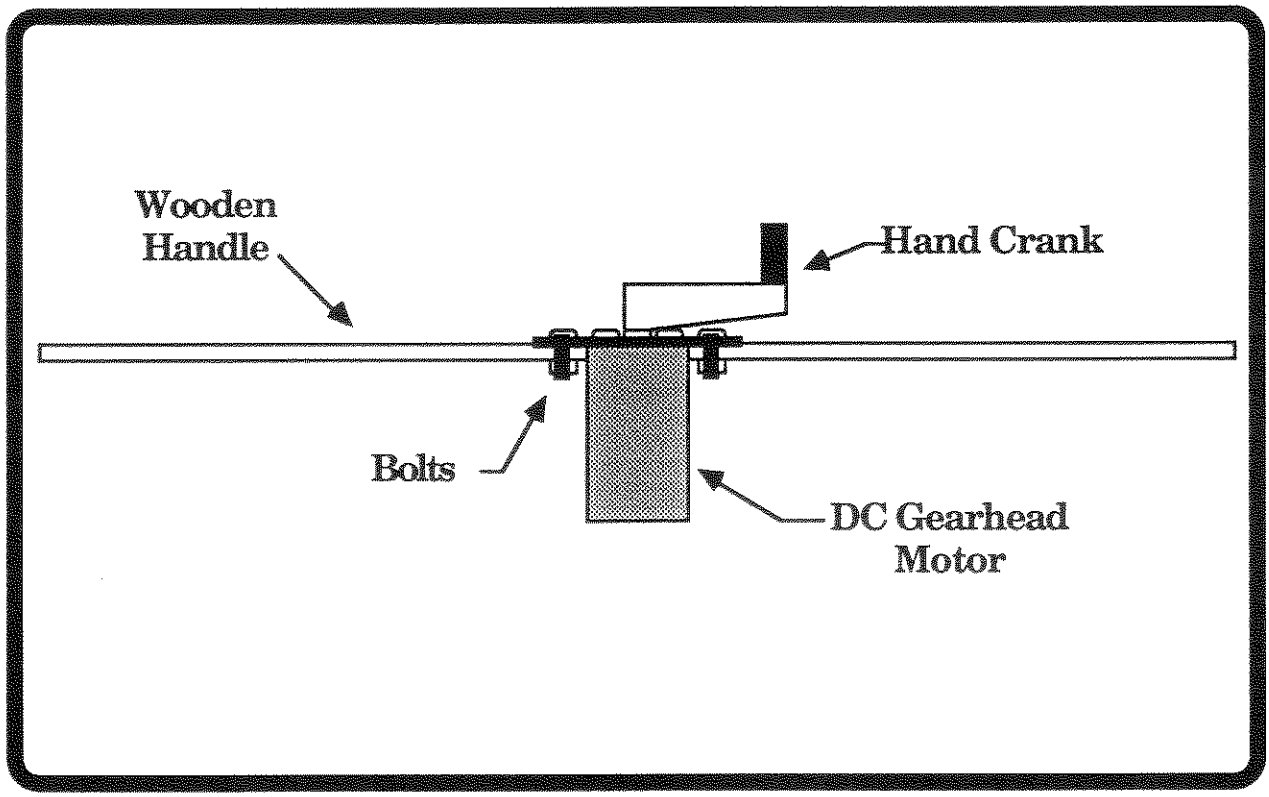
Handcranked DC Generators



MTM Technical Inc. Press

Handcranked DC Generators

MTM Technical Inc.

Introduction

This booklet explains how to build a handcranked direct current (DC) generator using a surplus gearhead motor. A handcranked generator can substitute for batteries in many useful applications. For example, a flashlight or transistor radio can be directly driven by the generator's output. A handcranked generator is a good addition to "emergency" kits for floods, hurricanes, earthquakes, etc. Handcranked generators can also be used for charging batteries, such as an ordinary car battery.

This project uses a surplus DC gearhead motor for the generator. Many different types of surplus motors are available through mail order, at bargain prices. This booklet presents some guidelines for selecting the right one for your application and budget. In general, handcranked generators can produce about 5 Watts of power before the cranking becomes too hard.

It is difficult to crank the generator at a constant speed to produce a constant voltage. In some cases it is necessary to build a voltage regulator. This booklet describes a simple regulator which can be built using a few inexpensive parts.

Finally, this booklet contains tips and ideas for using your handcranked generator in some everday applications.

How DC Generators work

Many people are surprised to learn that almost any permanent magnet DC motor can be used as a generator. A simple DC motor/generator is shown in Figure 1. In a simple DC generator the magnetic field is provided by a stationary permanent magnet. Rotating within the magnetic field of the permanent magnet is the rotor. The rotor is wound with multiple turns of copper wire. It is within these turns of wire that the electricity is generated.

The DC generator produces electricity when the rotor is turning. Since the rotor is moving, brushes are used to transfer current to the stationary frame. In Figure 1 the generator's output is shown operating an electric lamp. Turning the generator to operate the lamp requires work. In our case, we use a handcrank to rotate the generator and produce electricity.

The DC voltage output of the generator depends on three main things: 1) How fast the generator is turning, 2) The field strength of the permanent magnet, and 3) The number of wire turns wound on the rotor. The voltage output increases with faster turning, stronger magnets and more turns of wire. It's simple! Unfortunately, the only thing we control is how fast the generator is turning.

Ordinary DC generators must turn at several thousand RPM (rotations per minute) to produce useful voltages. This is much too fast to do by hand. The high RPM requirement is why we use a *gearhead* DC motor for handcranked generators. Gearheads are useful because they can

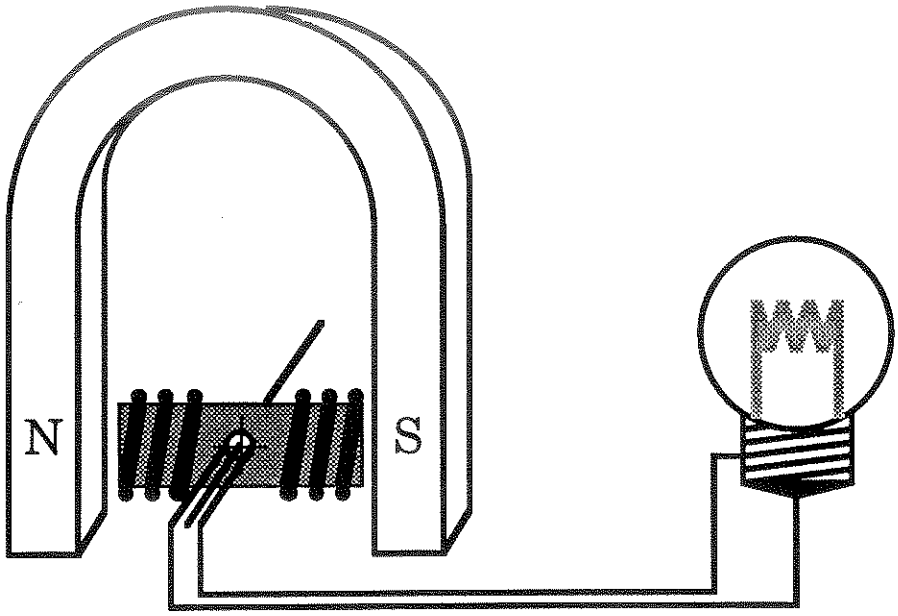


Figure 1. A basic DC generator consists of a wirewound rotor rotating within a magnetic field. Here, the output is lighting a lamp.

Figure 2. The motor/generators we purchased and tested are shown here in order: "A", "B", "C", "D" and "E".

Motor & Cat #	Price	Rated RPM	Rated Voltage	Shaft Size	Rated Current	Voltage at 100 RPM	Maximum Output Current
A* 5-993	$7.49	56	24	.1875"	.03 amp	39 V	.22 amp
B* 5-1021	$6.99	20	24	.25"	.15 amp	105 V	.15 amp
C* 5-1044	$14.99	95	12 to 36	.3125"	1.2 amp	32 V	.79 amp
D** DM-390	$17.50	350	12	.25"	.65 amp	4.3 V	.70 amp
E** DM-503	$19.50	55	12	.25"	.50 amp	40 V	1.1 amp

* Surplus Center, P.O. Box 82209, Lincoln, NE 68501-2209.
** Servo Systems Co. 115 Main Rd., Montville, NJ 07045-0097

Table 1. We tested five different motor/generators for use in a handcranked generator. The test results are summarized in this table. Note: Motor 'E' was hard to turn and isn't recommended.

convert one turn of the handcrank into several hundred turns of the rotor. For our project we want a gearhead motor/generator capable of producing the desired voltage at a reasonable handcranking speed, generally between 25 and 100 RPM.

In addition to generating adequate voltage, a handcranked generator must also generate adequate current. The amount of current a generator can provide is determined primarily by the wire winding on the rotor. The rotor is often wound with small diameter wire. The fine wire creates a large resistance to the flow of current. The resistance of the wire limits how much current can be supplied. The maximum output current is measured by connecting the generator's output directly to an amp meter. Most motor/generators are limited to less than 1 amp.

Selecting a DC Motor for a Generator

We have outlined several desirable features for a DC Motor when used in a handcranked generator. Stated briefly, we want a gearhead motor with good voltage and current output at a reasonable handcranking speed. In the real world, the price of the motor is also an important consideration... especially for experimenters on a budget!

We have found that the best bargains for DC gearhead motors can usually be found in "surplus" type mail order catalogs. A list of potential mail order suppliers is presented in the reference section at the end of this booklet. It's difficult to recommend a specific DC motor because the inventories are constantly changing. What's available today may not be available tomorrow. We will focus on identifying a suitable

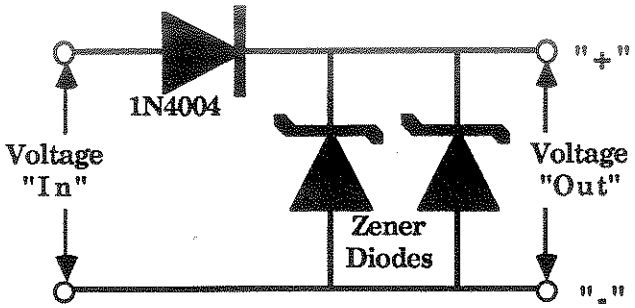
motor/generator based on a general catalog description, since many different motors can be successfully used.

Table 1 describes five different gearhead DC motors offered by two large surplus mail order houses in recent catalogs. We have purchased each of the motors and tested them for use as a handcranked generator. In our tests we labeled the motors "A", "B", "C", "D" and "E". The motors were purchased from the Surplus Center in Omaha, NE and Servo Systems Corporation in Montville, New Jersey. The catalog number of each motor is shown in the first column, under the letter identifier. A photograph of the 5 different motors appears in Figure 2. All of the motors we tested cost less than $20.

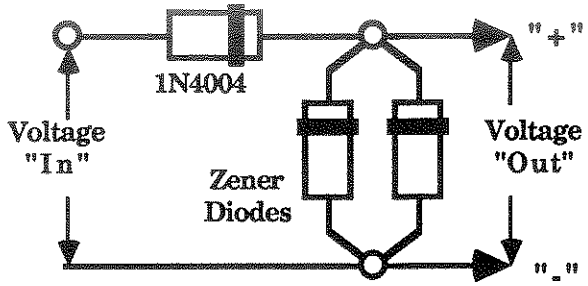
Most of the motor information in Table 1 is taken directly from the catalog. Motor catalog descriptions generally state the RPM output, input voltage, shaft size and current draw. The two shaded columns of Table 1 contain data measured in our lab. We measured the voltage output at 100 RPM cranking speed and the maximum output current.

The five motor/generators we tested in Table 1 all produced useful voltages with low RPM handcranking. In the Table we have listed their measured voltage outputs at 100 RPM. Their voltage output at other speeds can be easily calculated. For example, at 50 RPM their voltage output is exactly half. At 25 RPM their voltage output is one quarter as much, and so on. We found that the motors with the lowest RPM output rating produced the highest voltage when run in reverse as generators, as you might expect.

Voltage Regulator Circuit



Construction Layout Information



Item	Type	Radio Shack #
Blocking Diode	1N4004	276-1103
5.1 Volt Zener Diodes	1N4733	276-565
6.2 Volt Zener Diodes	1N4735	276-561
9.1 Volt Zener Diodes	1N4739	276-562
12 Volt Zener Diodes	1N4742	276-563
15 Volt Zener Diodes	1N4744	276-564

Figure 3. This is a useful voltage regulator circuit for handcranked generators. Select the appropriate zener diodes based on the application.

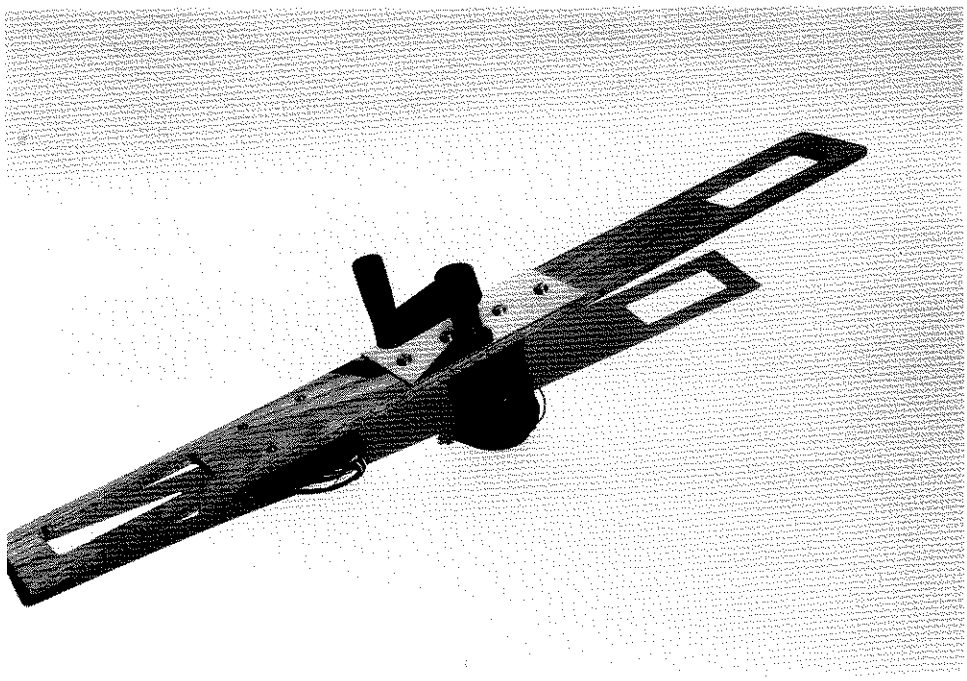


Figure 4. This is a photograph of the completed prototype generator.

The motor/generators we tested were not equal in their output current capability. In general, we found that the rated "current draw" of a motor comes close to predicting the output current of the same motor when used as a generator. This simple "rule-of-thumb" makes it relatively easy to pick a motor/generator for your application, since most catalog descriptions state a current rating. Another "rule-of-thumb" is to select a motor/generator with a larger shaft for larger output current.

A hand-cranked generator can produce about 5 Watts of electrical power before the cranking becomes too difficult. You will find that even 1 or 2 Watts takes a fair degree of effort. DC electrical power is calculated by multiplying the voltage times the current. (Power = Voltage x Current). Suppose your application requires 9 VDC for a transistor radio which draws .10 amps of current. The power requirement is therefore .90 Watts (9 volts x .10 amps = .90 Watts).

Voltage Regulators

It is very difficult to hand-crank a generator at a constant speed to produce a constant voltage. This creates a problem if you are operating a device, such as a radio, which can be damaged by high voltage. Fortunately, it's easy to build a simple and inexpensive voltage regulator using commonly available parts. A circuit diagram and parts information for a voltage regulator is shown in Figure 3.

The voltage regulator uses three small electrical components called diodes. One diode, the 1N4004, controls the direction of the current. The

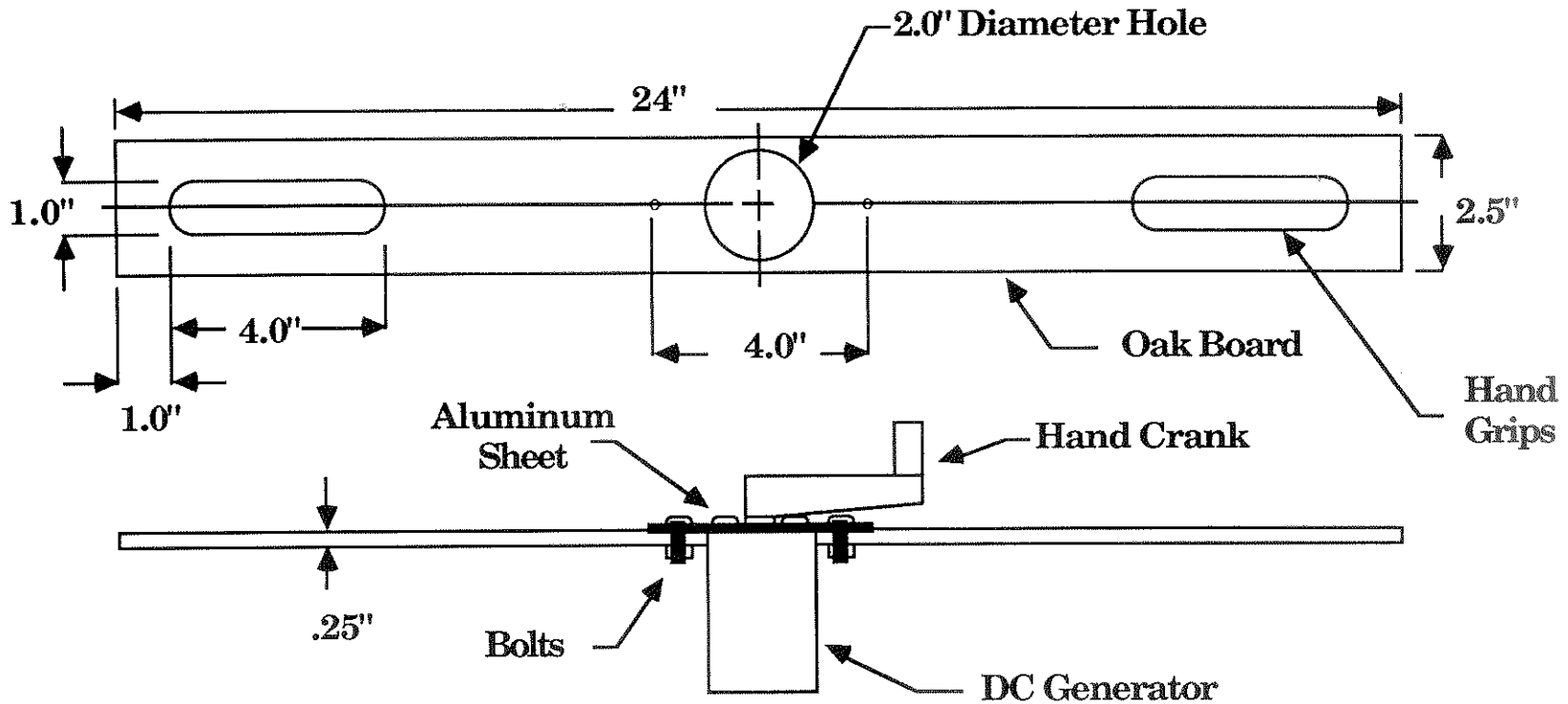
other two diodes, called "zener diodes", control the output voltage. Standard zener diodes are available from Radio Shack for producing 5, 9, 12 or 15 volts. We recommend using two zener diodes to control the output voltage, in case one of them burns out. Note that all diodes, including zeners, have a distinctive circular band on their case. The band indicates "which end is which" when they are used in a circuit. Make sure they are pointing in the right direction, or the circuit won't work!

Advanced electronic amateurs may decide to build a voltage regulator of their own design. A large selection of integrated circuit ("IC") type voltage regulators are readily available and can be successfully used. With "IC" regulators it is important not to exceed their maximum input voltage rating, with handcranking which is too fast. Integrated circuit voltage regulators generally can't handle more than about 30 volts input.

Construction Notes & Tips

Once the motor/generator for your project has been selected, you can proceed to the actual construction stage. We chose to use motor/generator "B" from Table 1 in our prototype. Unit "B" has excellent voltage output and reasonable current output. Unit "D" would be a good choice if more current and less voltage is desired. (Incidentally, the outside case dimensions of "B" and "D" are exactly identical.) A photograph of our completed prototype is shown in Figure 4. Detailed construction plans for the prototype are given in Figure 5.

A sturdy handcrank is required for turning the shaft of the generator.



Item	Supplier	Catalog #
DC Motor/Generator	Surplus Center P.O. Box 82209 Lincoln, NE 68501	#5-1021
Crank Handle	REID 2265 Black Creek Rd. Muskegon, MI 49444	#KHR-10

Note: Aluminum Sheet, Oak Board and Nuts/Bolts are available from Home Improvement Centers such as Lowes, Home Depot, Home Quarters, etc.

Figure 5. These are the plans for building a typical handcranked generator. The exact dimensions can be adjusted to fit the particular motor/generator you have chosen.

You will find the generator requires a surprisingly large amount of cranking force to produce even 5 Watts of power. In the prototype we used a commercially available handcrank, as described in the plans. The commercial handcrank looks and works good. It costs about $15, and is available through mail order. Handcranks for other shaft sizes are available from the same supplier mentioned in the plans.

Two simple machining steps are required before the commercial handcrank can be used. First, the hole for the generator's shaft must be enlarged slightly to .250 inches. The hole can easily be enlarged with a simple hand drill. Second, the handcrank must be drilled and tapped for a set screw. Tapping is the process of creating screw threads inside a drilled hole. Begin the tapping process by drilling a #36 hole in the handcrank where it slips onto the shaft. Then run a #6-32 tap into the hole using a tap handle, being careful to guide it in straight. The #36 drill, #6-32 tap and tap handle are available at any good hardware store. Together they shouldn't cost more than a few dollars.

Some experimenters may decide to use a substitute handcrank, in order to save money. Automotive junk yards are a good place for "scrounging" crankhandles. One possibility is the crankhandle for rolling up a car window. Broken toys and appliances are another good place to find useable crankhandles. Another possibility is the replacement crankhandle sold for louver type house windows.

Figure 5 contains information about building a wooden handle for holding the generator. A wooden handle makes the handcranked

generator easier to use. The exact dimensions of the handle are not critical, and it can easily be adapted to your particular motor/generator. The pattern for the handle should be sketched on a piece of wood, and then cutout using a jig saw. Oak works well for the handle because it is lightweight and strong. Many home improvement centers offer a good selection of small hardwood boards in convenient sizes. We purchased ours "off the shelf" for less than two dollars.

Some builders may find it more convenient to mount the motor/generator directly to a table or stand. This is a good approach if the unit doesn't need to be portable, and it is especially convenient for dedicated long term "cranking" sessions.

The voltage regulator in our prototype generator was mounted directly on the wooden handle. This design is especially flexible when the diodes are mounted using brass nuts and bolts. Different output voltages can then be created by simply changing the zener diodes. However, if you plan on generating more than 15 volts, insulate the bare terminals to avoid getting accidentially shocked!

Operating a Handcranked Generator

The simplest load to operate using a handcranked generator is an electric lamp. Replacement bulbs for flashlights are widely available and work well with handcranked generators. Radio Shack also offers a very large selection of lightbulbs and sockets. Some experimentation with different voltage bulbs may be required to find a good match with your particular motor/generator. For example, with the prototype (built using

motor/generator "B") we were able to directly drive a standard household 5 watt nightlight bulb. A voltage regulator is not required for operating a lamp. However, a regulator will make the light more steady and protect the lamp from overly vigorous handcranking.

Charging batteries is another useful application for handcranked generators. A voltage regulator is not required. Begin the charging process by connecting the two output wires from the generator to the battery being charged. Unless the battery is completely dead, the motor/generator will start turning and the crankhandle will begin to move. Grasp the crankhandle and begin turning it in the same direction it is moving, only faster! The battery is now being charged. When you are ready to stop the charging, disconnect the wires.

Battery charging is usually a low voltage, high current process. Try to select a motor/generator with a high current rating, if you plan to do much battery charging. A DC amp meter, installed in one of the output wires, is a great convenience for measuring your progress.

Another useful application for handcranked generators is driving a small electrical device directly, without batteries. A good example is a transistor radio. In this case a voltage regulator is definitely required because cranking the generator too fast could "fry" the radio. Don't expect to operate a loud boombox with a handcranked generator, 5 Watts of power simply isn't enough! In fact, even when operating a small radio you will notice the cranking becomes more difficult as the volume level increases.

The potential uses for a handcranked generator are only limited by your imagination. Whatever you have in mind, always keep safety your first priority and happy experimenting!

References/ Suppliers

Surplus Center, P.O. Box 82209, Lincoln, NE 68501-2209. (Excellent source of used/surplus motors for handcranked generators. Large selection and small minimum order. Write for catalog.)

Servo Systems Co., 115 Main Road, P.O. Box 97, Montville, NJ 07045-0097. (Another source of surplus motor/generators. Slightly higher prices and a $50 minimum order. Write for catalog.)

All Electronics Corp., P.O. Box 567, Van Nuys, CA 91408-0567. (Good source of electrical supplies for building regulators. Large selection of different voltage Zener diodes. Write for catalog.)

Nuts & Volts Magazine, 430 Princeland Court, Corona, CA 91719. (A monthly magazine of electronic classifieds. Good source for motors and parts. Yearly subscriptions start at under $20.)

REID, 2265 Black Creek Rd., Muskegon, MI 49444. (A commercial source of high quality crankhandles. Write for catalog.)

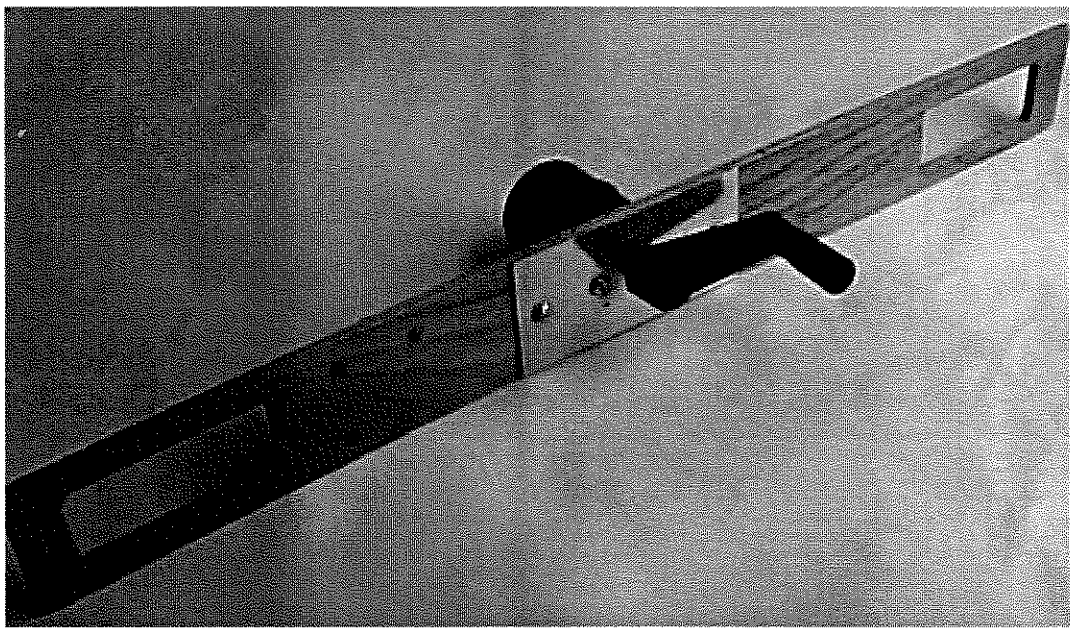
Project Booklet Update

This booklet was written about 10 years ago. Most of the information is still quite relevant, however the sources and prices for the motors are out of date.

On the next page you will find updated information on DC Gearhead Motor suppliers. All the suppliers have web sites, as noted.

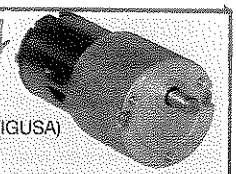
Of course, another great source of surplus motors is always EBAY. Local ham radio swap fests are another good source.

Radio Shack is gradually reducing their off-the-shelf supply of diodes and components. A good source for the voltage regulator parts is now Jameco Electronics. (www.jameco.com) They have no minimum order when you order via the web.



www.mpja.com

12VDC/6.8RPM GEAR MOTOR

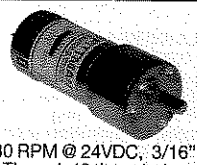


MFG: IGARASHI MOTORS (IGUSA)
P/N: Custom 2732-0300
COIL: 12V
Gear motor rated: 6.8 RPM @ 12VDC, 5mm (3/16") dia. X 10mm (3/8"), flatted steel shaft, bronze bearings. Three M3-.5 threaded mounting holes in front. Solder terminals
L: 2-11/16" (Body) **Dia:** 1-1/4" **WT:** .25

STOCK #	DESC.	1EA	10+EA
15870-MD	12V 6.8RPM Motor	$12.95	$9.95

24VDC/230RPM GEAR MOTOR

www.mpja.com



MFG: PITTMAN
P/N: GM8513E411
COIL: 24V
USED, gear motor rated: 230 RPM @ 24VDC, 3/16" dia. X 11/16", flatted steel shaft. Three 4-40 threaded mounting holes in front. Solder pin terminals
L: 3-1/8" (Body) **Dia:** 1-3/8" **WT:** .49

STOCK #	DESC.	1EA	5+EA
15669-MD	24V 230RPM Motor	$18.95	$16.95

24VDC/400RPM GEAR MOTOR

MFG: PITTMAN
P/N: GM8513E658
COIL: 24V www.mpja.com
USED, gear motor rated: 400 RPM @ 24VDC, 3/16" dia. X 11/16", flatted steel shaft. Three 4-40 threaded mounting holes in front. Solder pin terminals
L: 3-1/8" (Body) **Dia:** 1-3/8" **WT:** .49

STOCK #	DESC.	1EA	5+EA
15675-MD	24V 400RPM Motor	$18.95	$16.95

23.5V 17RPM MOTOR

www.mpja.com

MFG: BUEHLER
P/N: 1.61.46.037
COIL : 23.5VDC
USED gearhead DC motor rated 18RPM @ 23.5 V. 5mm dia. X 21mm flatted steel shaft. 2 threaded mounting holes. 6" leads.
L: 2-3/4" (Body) **Dia:** 1-3/8" **WT:** 4

STOCK #	DESC.	1EA	10+EA
14204-MD	23.5VDC Motor	$18.95	$16.95

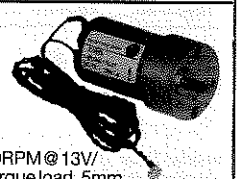
12VDC 2 SPEED GEAR MOTOR

MFG: TRICO PROD.
VOLTS: 12VDC
CURRENT: 1A N/L @ Low speed
4A N/L @ High speed
RPM: 40 low/106 high www.mpja.com
Specifications/Features:
Car wiper motor with one end of motor windings grounded to case. 2-1/4" long offset steel bracket with ball swivel, attached to 3/8" X 3/8" threaded shaft. Metal case & gear housing. Sorry but no mating connector.
L: 7" **W:** 4" O/A **T:** 4" O/A **WT:** 3

STOCK #	DESC.	1EA	5+EA
15007-MD	12VDC Gear Motor	$19.95	$16.95

13V 700 RPM MOTOR

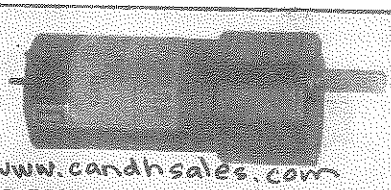
www.mpja.com



MFG: BUEHLER
P/N: 1.61.046.178.01
COIL : 13VDC
Gearhead DC motor rated 700RPM @ 13V/ 500RPM @ 13V with 6oz/in torque load. 5mm dia. X 11mm flatted steel shaft. 3 metric (M3) threaded mounting holes. 36" leads.
L: 2-1/2" (Body) **Dia:** 1-3/8" **WT:** .4

STOCK #	DESC.	1EA	10+EA
16392-MD	13V 700RPM Motor	$18.95	$16.65

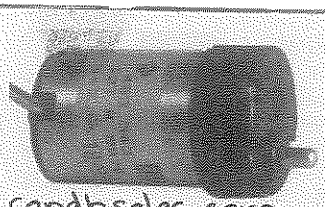
www.candhsales.com



160 RPM PITTMAN, #GM8513E411. Permanent magnet motor with gearhead. Reversible, has sleeve bearings. The motor is rated 24 VDC. Gearbox ratio is 31:1. No-load speed 250 rpm @ 0.188 amp. With a 50 oz/in load the speed is 160 rpm with a current draw of 0.80 amp. Shaft: 6mm dia. x 11/16" long. The front face of the gearhead has 3 tapped mounting holes. The thread size of the tapped holes is 3mm x 0.5mm. The motor has short solder pins on the rear for electrical input. Dimensions: 1-3/8" dia. x 3" long (excluding shaft).

Stock #DCGM2402 **$22.50**

www.candhsales.com

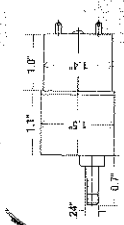


300 RPM SWF/ITT AUTOMOTIVE, #403.343-127K9. Rated 16 VDC. Permanent magnet, sleeve bearings, Reversible. 470 rpm @ 0.09 amp, no load speed. 300 rpm, with a 10 oz-in load @ 0.460 amp. Tested on 12 VDC the no load speed is 340 @ 0.08 amp. With a 10 oz-in load on 12 VDC the rpm is 160. Dimensions: 1-7/16" dia. x 2-1/2" long. Offset shaft: 5mm dia. x 5/16" long. Face mount with five tapped holes. Has 1-3/4" long wire leads.

Stock #DCGM2150 **$19.95**

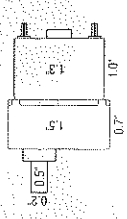
DC Gearhead Motor Supplier Information
Jameco Electronics www.jameco.com 1-800-831-4242
Marlin P. Jones www.mpja.com 1-800-652-6733
C and H Sales www.candhsales.com 1-800-325-9465

www.jameco.com



GH35GM Series

155011CK



38GM Series

253446CK

www.jameco.com

Electromech

12VDC and 24VDC Reversible Gear Head Motors

A Jameco EXCLUSIVE

JAMECO ReliaPro

GH35GM Series

Part No.	Cross Ref. No.	Rated Voltage (VDC)	Operating Range (VDC)	@ Maximum Efficiency Current (mA)	@ Maximum Efficiency Speed (RPM)	@ Maximum Efficiency Torque (g-cm)	Gear Ratio	Gear Case Size Dia. x Length (in.)	Motor Size Dia. x Depth (in.)	Shaft Size Dia. x Length (in.)	Pricing 1	Pricing 10	Pricing 50
155011CK	GH12-1926⊕	12	4.5 – 12	250	2	6000	3000:1	1.3 x 0.9	1.5 x 1.1	.23 x .90	$21.95	$19.79	$17.79
155820CK	GH12-1830Y-P⊕	12	4.5 – 12	220	4.5	4500	1000:1	1.3 x 0.9	1.5 x 1.0	.23 x .90	21.95	19.79	17.79
155838CK	GH12-1641T-L⊕	12	3.0 – 12	250	15	3000	270:1	1.3 x 0.9	1.5 x 0.8	.23 x .90	23.95	21.59	19.45
152910CK	GH12-1926Y⊕	12	4.5 – 12	172	35	2370	100:1	1.3 x 1.0	1.5 x 0.7	.24 x .90	21.95	19.75	17.75
151440CK	GH12-1632TI⊕	12	4.5 – 12	275	57	2200	100:1	1.3 x 0.9	1.5 x 0.7	.23 x .90	21.95	18.55	16.69
155854CK	GH12-1641T-F⊕	12	3.0 – 12	250	71	1000	60:1	1.3 x 0.9	1.4 x 0.9	.23 x .90	21.95	19.79	17.79
155862CK	GH12-1926Y-F⊕	12	4.5 – 12	300	70	1000	60:1	1.3 x 0.9	1.4 x 0.9	.23 x .90	22.95	20.79	18.79
161373CK	GH12-1345T⊕	12	4.5 – 12	185	116	650	30:1	1.3 x 0.9	1.5 x 0.7	.23 x .90	23.95	21.59	19.45
161381CK	GH12-1634T⊕	12	4.5 – 12	293	145	850	30:1	1.3 x 0.9	1.4 x 0.7	.23 x .90	22.49	20.29	18.25
164785CK	GH12-1640Y⊕	12	4.5 – 24	120	220	180	10:1	1.3 x 0.9	1.4 x 0.7	.23 x .90	23.95	21.59	19.45
176049CK	GH12-1640Y00⊕	24	12 – 24	340	1.8	6000	3000:1	1.3 x 0.9	1.5 x 1.1	.23 x .90	21.95	18.66	15.52
176031CK	GH24-1640Y06⊕	24	12 – 24	340	50	2000	90:1	1.3 x 0.9	1.4 x 0.7	.23 x .90	22.49	20.25	18.39
176022CK	GH24-1640Y19⊕	24	12 – 24	340	148	1000	30:1	1.3 x 0.9	1.4 x 0.7	.23 x .90	21.95	19.79	17.79

38GM Series

Part No.	Cross Ref. No.	Rated Voltage (VDC)	@ Maximum Efficiency Current (mA)	@ Maximum Efficiency Speed (RPM)	@ Maximum Efficiency Torque (g-cm)	Gear Ratio	Gear Case Size Dia. x Height (in.)	Motor Size Dia. x Depth (in.)	Shaft Size Dia. x Length (in.)	Pricing 1	Pricing 10	Pricing 50
253534CK	38-010⊕	12	97	24	7500	250:1	1.5 x 0.7	1.3 x 1.0	0.2 x 0.5	$18.95	$17.09	$15.35
253526CK	38-009⊕	12	93.5	36	5400	167:1	1.5 x 0.7	1.3 x 1.0	0.2 x 0.5	18.95	17.09	15.35
253518CK	38-008⊕	12	87.5	40	4600	150:1	1.5 x 0.7	1.3 x 1.0	0.2 x 0.5	18.95	17.09	15.35
253500CK	38-007⊕	12	82	60	3200	100:1	1.5 x 0.7	1.3 x 1.0	0.2 x 0.5	18.95	17.09	15.35
253497CK	38-006⊕	12	80	66	2100	90:1	1.5 x 0.7	1.3 x 1.0	0.2 x 0.5	18.95	17.09	15.35
253489CK	38-005⊕	12	76	110	1300	56:1	1.5 x 0.7	1.3 x 1.0	0.2 x 0.5	18.95	17.09	15.35
253471CK	38-004⊕	12	74	120	1100	50:1	1.5 x 0.7	1.3 x 1.0	0.2 x 0.5	18.95	17.09	15.35
253462CK	38-003 ✪	12	68	180	800	33:1	1.5 x 0.7	1.3 x 1.0	0.2 x 0.5	15.95	14.39	12.95
253454CK	38-002⊕	12	65	200	700	30:1	1.5 x 0.7	1.3 x 1.0	0.2 x 0.5	18.95	17.09	15.35
253446CK	38-001⊕	12	61.8	600	350	10:1	1.5 x 0.7	1.3 x 1.0	0.2 x 0.5	18.95	17.09	15.35

✪ Blue Part No. = Limited Quantity Available