

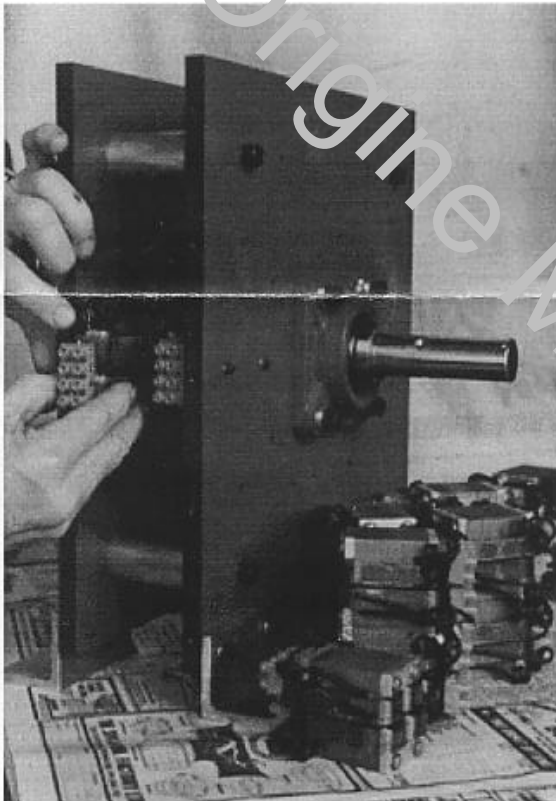
HOMEMADE GENERATORS - How to Instructions

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The Homebuilt Dynamo:

Dynamo Design and Construction with Ceramic Magnets.

By Alfred T. Forbes. Published by Todd-Forbes Publishing. 1987.



DYNAMO - (short version for dynamoelectric machine)

- 1. GENERATOR,
- 2. a forceful energetic individual.

The construction of the generator itself has been simplified so that it requires no previous knowledge of electrical machines, no castings, no welding and - surprisingly - not even any soldering!

-- ELECTRONICS AUSTRALIA

It's hard to imagine a better set of instructions for making anything. To me, however, the book is most valuable as an apprenticeship in how to imbue an idea with sufficient intellectual energy and information to make it flicker into being as irrefutable proof-of-concept hardware, a skill not taught in schools or textbooks.

-- J. Baldwin, WHOLE EARTH REVIEW

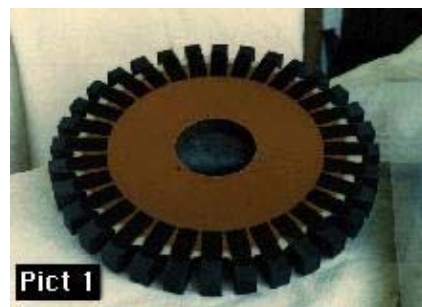
The Homebuilt Dynamo - Introduction

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The following is taken from the introduction to *The Homebuilt Dynamo*

Why this book?

1969:



Decided to live the simple life. Bought a few acres of steep land very cheaply - most of it nearly straight up and down, hard to find a flat spot that wasn't marsh or swamp. did find one big enough to erect a 12'x12' tent which we lived in for a year while building a small house at the bottom end of the property.

1970:

Electric power people wanted lots of money - in advance - to put in power poles to house. Seemed like a better idea was to get a book on small dynamo construction and make our own power.

To make a long story short, we couldn't find that book. So that's why this book was written.

This book is a picture-diary of how we build our dynamo, with some practical information and advice along the way for anyone following our steps. You will appreciate my wife Julia's invaluable help in translating my text into understandable English.



To some people, this book may seem to go into too much detail; for others, perhaps not so experienced in electronics or shop techniques, the extra details of how I made The Homebuilt Dynamo will be welcomed. My aim is to leave out nothing that will help any person with an ordinary home workshop to produce a working Homebuilt Dynamo using the materials, tools, and techniques described.

Having no such directions ourselves, it took us a while. It was on January 15th, 1984, when - with great pomp and ceremony - we retired the smelly and dangerous kerosene lamps and started a new era on 12v miniature fluorescent lighting fixtures.

The Homebuilt Dynamo is not another "do-it-yourself" book, it is simply a careful diary with photographs, detailed working drawings, and text of how I build myself a low speed, low voltage, three phase permanent magnet alternator with internal rectifier diodes which make, in effect, a direct current generator. To avoid that last longwinded description, I have substituted the word "dynamo" which, anyway, I hate to see disappear

from the language.



Except for the small amount of lathe work (see drawings D182 and D183), all the construction was done by me, using hand tools normally available in the average home workshop plus two handgrinders and two hand powered drill presses. To simplify constructions and make it easy to fabricate (and, if necessary, to dismantle), I have avoided the necessity for any welding or soldering.

Of modular construction, the Stator Units can be removed and the Frame completely dismantled using only an Allen key set and a small screw driver.

The materials I used to construct The Homebuilt Dynamo are, by no means, the only ones you can use. For example, the Formica Supporting Plates could be made from aluminium, cast iron, mild steel, or stainless steel - all of which would be heavier and harder to work than the Industrial Formica I used, but the output rating of the dynamo could be substantially increased because of the much better heat dissipation of metals.

The reader may well ask: why all the fuss over a low speed machine when mass-produced car and truck alternators are available at very reasonable cost? Well, the answer to that is that the alternative power sources such as small windmills, water turbines, and steam engines have speeds in the 100 to 800 range of RPM. To match the power source generally available to these high-speed machines requires expensive high ratio gearing or a complicated maze of belts and pulleys which aren't very energy efficient and require frequent maintenance.



In conventional alternators, it is hard to follow the action because a common stator core is used for all the windings. In my machine, each individual Stator has its own separate laminated core and windings so it is easy to make electrical calculations using a modification of the standard transformer formula.

The structure of The Homebuilt Dynamo can be thought of as basically a bunch of core type electric transformers cut in half and the two halves positioned on opposite sides of a rotating disk which has powerful ceramic magnets embedded in its rim (which passes between the two halves of the "transformers"). The north-south direction of magnetism in each of these magnets is opposite to the ones next to it all around the rim, so when the disk is rotated, the "transformer halves" on either side of the disk are caused to be magnetized first in one direction and then in the other (see drawing D296) as each pair of magnets passes between the "transformer halves". The "transformer halves" thus act in the same way as the stator of an alternator, generating a current of alternating electricity as the Magnet Rotor turns.

The amount of power that can be collected from the Stator Units depends on three factors which are listed below:

1. The larger the individual Stator Units, the more power is generated for each RPM of the Magnet Rotor.
2. The more Stator Units that can be packed around the Magnet Rotor disk, the more power is generated - that is why I've wound the copper



coils in such a way that they are much longer than their width in The Homebuilt Dynamo, so as to get as many Stator Units as possible around both sides of the Magnet Rotor.



3. The larger the Magnet Rotor, the more magnets can be positioned around its rim and this means more power will be generated from each Stator Unit for each RPM of the Magnet Rotor.

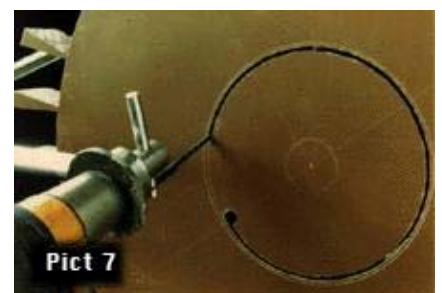
So, if we want a lot of power at a low rotor RPM, theoretically all we need is a huge rotor with hundreds of small magnets revolving between hundreds of little stator units. In a real-life situation, though, we have to compromise quite a bit here. For example, the rotor unit must be very rigid or it will tend to vibrate between the Stator units as it revolves, so its thickness must be about one-sixteenth its diameter (for industrial Formica material). Also, the Stator Units must be supported by a frame heavy enough so that it, as well, will not vibrate.

Obviously, then, compromises must be made and a balance struck between the three factors determining maximum power and practical dynamo design.



After experimenting with various combinations, taking each of the three factors to its maximum practical limit, my final design brought the frame to fourteen and one-quarter inches by fourteen and one-quarter inches by one-half inch thick Industrial Formica for the two Supporting Plates with four Housing Panels made of fourteen and three-eighths inches by four and one-sixteenth inches by one-eighth inch thin aluminium plate. (One of the four Housing Panels would become the Rectifier Panel). The eleven and five-eighths inches overall diameter Magnet Rotor made of three-quarter inch thick Industrial Formica accommodates thirty-two magnets of such a size and spacing around its rim that two adjacent magnets will cover two legs of the Stator Units, one unit after the other, as the Rotor revolves. There are twelve Stator Units fastened to each of the Supporting Plates, each exactly opposite one on the other Supporting Plate, making up twelve Stator Unit Pairs with the Magnet Rotor revolving between them. The pairs of magnets as they cover the legs of two opposite Stator Units, complete the magnetic path between the Stator Unit Pairs as the Magnet Rotor revolves (see drawing D296).

The ratio of twelve Stator Unit Pairs to sixteen Magnet pairs is important to the three-phase circuitry of The Homebuilt Dynamo since this ration works out so that only four pairs of magnets are covering the legs of four Stator Unit Pairs (these four Stator Unit Pairs being covered by the four pairs of magnets are spaced 90 degrees apart on the Supporting Plates) at any one time with the other magnet pairs either just coming up to, or just passing on from, the remaining eight Stator Unit Pairs. The effect of this is to practically eliminate any "cogging" action which would immobilize the Magnet Rotor and make it next to impossible for it to get started again - which would be the result if all the magnets lined up with all the Stator Units legs at the same time.



On this machine, no extra insulation is used between coil layers and there is no process of special dipping, drying, and baking of coils. This is because it's not necessary for The Homebuilt Dynamo where the peak voltage between any two layers of the coil winding (at maximum rated DC output - either parallel or series connected) is just under 2v compared to 54v between layers in the coil of a conventional 230v 2kw transformer - where insulation and such processes are indeed necessary.

Actually based on an old (turn of the century) idea - which was at the time impractical - the design of The Homebuilt Dynamo is only practical because of the availability of modern ceramic permanent magnets. When compared to the conventional metal magnets, their power is enormous - especially in their power to pull over a much greater distance and to withstand strong demagnetizing forces. The "long-throw" capability of the modern ceramic permanent magnets as used in The Homebuilt Dynamo allows us to have an air gap of one-sixteenth inch between the Stator Units and the magnets, on both sides of the revolving Magnet Rotor and this means that the construction tolerances permitted are much larger than in the conventional machine permitting only about a one-hundredth inch air gap - and it is this difference which brings the construction of The Homebuilt Dynamo within reach of the amateur craftsman.

As an option, in Appendix 1, I have put forward some ideas for enlarging The Homebuilt Dynamo by doubling or tripling the linear dimensions of each component to gain a really spectacular increase in output and efficiency. It is a well-known fact in electrical engineering that electric motors, generators, and transformers all become much more efficient as their size increase provided that all the components, (with the exception of the thickness of the individual iron laminations in the rotor and stator cores), are enlarged in the same ratio.



In course of developing The Homebuilt Dynamo, I have often relied on hunches about how electricity "could" be generated and consequently I have spent quite a few years running up blind alleys, many of which in hindsight have seemed a bit ridiculous. I sincerely hope that this book will help a like-minded reader to avoid a few of those blind alleys.

What this book contains.

This book originated from the premise that there just had to be a method of generating low voltage electricity from mechanical energy which could be developed from scratch in the average home workshop using home modified, off-the-shelf components and materials.

The systems of construction described here were mainly worked out by the Trial & Error System with help from bits and pieces of know-how from various trades picked up during 15 years as a factory process worker in the Auckland area. I do not profess to be an expert at anything - I'm still learning.

This book is a picture-diary with over 300 illustrations detailing (with photos, schematics, and working drawings) the design and construction steps in the building of a low speed, low voltage, permanent magnet, three-phase alternator with built-in full-wave rectifier - which makes it, in effect, a DC generator or what I prefer to call a dynamo.

The Homebuilt Dynamo (as wired in this book) can be used from 12v to 36v with a top rated output of 1000 watts - 28 amps and 36 volts at 740 RPM.



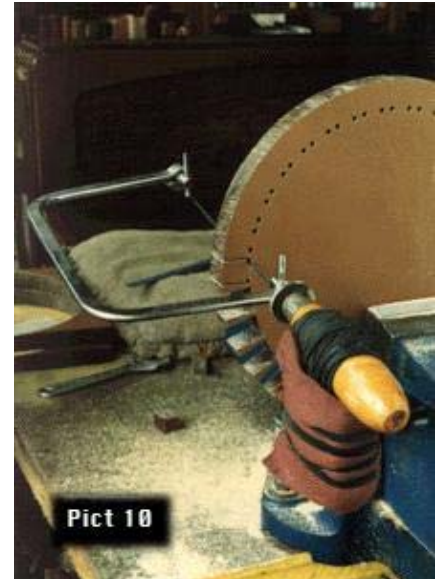
This machine has been specifically designed and simplified to the point where no soldering or welding is required. The use of connector strips (terminal blocks) for all wiring connections allows maximum

experimentation and changing of components without a major hassle. Neither is there any foundry work - i.e. no casting for the housing. There are no brushes to wear out.

I have done all the work at home (except for an essential bit of lathe work done on the Rotor Hub and the four Spacers holding the Main Frame together) using all new off-the-shelf quality materials purchased from local firms in the Auckland area (these are listed and addresses given).

This book also includes descriptions of how I constructed:

1. A precision cutting diamond saw used to cut magnets to size (based on alterations to a sturdy old hand grinder).
2. A special high-power magnetizer used to magnetize ceramic magnets (uses old-fashioned telephone dynamo for power source).
3. A precision sheet metal cutter (small) for cutting standard transformer laminations to the size required (built around a pair of tin snips).
4. A small (four and one-half ounces) lifting magnet which uses a Homebuilt Dynamo Rotor Magnet as its power source and lifts 145 times its own weight.
5. A foot-powered version of The Homebuilt Dynamo (for charging a deep-cycle marine battery) build around a bicycle frame with improvised reading stand.
6. A 139 pound flywheel used on the pedal powered machine made from lead-filled mackerel tins set around an Industrial Formica disk with aluminium hub and stainless steel rods.
7. Precision wire-winding jigs (for winding the stator coils and the magnetizing coils).
8. Several test apparatus built for various tests on magnets and on the Dynamo (in the Appendix).

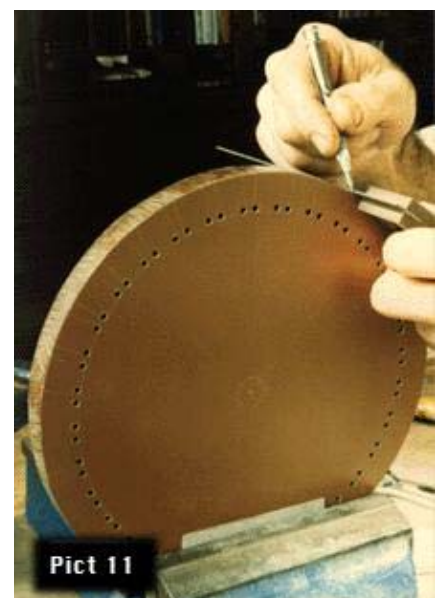


The appendix also contains details of tests made on The Homebuilt Dynamo plus some theories and opinions on various theories and ideas, and some simple data on scaling up The Homebuilt Dynamo to obtain large increases in output and efficiency.

All the active construction photos in this book show me "doing it the hard way" with hand-tools or hand-powered machines - because that was all I had to work with. But a person more fortunate, who had the use of power tools, would naturally finish the job faster.

Book Review:

MODEL ENGINEER 15 DECEMBER 1989 VOL 163 #3863, page 793 - The Homebuilt Dynamo by Alfred T. Forbes



The background to this book is that the author opted out of the rat race to an apparently remote plot of land in New Zealand where he built his own house. There was no possibility of getting a connection to a public electricity supply but he soon grew tired of the smell and inconvenience of oil lamps. He sought a low voltage d.c. generator to charge storage batteries which could be driven by a wind or water mill. The obvious ready-made article was a car alternator and rectifier but that would have needed to run at several thousand r.p.m. and he wanted to avoid the gearing or pulley system that would have been needed. He found that if he wanted a low-speed machine he would have to build his own. The book records in the greatest detail the design and construction of a 3-phase alternator-rectifier machine that produces up to 1kW at 740 r.p.m. at voltages from 12 to 36 volts depending on the interconnection of the windings.

The workshop equipment available to him was of the simplest - he had no lathe and of course no power-driven equipment, so the design of the machine is dictated largely by this. Consequently its appearance is, for a generator, distinctly odd but the electrical engineering in it is absolutely sound. It is a multi-pole, permanent magnet rotor machine similar in its general philosophy to the original Raleigh bicycle Hubdyno, but of course much larger and anyone needing a low-speed generator could do much worse than adopt this design.



The author has logged and photographed every stage in the construction and has produced in this book the most comprehensive and detailed set of "How to do it" instructions I have ever seen. True, the book is expensive but the 300 or so pictures are so clear and well-chosen that it must be regarded as good value for money. The approach to the subject is essentially practical. The theoretical basis of generator design is not gone into (it would probably frighten away a number of possible readers) but it is clear to your reviewer that the design is soundly based. It could be built, following these instructions, by a person with no electrical knowledge whatever.

In the education world the construction of this machine would be an interesting and instructive project and the completed machine would be valuable to illustrate the principles of electromagnetic induction, particularly since the form of construction allows the "works" to be seen in action. Moreover, the whole machine can be dismantled and reassembled without damage, thus adding to its instructional value.



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