not matter if the 10,000 Gauss field is being generated by 3, 10, or 40A.*** The input and output powers are estimated as **Pp** = 240 x 10 which is 2,400W (the input power) and **Ps** = 120 x 20 which is 2,400W (the output power). Notice that the primary magnetic field **Bp** and the secondary magnetic field **Bs** are operating within the same magnetic path or iron core. The following question is in order - is it possible to reroute some of the induced magnetic field **Bs** so as to not affect the primary magnetic field **Bp**? In other words, is it possible to minimise the effects of Lenz’s law?

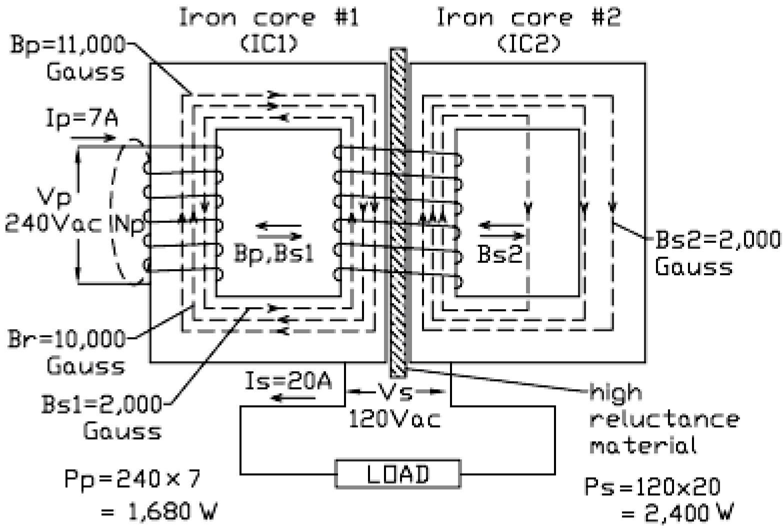


FIG. 13

The first approach that came to my mind is shown in figure 13. The secondary coil is also wound around a second iron core IC2 separated from the first iron core IC1 by a non-magnetic material (high reluctance) NMM. The goal is to divert part of the secondary magnetic field **Bs** through the second core IC2 while preventing the primary magnetic field **Bp** from flowing into the second iron core IC2. The effect of the secondary magnetic field **Bs** is to increase the reluctance of the first iron core IC1. If the value of the reluctance of IC1 is comparable to the reluctance of the non-magnetic sheet NMM, then, the primary magnetic field **Bp** can easily move into the second iron core IC2. Assume that the reluctance of the NMM is high enough to keep most of the primary magnetic field within the iron core 1 (IC1). When the secondary magnetic field **Bs** starts flowing, part of the induced magnetic field **Bs** can flow in the iron core IC2 because it represents a lower reluctance path.

The following is a qualitative analysis performed for the purpose of giving an idea of how the variables changes relative to each other. The values of the variables are not the result of measurements but they are based on an educated guess. This is a very simple method for explaining how the machine works. Assume that the induced magnetic field **Bs** = 4,000 Gauss is split into **Bs1** = 1,000 Gauss and **Bs2** = 3,000 Gauss, where **Bs1** and **Bs2** are the magnetic fields flowing within the iron cores IC1 and IC2, respectively. As shown in figure 13, the opposition to the primary magnetic field **Bp** is just 1,000 Gauss. Under these conditions and in order to keep the resultant magnetic field **Br** at a constant value of 10,000 Gauss, the primary magnetic field **Bp** will increase to 11,000 Gauss, only. Also, assume that the primary current **Ip** required to generate the new primary magnetic field is 7A. Notice that the transformer is now powering the same load as before, but only needing a lower primary current. The power flow for the transformer shown in figure 13 is estimated as: Ps = 120Vac x 20A = 2,400 W (the same output power) Pp = 240Vac x 7A = 1,680 W (a lower input power) The efficiency = Pp/Ps = 2,400/1,680 = 1.43, that is, the output power is 43% higher than the input. So, at least in theory, it is possible to have higher output power from a transformer if the effects from the Lenz's law are reduced.

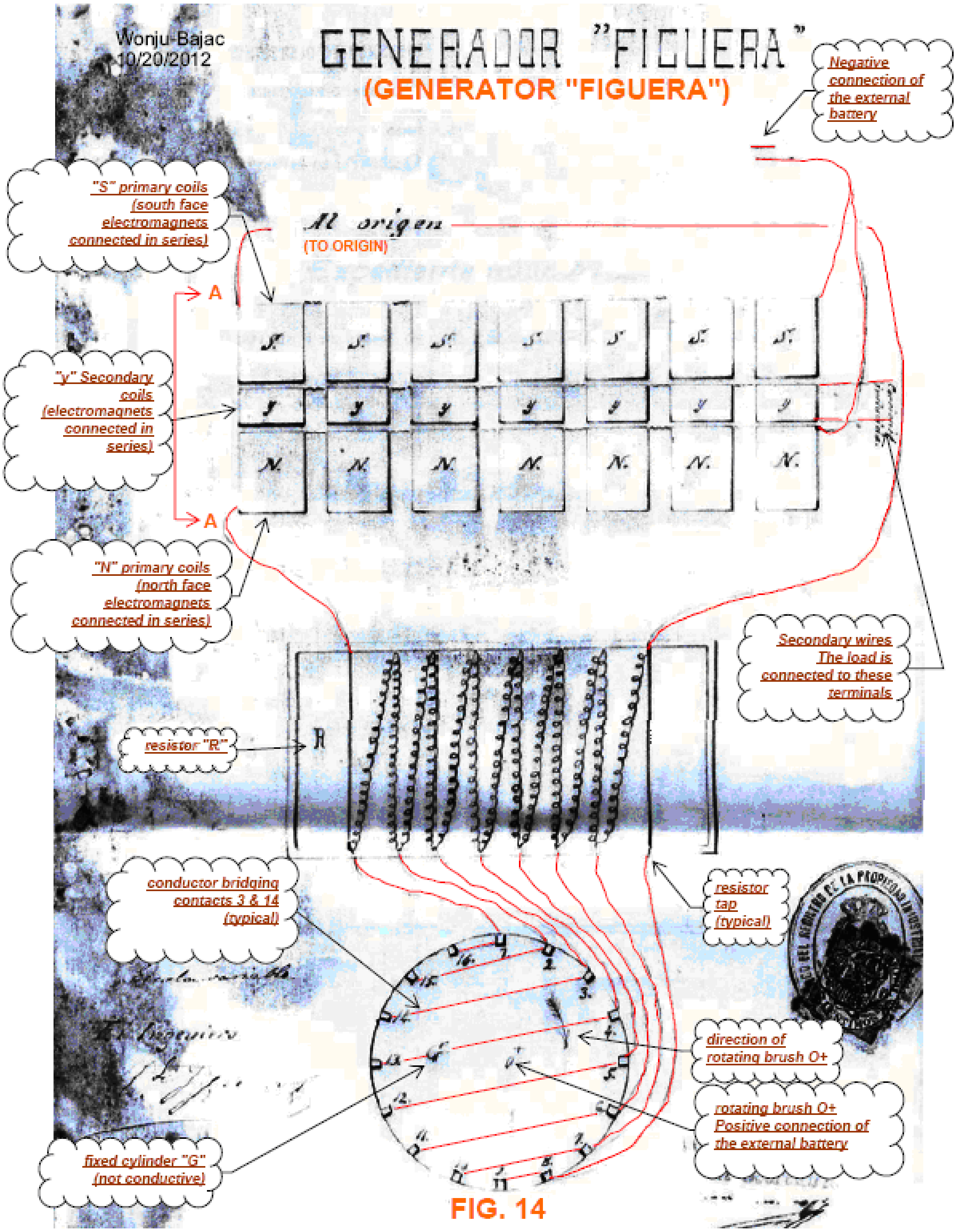


FIG. 14

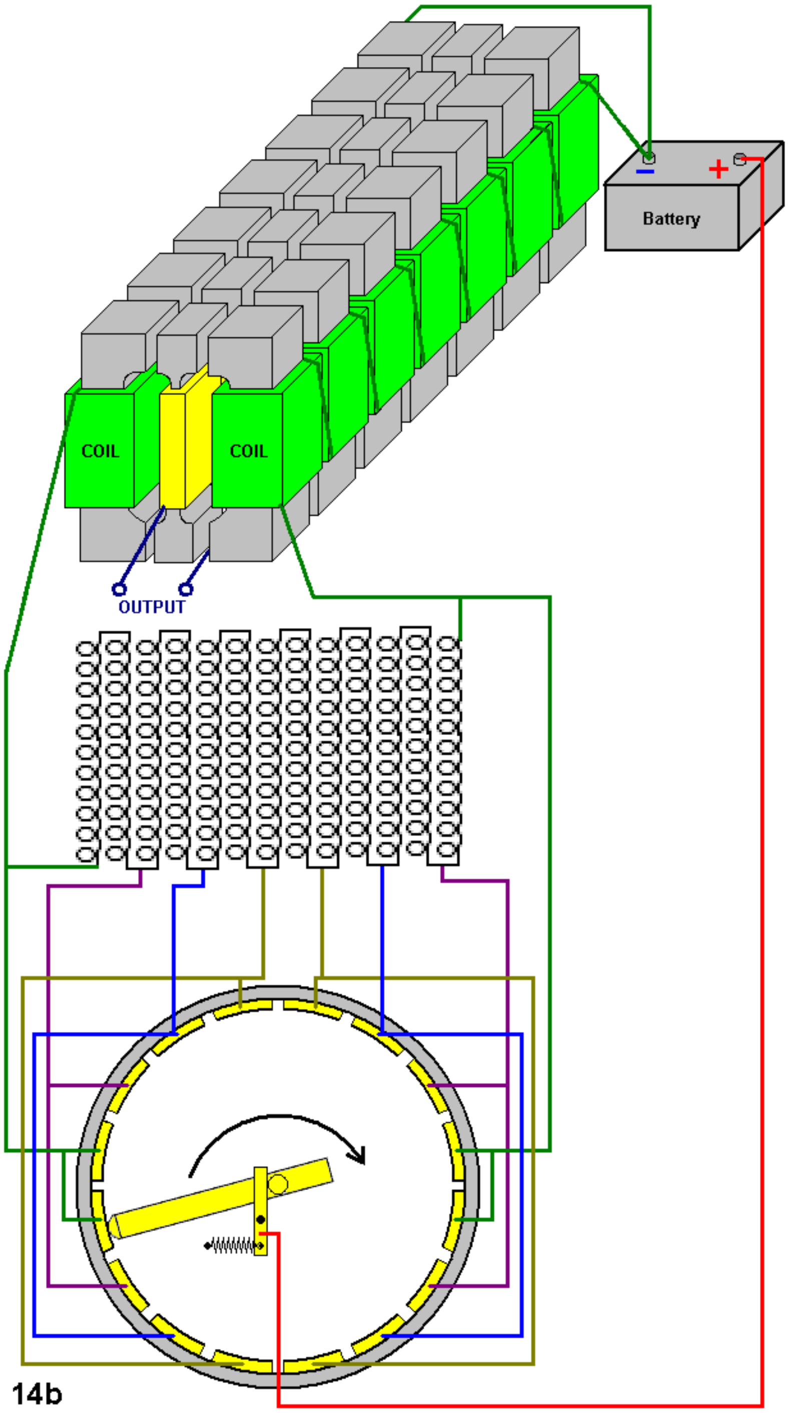


Fig. 14b

Please note that the rotating contact brush needs to be a “Make Before Break” type. That is, it needs to bridge across the gap between adjacent stator contact strips so that there is no sparking due to the current flow being interrupted.

Two weeks ago - when I first look at Mr. Figuera’s generator shown in figure 14 – I was amazed to see that someone had not only worked out the “impossible event” but had also been awarded patents for it. According to Mr. Figuera, an over-unity transformer can be built without using permanent magnets, and based on a very simple concept. Figuera’s generator consists of three rows of electromagnets, where each row is connected in series. The rows of “S” and “N” electromagnets function as the primary of the transformer, while the row of “y” electromagnets, located in the centre, functions as the secondary. The “S” and “N” stand for South and North poles, respectively. The apparatus includes a resistor “R” having multiple taps connected to a type of distributor formed by a cylinder “G” and brush “O”. The brush “O” rotates inside the cylinder “G” changing the connection to the resistor taps. When the brush “O” rotates around the eight taps, it generates two stepped half-cycle sine waves which are 90° out of phase with each other. I suggest that figure 15 is the wiring diagram as originally disclosed by Mr. Figuera in his patents. The most significant component of the system is the arrangement of the electromagnets shown in section A-A of figure 14. Keep in mind that each electromagnet shown in figure 15 corresponds to a row of seven electromagnets connected in series as shown in figure 14. In addition, I recommend that when building this apparatus, at least for the first implementation, that you try to replicate all of the details of the machine shown in the patent. For example, figure 14 shows the top area of the “S” and “N” electromagnets being approximately equal to twice the top area of the “y” electromagnets.

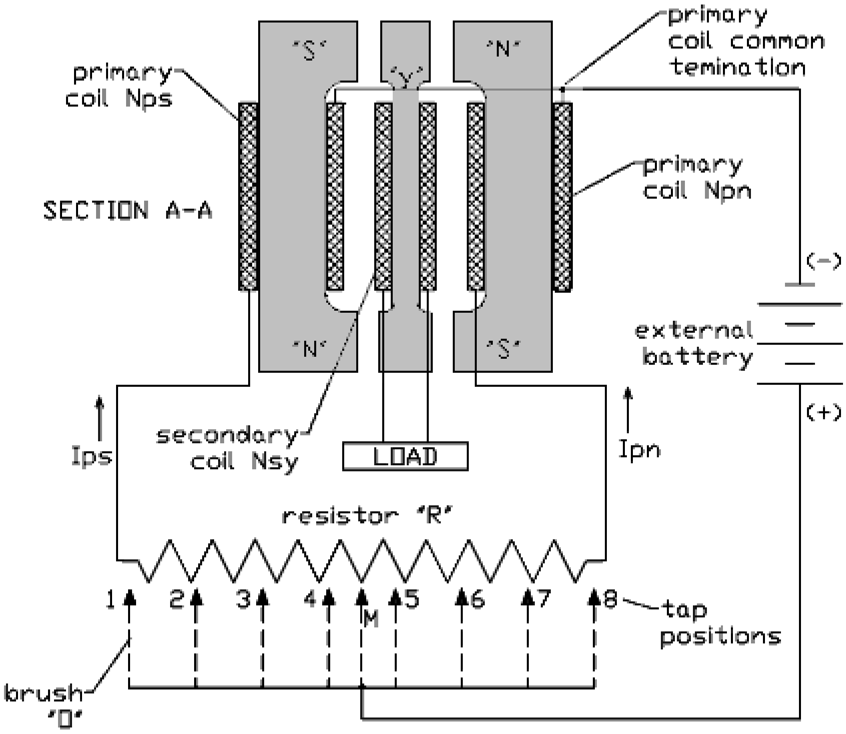


FIG. 15

SIDE VIEW

Even though Mr. Figuera used stepped sinusoidal currents **Ips** and **Ipn**, I consider the resistor shown in figure 15, to be a linear variable resistor having infinite ‘taps’ and the voltage and current generated to be pure half-cycle sine waves which are 90° out of phase. The coils of the “S” and “N” electromagnets are connected together and attached to the negative terminal of the battery. The other ends of both electromagnets are connected to both ends of the resistor “R”. The sliding contact “O” is connected to the positive terminal of the battery and is rotated continuously making electrical connections repeatedly from left to right and then back from right to left across the multi-tap resistor “R”. The position of the sliding contact “O”, determines the magnitude of the DC currents **Ips** and **Ipn** passing through the primary coils “S” and “N”. For instance, when the brush is in position 1, the “S” coils receive the full voltage of the battery, producing the maximum current **Ips** and maximum magnetic field **Bps**, while at the same time, the current **Ipn** and magnetic field **Bpn** of the “N” coils are at their minimum values because they are now connected to the battery through the maximum value of the resistor “R”. Figure 21 shows the voltage, current, and magnetic field waveforms flowing through these coils. The voltage induced in the secondary coils “y” is a sinusoidal alternating voltage. The secondary voltage should be zero when the magnitudes of the currents Ips and Ipn are equal. At this point, the magnetic fields **Bps** and **Bpn** induce two voltages of the same magnitude and opposite polarity.

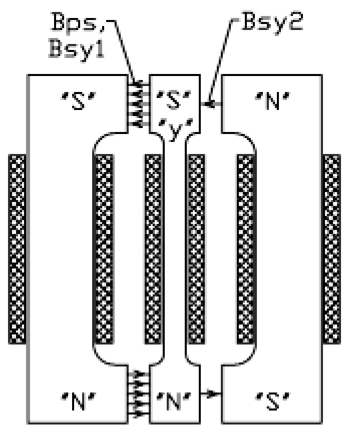


FIG. 16

POSITION 1

The magnetic interaction of the “S”, “N”, and “y” electromagnets is shown in figures 16 to 20. Figure 16 illustrates the situation when the brush “O” is at position 1. Here, the current **Ips** and magnetic field **Bps** are at their maximum, while the current **Ipn** and magnetic field **Bpn** are at their minimum values. When the secondary current **Isy** starts flowing, the “y” coils generate a magnetic field **Bsy** which opposes the magnetic field **Bps** in accordance with Lenz’s law. As a consequence, a South pole is created at the top of the “y” electromagnet and a North pole at the bottom. Because magnets of the same polarity repel and opposite polarities attract, it is likely that some of the induced magnetic field **Bsy2** is diverted through the iron core of the “N” electromagnet, which represents a lower reluctance path. And, if the induced magnetic field **Bsy** can be rerouted so as to avoid opposing the magnetic field **Bps** which generates it, then, it might be possible to have an over-unity transformer.

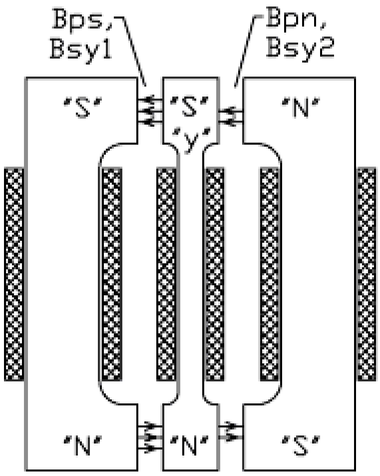


FIG. 17 POSITION 3

Figure 17 illustrates the situation when the sliding contact “O” is at position 3. The primary current **Ips** and the primary magnetic field **Bps** are decreasing in magnitude while the magnitude of the primary current **Ipn** and magnetic field **Bpn** are both increasing. The primary current **Ips** (and **Bps**) is still larger than primary current **Ipn** (and **Bpn**). As shown in the figure, part of the induced magnetic field **Bsy2** is still coupled to the “N” electromagnets.

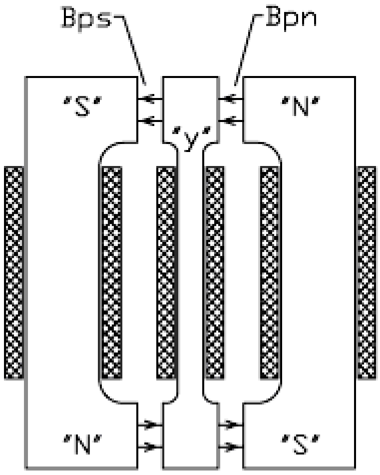


FIG. 18 POSITION M

Figure 18 illustrates the scenario when the brush is at position M. This position is exactly at the centre of the resistor “R” and both currents **Ips** and **Ipn** are of equal magnitudes, and as a result, the magnetic fields **Bps** and **Bpn** are also equal. The net voltage Vsy, current **Isy**, and magnetic field **Bsy** induced in the secondary coils “y” are all zero.

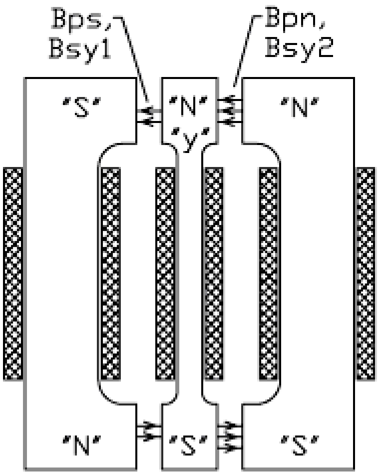


FIG. 19 POSITION 6

Figure 19 shows the situation when sliding contact "O" is at position 6. The primary current **Ips** and the primary magnetic field **Bps** are still decreasing in magnitude while the magnitude of the primary current **Ipn** and the magnetic field **Bpn** are increasing. The primary current **Ips** (and **Bps**) is now of lower magnitude than primary current **Ipn** (and **Bpn**). Because the magnetic field **Bpn** of the "N" electromagnets is stronger than the magnetic field **Bps** of the "S" electromagnets, the polarity of the induced voltage Vsy, current **Isy**, and magnetic field **Bsy** are reversed in accordance with Lenz's law. In this situation, the secondary electromagnets "y" present the north poles at the top and the south poles at the bottom making the "y" and "N" electromagnets to repel and the "y" and "S" to attract. Because of the now higher reluctance of the "N" electromagnets and lower reluctance of the "S" electromagnets, it is expected that part of the induced magnetic field **Bsy** will couple with the "S" electromagnets, and therefore, the effect of Lenz's law is minimised.

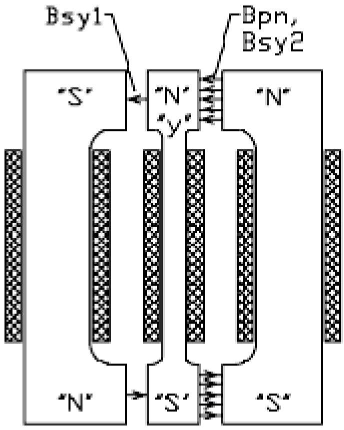


FIG. 20 POSITION 8

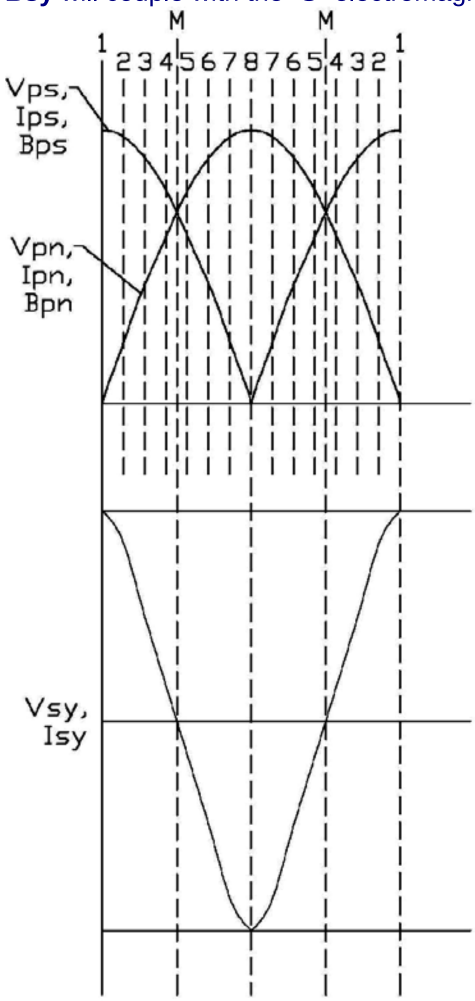


FIG. 21

Figure 20 illustrates the situation when the brush "O" is at position 8. The primary current **Ipn** and the magnetic field **Bpn** are at their maximum values. The induced secondary voltage Vsy, current **Isy**, and magnetic field **Bsy** are also maximum and of opposite polarities to those which they had at position 1. Again, part of the induced secondary magnetic field **Bsy** is attracted by the "S" electromagnet mitigating the effect of Lenz's law.

Figure 21 illustrates the different voltage, current, and magnetic filed waveforms of the primary electromagnets 'S' and 'N'. It also shows the induced voltage Vsy in the secondary electromagnet coils. As indicated in the figure, when the primary magnetic fields are of equal magnitude at position 'M', the induced voltage Vsy is equal to zero. It should also be noted that the waveforms are 90° out of phase for the two primary coils.

In summary, it seems that there are some advantages not only for splitting the primary into two coils but for operating them with quadratic voltages. If both primary voltages and currents are in phase, the primary magnetic fields **Bps** and **Bpn** will also be in phase. Then, it could happen that the attraction between the two primaries is strong enough to couple their magnetic fields resulting in a zero induced secondary voltage. I am guessing that it was what happened to my first and only test of this concept using permanent magnets instead of electromagnets configured for quadratic operation.

References:

[1] http://orbo.es/?p=26
http://www.bibliotecapleyades.net/tesla/esp_tesla_27.htm
http://globedia.com/enigma-clemente-figuera-maquina-energia-infinita

Our thanks are due to the anonymous contributor who produced the above information on the work of Clemente Figuera whom I had never heard of before. There are some practical points which have not been included so far and which need to be mentioned.

While it is definitely possible to construct each of the cores of the electromagnets from a solid block of iron, doing that will certainl allow eddy currents to generate heat in the cores, wasting useful energy in the process. It would be advisable therefore, to use the standard manufacturing method of assembling each core from a number of thin iron pieces, each separated from it's neighbour by a thin layer of insulating material. These components are available from companies which manufacture transformers.

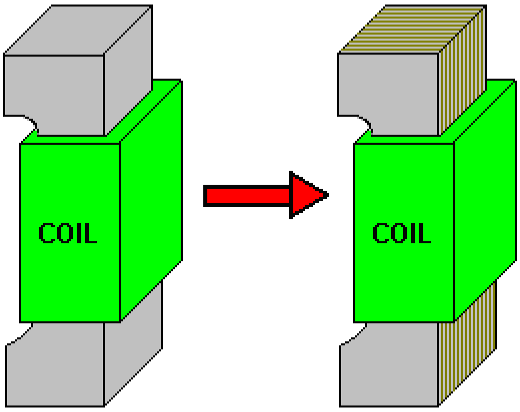


Fig. 22

I have to agree wholeheartedly with the anonymous contributor when he recommends that any attempted replications stay as close to the arrangement shown in the patent drawing, and have seven separate sets of three electromagnets. However, for subsequent experiments, a somewhat easier construction with just one set of electromagnets might be tried, making the electromagents equal in length to the seven separate units:

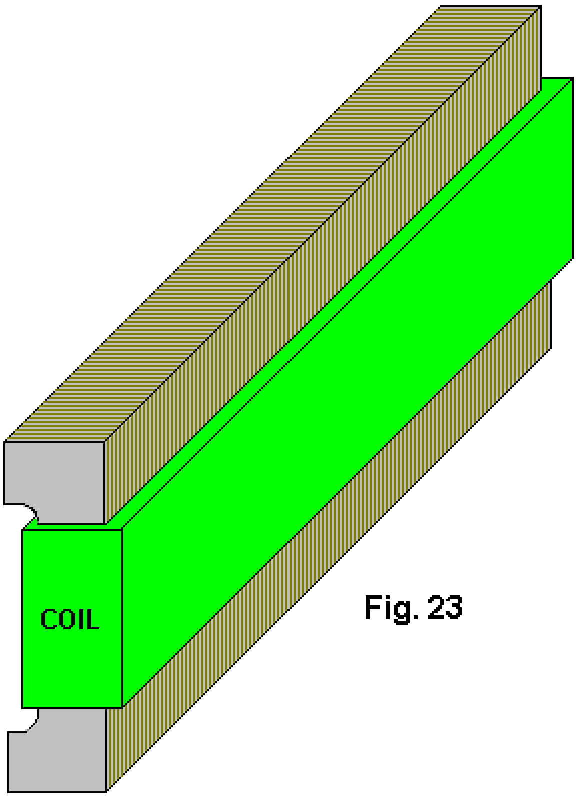


Fig. 23

This arrangement has advantages if the design is taken on into manufacturing as less costruction is needed.

Figure 15 shows two electromagnets connected at the top to the battery Minus and at the bottom to the battery Plus. But, one is marked with a North pole at the top and the other with a South pole at the top, so perhaps some explanation would be helpful. If the coils are connected that way, then one will have to be wound in a clockwise ("CW") direction and the other in a counter-clockwise ("CCW") direction:

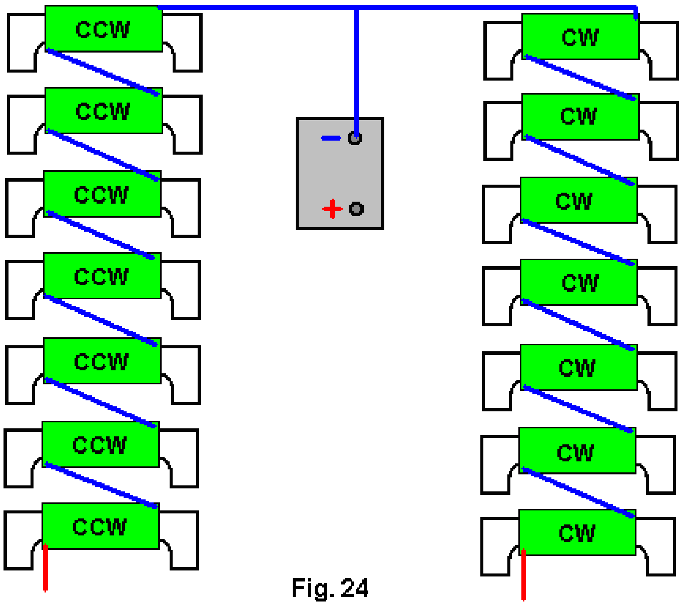


Fig. 24

Or the alternative is to have all of the electromagnets wound in the same way, and adjust the connections:

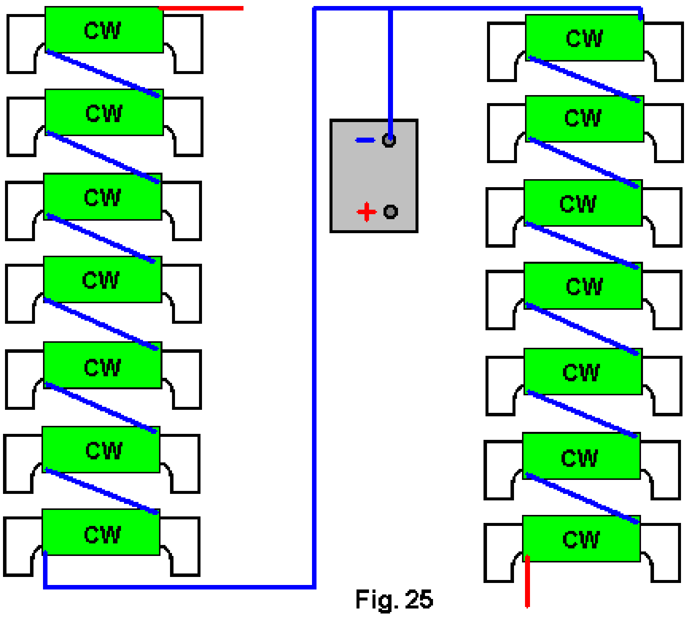


Fig. 25

The Figuera design was implemented more than a hundred years ago, and so Clemente did not have any semiconductors available to him, and so he used a motor-driven commutator arrangement to produce the electrical switching which he needed.

While I am in no way opposed to mechanical switching, especially where prototypes are concerned, there has to be an advantage in using solid-state switching, and while I am by no means an expert in that field, the following suggestions might be useful for experienced circuit builders.

In spite of the wire-wound resistor bank having only eight connection points, the switching has to have sixteen outputs due to the backwards and forwards switching sequence which is used. A solid-state 16-way switching module can be constructed from two CD4017 Divide-by-Ten integrated circuits like this:

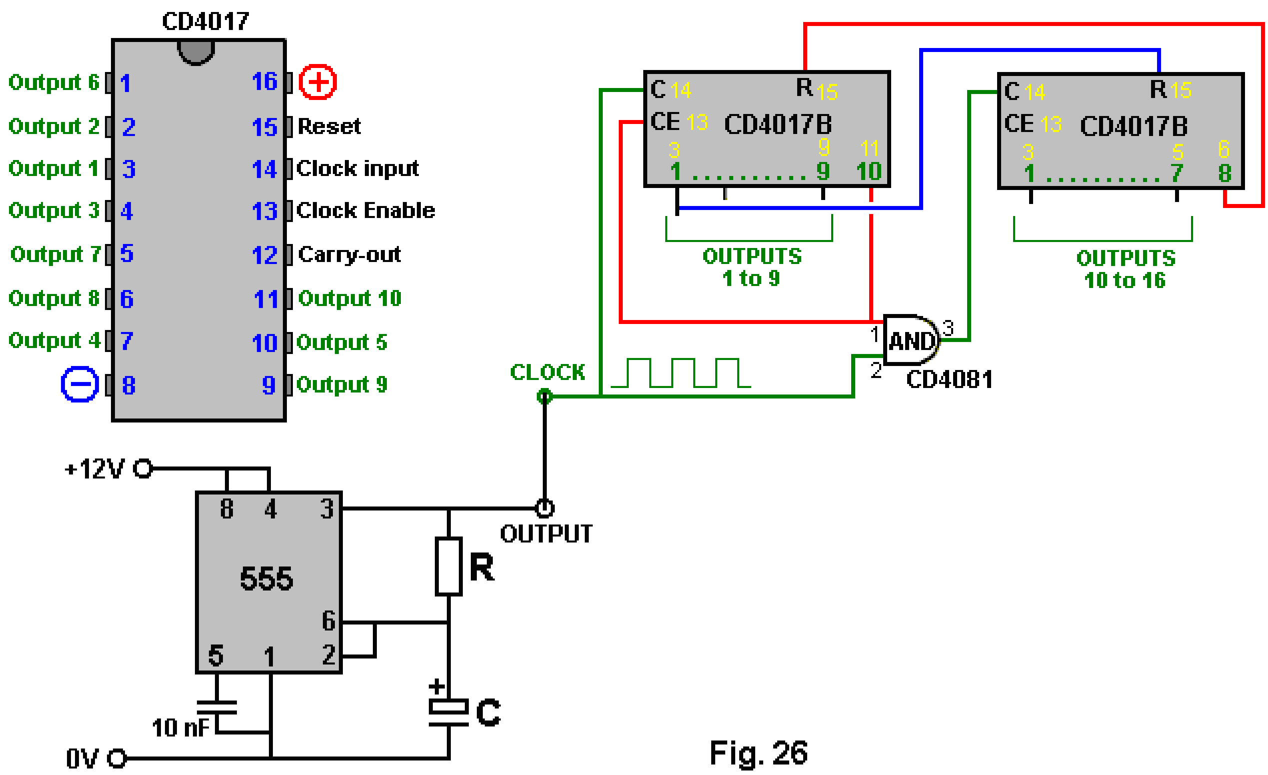


Fig. 26

This arrangement gives sixteen outputs in sequence, so two outputs need to be connected together in order to match the mechanical switching which Clemente used. Presumably, it would not be advisable to connect two outputs together, and so an isolation diode on each output would be required. For 50 Hz or 60 Hz the 'R' and 'C' values for the 555 chip will be about 100K and 100nF. The pin connections would be:

Output Number	Chip and Pin Nos	Paired with Output	Resistor Connection
1	Chip 1 Pin 3	16	1
2	Chip 1 Pin 2	15	2
3	Chip 1 Pin 4	14	3
4	Chip 1 Pin 7	13	4
5	Chip 1 Pin 10	12	5
6	Chip 1 Pin 1	11	6
7	Chip 1 Pin 5	10	7
8	Chip 1 Pin 6	9	8
9	Chip 1 Pin 9		
10	Chip 2 Pin 3		
11	Chip 2 Pin 2		
12	Chip 2 Pin 4		
13	Chip 2 Pin 7		
14	Chip 2 Pin 10		
15	Chip 2 Pin 1		
16	Chip 2 Pin 5		

Eight power transistors can be used to energise each resistor connection point in the sequence required. As mechanical switching was used by Clemente, it really did not matter which way round the battery connections were made. We can match his switching exactly by using PNP power transistors (or possibly, P-channel FETs) which would make the arrangement like this (with just two of the eight connections being shown):

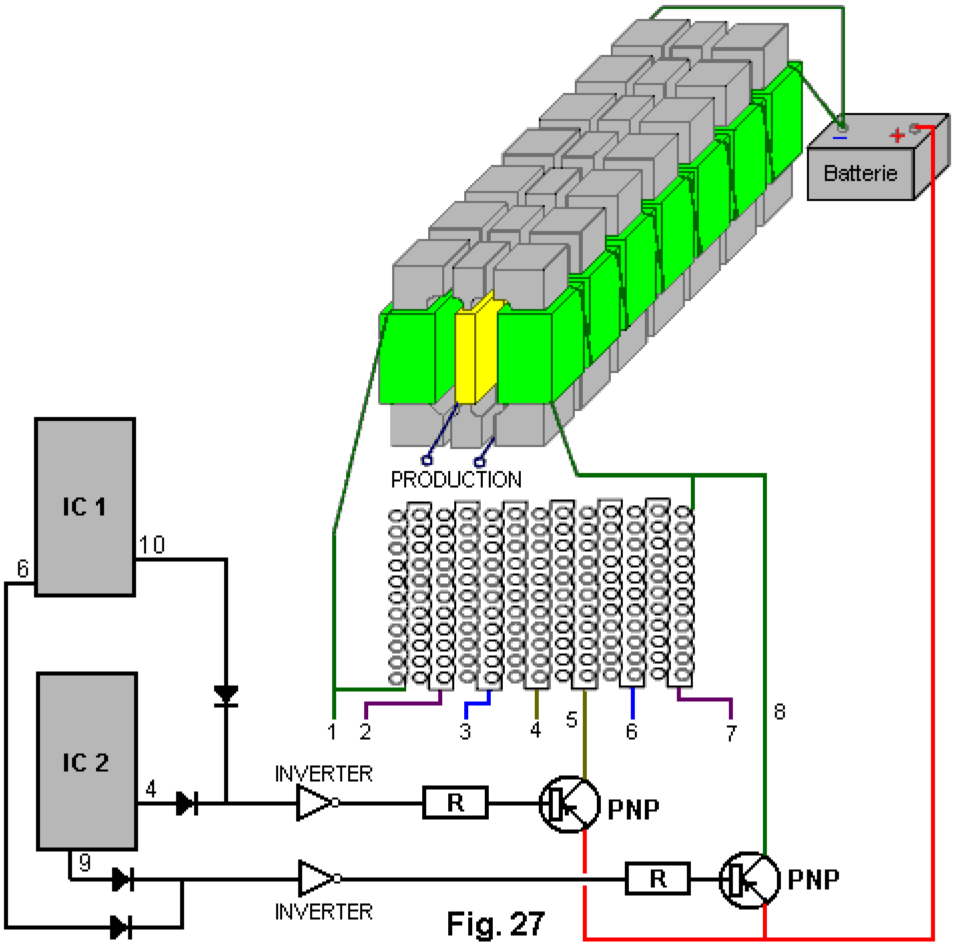


Fig. 27

Or choose the easier NPN option:

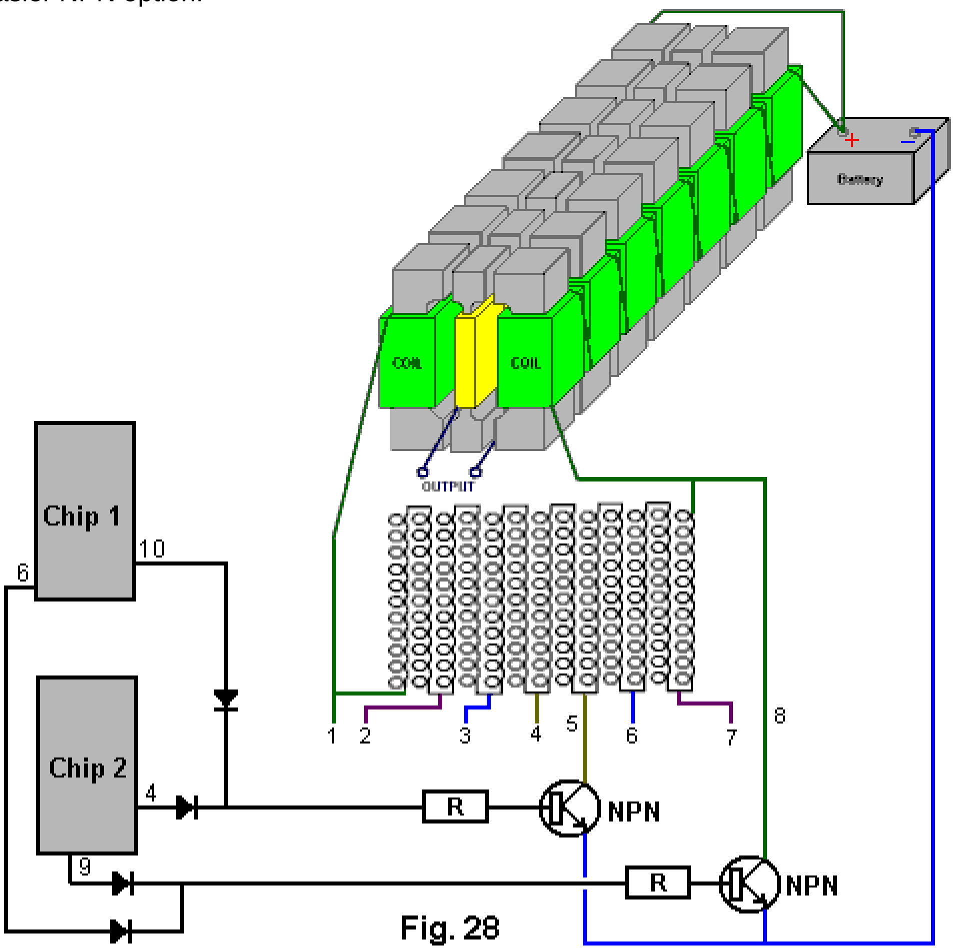
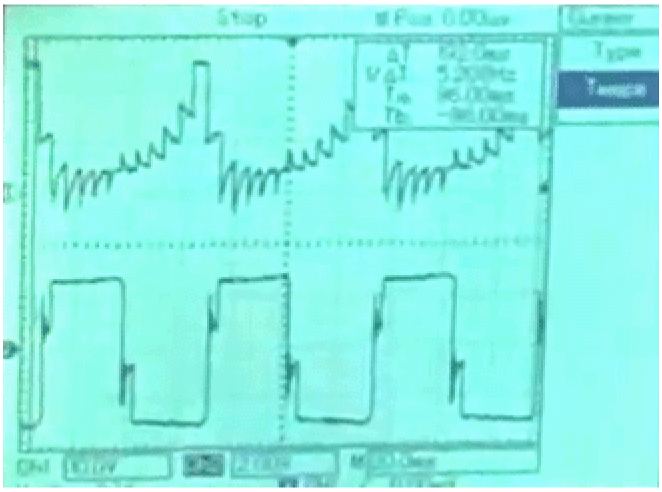
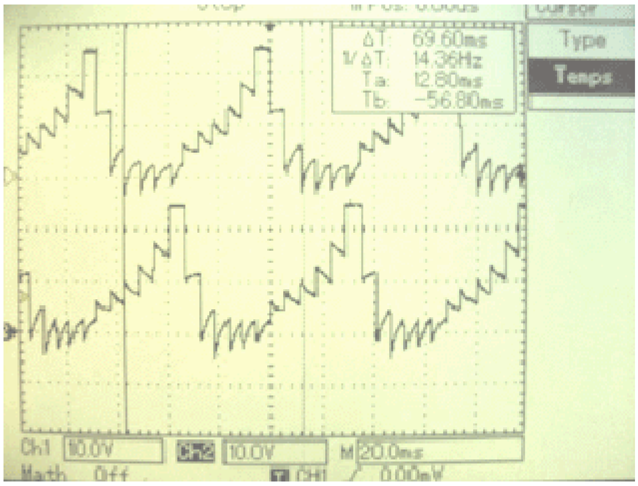


Fig. 28

Experienced experimenter 'Woopy' has posted a video of a quick experiment to test the working principle of this Figuera design. It is at http://www.youtube.com/watch?v=HlOGEnKpO-w&feature=g-u-u and in it, he short-circuits the secondary winding, showing that the input power is totally unaffected by the current draw from the secondary.
He shows some very interesting oscilloscope shots:



One primary and the secondary output



Both primaries, showing their phases

The first screen shot surprises me as it shows clearly that the output is actually an excellent square wave while I would have expected it to be a sinewave as it is coming from a coil which has inductance. The second shot shows very clearly, how the two banks of primary electromagnets operate out of phase with each other thanks to Woopy's mechanical 6-way switching arrangement. It is reported that Mr Figuera ran a 20-horsepower motor with his prototype and if that motor were fully loaded, then that is 15 kilowatts of power, easily enough to power a household.

Please bear in mind that if the electromagnets are made from iron, whether laminated or not, that iron restricts the frequency, probably to 500 Hz or less, and so it is necessary to keep the frequency that low if using a solid-state circuit to drive the transformer. For 60 Hz output with mechanical switching, requires the motor to run at 3,600 rpm which is fairly fast although definitely achievable. Also, the output power will be limited by the current handling capacity of the wire in the secondary winding. The first page of the Appendix shows the current capacities for the standard AWG and swg wire sizes.