ELECTRONIC TECHNICIANS!

Raise your professional standing and prepare for promotion! Win your diploma in

**ENGINEERING MATHEMATICS**

from the Indiana Home Study Institute

We are proud to announce two great new courses in Engineering Mathematics for the electronic industry.

These unusual courses are the result of many years of study and thought by the President of Indiana Home Study, who has *personally* lectured in the classroom to *thousands* of men, from all walks of life, on mathematics, and electrical and electronic engineering.

You will have to see the lessons to appreciate them!

NOW you can master engineering mathematics and actually *enjoy* doing it!

WE ARE THIS SURE: you sign no contracts—you order your lessons on a money-back guarantee.

In plain language, *if you aren't satisfied you don't pay,* and there are no strings attached.

Write today for more information and your outline of courses.

You have nothing to lose, and everything to gain!

**The INDIANA HOME STUDY INSTITUTE**

Dept. RE-7, P.O. Box 1189, Panama City, Fla. 32401

*Circle 26 on reader service card*

FREE catalog

over 1000 unique tools, handy kits, precision instruments, technical supplies.

Our 21st year of service to the World's finest craftsmen and technicians.

National Camera
2000 West Union Ave. Dept. GBB
Englewood, Colorado, 80110

Send a FREE copy of the nc Flasher

name

address

city

state zip

National Camera
2000 West Union Ave. Dept. GBB
Englewood, Colorado, 80110

*Circle 27 on reader service card*


# appliance clinic

## REVERSING AC MOTORS

by JACK DARR
SERVICE EDITOR

DC ELECTRIC MOTORS WILL OFTEN RUN the other way if the battery polarity is reversed. How do you reverse the rotation of an ac motor? In any one of several ways. Some ac motors aren't easily reversible; synchronous types as used in clocks, phonograph turntables, and so on. Some of these can be reversed, if necessary, by taking them apart and putting the field and frame back upside down. You can make a phono-turntable run backward by doing this; especially if the motor has been taken apart for cleaning.

In the common repulsion-induction fractional-horsepower motor, used on many larger appliances, the rotation can be reversed by reversing the leads of the starter winding only. A lot of replacement-type motors have the starter leads brought out to a terminal box on the frame, just for this purpose. Only the starter-winding leads need be switched; the running windings don't care which way the thing goes. In fact, with the starter winding disconnected and power applied, the motor can be started either way by spinning the shaft by hand. In service work, motor-reversing isn't too common, but it's handy to know how, if you have to.

There are quite a few applications which need an easily-reversible motor. Garage door openers and TV antenna rotators are two examples. The motors used for this purpose are basically all the same, though sizes differ with the power needed. This is called a "capacitor-run" motor and has two windings. Fig. 1 shows the circuit. Both of the windings stay in-circuit at all times; one isn't disconnected by the starter-switch.

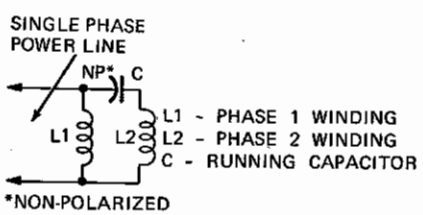


**FIG. 1—DIRECTION MOTOR RUNS is determined by winding in series with capacitor.**

The running capacitor causes a phase-shift of the voltage and current across it. This type of motor actually operates as a two-phase motor, though the ac line supply is single phase. This type of operation gives the motor far greater efficiency, by improving the power factor. For a given amount of power, this motor draws much less current from the line.

These motors can be reversed by simply switching the connections of the two windings to the hot side of the line; the common stays connected to the other side. In TV antenna rotators, this is done by a simple manual switch. Figure 2 shows how. (These are low-voltage motors that run on 24 volts ac from a transformer) with the switch in the **CW** position, winding **A** is connected directly to the line, and winding **B** is connected through capacitor **C**. With the switch turned to **CCW** position, **A** is now fed through the capacitor, and **B** directly from the line. In the typical antenna rotator, C is a non-polarized electrolytic capacitor of about 100 $\mu$F, rated at 150 volts ac. Motors are small and run the thing through gear-trains.

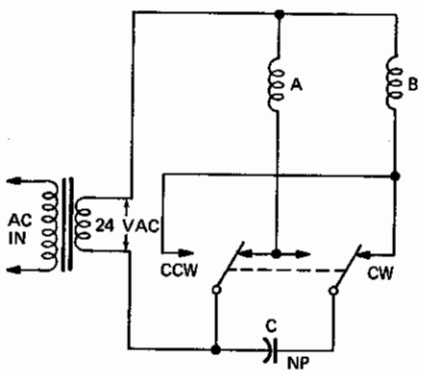


**FIG. 2—MOTOR REVERSING SCHEME for antenna rotator. Capacitor does the job.**

For heavier loads, such as garage-door openers, the motors will be bigger; still geared down for more power. They run directly from the ac line. However, circuitry and operating principles are exactly the same. If one winding is connected directly to the hot side of the line and the other

through the capacitor, the motor runs one way. Reverse these connections and it runs the other way. Switching can be done by a relay, actuated by a radio-control receiver.

Some of the early models of these units used dpdt limit-switches. Once started, the motor had to run all the way through the cycle, hitting the limit-switch and tripping it before the motor could be reversed. In later versions, limit-switches are still used, to be sure the machinery stops when the door reaches the end of its travel, either up or down. However, directional control is now possible; the door can be stopped and started in the other direction.

When the command pulse is received from the transmitter, the receiver starts the motor running. If the door was down, it goes up, and vice versa. However, now the direction of travel can be reversed by pushing the transmitter button again. The door will stop and start in the other direction. (Which is handy, if it happens to be coming down on your foot or the car top.

Many late models use solid-state switching. Fig. 3 shows a diagram of a circuit using two triacs, one for UP and another for DOWN. Motor windings are arranged just as before. The only difference lies in the addition of the current-limiting resistor ($R_S$) in series with motor capacitor $C_m$.

In this circuit, if the UP triac is switched on, winding **A** gets current through the capacitor, and winding **B** directly from the triac. For DOWN, the action is the same with winding **B** drawing current through the capacitor. The switching between UP and DOWN is done by the flip-flop circuit in the receiver. Similar methods are used in smaller appliances which need reversing motors; drills and so on.

The triac reversing circuit shown here comes from the RCA *Solid State Power Circuits Designers Handbook,* Technical Series SP-52. A complete circuit for the garage-door opener unit is shown in Fig. 445, page 401. Speed control and many other circuits are shown in this useful book. **R-E**

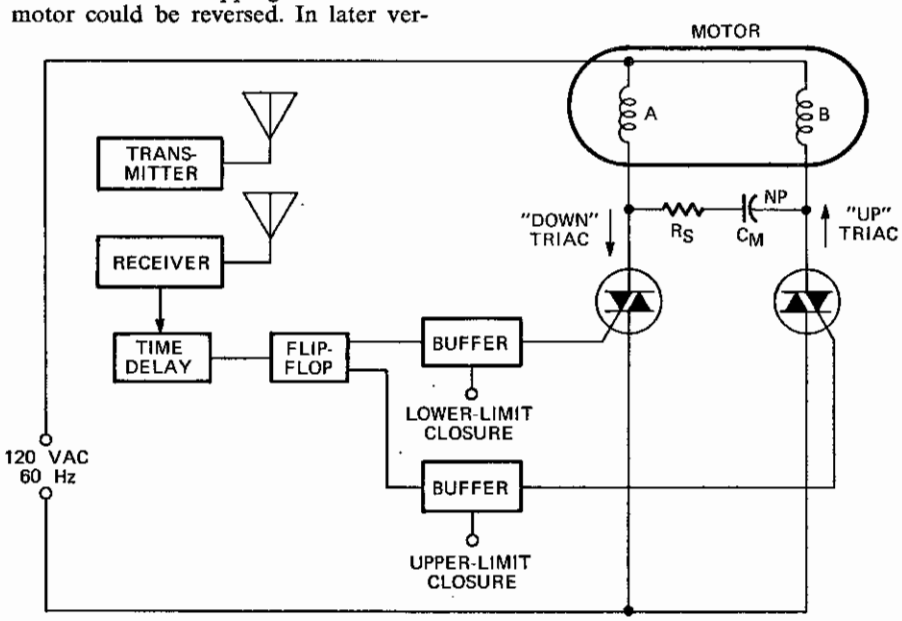


**FIG. 3—SOLID-STATE SWITCH consisting of two triacs alternately turned on and off replaces the double-pole, double-throw mechanical switch in some applications.**


TUNE-IN
on these TOP-RATED "NO-NOISE" PRODUCTS
PROVEN PERFORMANCE FOR COLOR AND B/W
FIRST, simply spray parts with SUPER SPRAY BATH.
Dissolve and flush away grease, dirt, oil and oxidation--penetrative action cleans and restores all component parts.
THEN, follow with VOLUME CONTROL AND CONTACT RESTORER
for special attention to volume controls, push button assemblies, band switches, relays and other electrical contacts.
"NO-NOISE" products are guranteed non-flammable, no carbon tet, non-toxic -- safe for plastics.
For Tuners (Incl. wafer type) use TUNER TONIC With Perma Film OR SUPER LUBE for further cleaning and lubrication – economical, a little does a lot.
Other Famous "NO-NOISE" Products
•EC-44 • Frigid-Air • Tape-Reco Head Cleaner
Often imitated but never duplicated
ELECTRONIC CHEMICAL CORP.
813 Communipaw Avenue Jersey City, N. J. 07304
Circle 61 on reader service card

why pay retail?
Buy from us, save money on hifi
Choose from over 100 name brands, and save on time and freight charges by ordering from the location nearest you!
Midwest Hifi
WHOLESALE & MAIL ORDER DIVISION
Send for our free catalog!
2455b Wisconsin Ave., Downers Grove, Ill. 60515 (Attn Ralph Edwards)
3309 E. J W Carpenter Frwy., Irving, Tex. 75060 (Attn Ron Elkins)
Circle 29 on reader service card

DISCOUNT PRICES TEST EQUIPMENT
B&K
SENCORE
Leader
Mullard Tube Specials
Telematic Test Jigs & Accessories
Catalog & Prices on Request
FORDHAM Radio Supply Company, Inc.
558 Morris Ave. Bronx, N.Y. Tel: (212) 585-0330
RCA
DISTRIBUTORS OF ELECTRONIC SUPPLIES
Circle 62 on reader service card