GOLF CART-OR FAMILY RUNABOUT

First, it's a golf cart powerful enough to carry two adults and equipment up steep slopes. But it's also a heart-saver for the aged, "legs" for an invalid, and a "school bus" or shopping "car" for Mom. It features twin-motor drive, four speeds forward and reverse, coil-spring suspension, 2-wheel brakes and tricycle steering, plus a built-in battery charger.

PART I

By Tom Riley

SPEEDS UP TO 20 m.p.h. and 30 to 40 miles on a single charging of the batteries make this cart an ideal utility vehicle for any home, farm or business. The cart is wide and low, both to assure stability on any terrain and to provide ample room for any of several combinations of motors and batteries.

First step in the construction is to make the main frame, Figs. 7 and 10, of steel channels and angles. Arc welding is required in this assembly. The next step after the main frame is assembled is to assemble the drive-unit frame, Figs. 7 through 11. The rear cross member of this frame is a length of 3/4-in. pipe that pivots in two U-shaped brackets bolted to plates that are welded to the rear cross member of the main frame. The brackets are a loose fit on the pipe. Strips of inner-tube rubber then are wrapped on the pipe under the brackets to provide a "snubbing" pivot. Stub axles for the rear wheels are welded to a length of pipe to produce a complete axle, that will give a width of 41-1/2 in. between the outer sides of the tires. This leaves a clearance of 3/4 in. between the tires and the outer edges of the cart's main frame. The drive-unit frame is made narrow enough to clear the brake drums on the wheels. Coil springs used in the rear suspension are kept aligned by 3/4-in.
AFTER COMPLETING the main frame, drive-unit frame and all other work described in Part I last month, the next step in construction of the cart is installation of the batteries. Heavy-duty, 6-volt batteries rated at 170-amp. hours or better should be used to assure maximum performance. Batteries having bolt-on connecting posts are the best for installation in the cart, as they allow interconnection of the batteries with inexpensive "bus bars" of 1/8 x 3/4-in. aluminum flats, Fig. 19. Screw strips of 3/4 x 3/4-in. hardwood to the floorboard around the batteries to keep them in place. Batteries shown in Fig. 19 are standard-sized, grouped in a rectangle and centered in the cart. If long, narrow batteries are used, place them four in a row across the center of the seat space. Weld a frame of 3/4-in. steel angles for a hold-down and secure this frame on two ends by means of long 5/16-in. bolts passed through the floorboard. This arrangement is similar to that used to hold the battery in an automobile. The lower, left-hand detail in Fig. 15 shows how four 6-volt batteries can be hooked together for 12 volts, the detail to the right shows a 24-volt hookup. Note the 6-volt take-off for lights. If the cart is used on the street, it will require a horn and lights as well as a license. When extra accessories are installed, tap each unit from a different battery. This distributes the electrical drain so that one battery is not overtaxed. Because the batteries are charged as a unit, when the other three were fully charged, the battery from which all the accessories were draining still would not be up to standard.

Next, it is necessary to determine the method to
use for reversing the motors you are going to use. Most traction motors have 3 or 4 terminals on the outside, with a diagram printed on the motor or terminal box, so no changes are necessary in this type of motor. Most surplus aircraft motors will require that short leads be run through the brush cover to extra terminals on an insulated base outside the motor, as shown in Fig. 16. Reversing diagrams sometimes are supplied with these surplus motors, but it is best to have an electrician check to make sure it is right. A diagram supplied with motors used on the original cart was incorrect; it recommended reversing the polarity of the brushes, resulting in a dead short, because these particular motors had grounded armatures. Fig. 16 shows how these were correctly reversed. It still is best to check with an electrician before connecting your motors.

The heavy-duty reversing switch required, Figs. 17 and 21, is obtained inexpensively by rebuilding an old-style 50 to 100-amp. double-pole, double-throw service entrance switch. They can be obtained at some electricians' shops because they are being replaced in homes today with less exposed disconnects. Raise the two center, or hinge, jaws of the switch about 3/4 in. on pipe spacers, so the blades will clear the end jaws by 3/16 in. when they are level, Fig. 17. Replace the two blades and handle with two 5-in.-long copper blades, pivoted at the middle. Bolt a block of insulating material between the blades at the center, then attach a new handle. If necessary, reposition the four outer jaws on the base plate so they fit under the new blades. Bolts securing all six jaws to the base should extend about 3/4 in. below it, so they

Above, wiring diagram for reversing aircraft starter motors as corrected by builder of original cart. It still is best to have electrician check motors

Photo, below, shows installation of four, 6-volt batteries, with hold-down frame. Charger and timer are in foreground. Wiring diagram is shown at left.
Speed-control unit, above, consists of four auto-
starter relays and a rectangular resistance coil

+ TO BATTERIES

TO REVERSING SWITCH ALUMINUM BUS BAR

SPEED CONTROL

RESISTANCE COIL

ELECTRIC-CABLE CLAMP

BUS BAR

2" FRAME ANGLE,

SIDE VIEW

Reversing switch, above, is raised on pipe spacers
so that wiring can be run in the space beneath it
can accommodate two nuts and cable termi-
nals. On the underside of the switch base, cross-connect the four outer terminals
as indicated in Fig. 17, using copper or alu-
minum strips. The switch handle is a 1/4 x
1/2 x 10-in. steel flat, twisted 90 deg. just
beyond the insulating block to which it is
bolted. The end is ground down and threaded
to accept a small gear-shift knob from an
automobile steering-column lever.

To vary the speed of the cart motors, a
speed control is assembled from four 6-volt
auto-starter relays, which pass the elec-
tric current through a varying length of
chrome-nickel resistance wire, Figs. 20 and
22. In operation—see Fig. 22—closing relay
No. 1 causes the current to pass through
the full length of the resistance coil, resulting
in low speed. Closing relays 2, 3 and 4 give
constantly higher speeds, with No. 4 pro-
ducing full speed because it allows the
current to bypass the resistance coil. Use
auto relays that have no connection be-
tween the relay coil and its main terminals,
such as for a 1946 to 1954 Plymouth. Most
Ford relays, for example, look the same,
but have the relay coil wired internally to
one of the main terminals, which will cause
the 12 to 24-volt current to feed back
through the 6-volt coils, causing either a
heavy "short" or chattering of the relays.
If available, 24-volt aircraft relays, which
have silver contacts, are best. Drill holes
3 in. apart in a 1/8 x 3/4 x 11-in. aluminum bar
and bolt the motor-side terminals of the
relays to it. Bolt the four relays to a 4 x 12-
in. piece of 1/4-in. hardboard, using rubber
washers as indicated in the lower detail,
Fig. 22, to quiet the click when they operate.
Connect the four relay housings together
with a small wire to provide a 6-volt ground.
Making the resistance coil is a cut-and-try
matter, depending on the wire, motor type
and voltage used. Try about 10 ft. of
1/8-in.-dia. chrome-nickel resistance wire, wrapped around a 2 x 6 to form a rectangular coil. Because the wire gets hot when the cart is running, mount the coil above the relays, and extending out from them as in Fig. 22. For the same reason, connect the coil to the relays with electric service-entrance cable clamps, rather than by looping the wire around the relay terminals. The clamps also allow you to tap off anywhere along the coil. Connect the clamps so there is more coil between relays 1 and 2, than between the others. If this produces too slow a first speed, cut down on the length, if too fast, add more resistance wire between the first two relays. The speed control is bolted to the center of the 2-in.-angle crossframe with two pieces of steel angle, Fig. 22.

The 6-volt wire from the batteries and the four wires from the relays to the "accelerator pedal" need be only 18-ga. stranded wire, secured to the underside of the floorboards. On the original cart, the accelerator switch, Fig. 24, was a long-wearing, silver-contact type made especially for this purpose by one of the larger golf-cart manufacturers. Some heavy-duty surplus radio switches also can be used. They are a "shorting type" switch. The wiper arm of the switch contacts each following terminals before disconnecting from the preceding terminal, providing a smooth action. The heavy wiring from the batteries to the speed control, reversing switch and motors, Fig. 15, should be 6 ga. or heavier. Auto-battery cable is excellent but expensive. House-service cable can be used, but is less satisfactory because it is difficult to bend at sharp angles.

The built-in charger is an optional feature, but it definitely simplifies servicing. The charger shown in Fig. 19 produces more than 20 amps, at 24 volts, and has both a 12 and 24-volt output. An 18-volt transformer would have to be used, if that current were used in your cart. Mount the transformer on brackets about 1/2 in. above the floorboard, so wiring can be located beneath it. A 12-hour, spring-wound timer switch, such as used for large fans, is mounted under the seat. The wiring diagram is shown in Fig. 18.

Figs. 14 and 25 show how the two sides, rear panel and rear deck, cut from 1/2-in. plywood are attached and trimmed with linoleum trim strips and steel angles. The side rails on the rear of the cart are bent
from 1/2-in. Thin-Wall electrical tubing. The hood of the cart is formed from a single sheet of 1/8-in. hardboard, measuring 24 x 76 in. Cut this panel after it has been clamped or screwed to the center of the floorboard, with about 5 in. extending below it. Then bend and clamp the ends of the hardboard to the frame. Push it down until the top end assumes an even curve, then screw it to the floorboard every 8 in. Now, mark the vertical lines of the doorway and any pleasing curve desired for the top and bottom edges of the hood; Fig. 23. Remove the hood and cut it with a bandsaw, or cut it in place with a handsaw. The glove, or package, shelf, shown in the photos in Part I of this article, is cut from 1/2 or 3/4-in. plywood and screwed to the inside of the hood at a convenient height. An instrument panel is screwed to the glove shelf at about a 10-deg. angle. Install a keyed "ignition" switch and any other accessories desired on the panel. The hand-brake lever is fastened to the underside of the glove shelf with a metal bracket.

Upholstering of the seat cushion and back may be done by a professional, or at home, if a heavy-duty sewing machine is available. The cover material of the seat should be weather-resistant plastic, and the filling should be two 2-in. layers of foam rubber cemented together. The seat cushion is assembled around a sheet of 1/2-in. plywood, the completed cushion resting on hardwood strips, right-hand detail, Fig. 25.

Note that the seat cushion is slanted slightly, to provide more comfortable seating. The degree of slant will vary, depending on the necessary clearance above the batteries being used. Drill a few holes in the bottom of the seat cushion to provide air escapes for the filling. The seat back is formed in the same manner as the cushion, except that it is assembled on a sheet of 1/4-in. plywood. The completed back then is screwed permanently to the seat back. It is necessary to have the seat cushion removable to permit access to the batteries.

The completed cart can be painted with any enamel, lacquer or other exterior-type finish. The original cart was finished with a vinyl-lacquer, two-color "spatter" paint, that has the advantage of producing a tough, heavy finish in one coat, and does not require a spray gun for application. Rubber floor matting, obtainable at most auto-supply stores, is used to cover the rear deck, floorboards and glove shelf. Metal enamel should be used on the wheels, rails and steering column of the cart.

If the cart is to be used for golfing, two lengths of web strapping are screwed to the top edge of the seat back. The golf bags then can be strapped in place. * * *
Pipe caps bolted to spring plates at the front of the drive-unit frame and to the 2-in. cross member of the main frame. A long 3/8-in. bolt with fuller balls at each end is used to "snub" the frames together and to prevent sidesway of the drive-unit frame. The lower right-hand detail in Fig. 7 shows the snubber bolt, springs and pivot-bracket setups. A piece of 3/4-in. plywood is bolted to the drive-unit frame to support the motors. Slotted holes in the plywood permit the motors to be moved to allow adjustment of chain tension. Heavy turnbuckles are attached to the frame and to the motors near the shaft ends to "hold" this adjustment.

Wheels, which should be purchased before assembling the drive-unit frame because of the need for measurements, can be of several types. For the rear, the wheels should have 4.80 or 5.50 x 8 turf-type tires, such as used on most golf carts. A less expensive substitute are wheels torn light aircraft, which are available as war surplus. These have tires with a channel tread, and are complete with bearings, hubs, and spindles. Also available are 6-in. brake drums and sprockets drilled to fit the wheels. For the front wheel of the cart a rounded tire is best. A 14-1/2-in. balloon aircraft tire or a 16-in. standard industrial tire should be used.

The fork assembly is made as shown in the left-hand detail, Fig. 7. Either turned brass bushings or ball bearings can be used, pressed into a counterbored length of pipe or tubing. The latter then is welded over a hole drilled in the 3-in. frame channel, Figs. 6 and 10.

Three types of d.c. electric motors can be used for the cart. Sprockets and chains from light motorcycles are used with each to deliver a speed of from 350 to 400 r.p.m. to the rear wheels. Aircraft starter motors,
Photo of frame front end shows location of fork, foot and hand brakes, extreme turning angle possible.

Fig. 8, available as war surplus, can be used if only moderate power is required. Although rated at 24 volts, they are designed for intermittent service and should be run with four batteries producing 12 volts, or three batteries that will provide 18 volts. Most of these motors turn only about 100 r.p.m., so a large sprocket is fitted on the motor and a smaller one on the wheel. Check the r.p.m. rating of any type motor before obtaining sprockets. A second type aircraft motor, also available as surplus, is a high-speed unit that rotates at about 5000 r.p.m., which makes it necessary to use a gear reducer of from 5-to-1 or 10-to-1 to reduce the speed to a point where chains and sprockets can handle it. A third type motor, the most expensive, is a propulsion or traction motor, Fig. 9, such
Drive-unit frame with aircraft starter motors installed. Note turnbuckles from the frame to motors such as used for golf carts and industrial lifts.
as is used for golf carts, electric lifts and the like. They are available from the larger motor manufacturers.

Brakes for the rear wheels of the cart can be made in two ways. If you purchase wheels with 6-in. drums, parking brakes of the external-contracting type, used on the drive shaft of Plymouth cars, can be modified for use as shown in the right-hand detail, Fig. 7. A second type of brake is to bolt a double V-pulley to each wheel and use two V-belts as "brake bands." The latter brake is efficient, but wears rapidly. Arrangement of the cables for both the hand and foot brakes is shown in Fig. 10. The parking-brake handle can be one picked up in an auto wrecking yard.

The seat back and three floorboards now are cut from 3/4-in., exterior-grade plywood. Ten 2-in.-dia. holes in the back are located toward the center so mud from the tires will not spatter through. These, and nine holes in the seat floorboard ventilate the charger and batteries. The seat front, cut from 1/2-in. plywood also is attached, after being slotted for the reversing switch, Figs. 11 and 13.

Figs. 1 through 5 show just a few of the
Springs used to counterbalance the hoods of some automobiles are strong enough for the fork assembly many uses for this versatile golf cart-runabout. If it is to be used by an invalid, the cart should be fitted with hand, rather than foot controls. The "accelerator" pedal can be replaced with a lever-controlled switch on the instrument panel or glove shelf. Brakes also can be operated by a long lever projecting upward through the floorboard and positioned for the driver to grasp it easily. An upward-projecting extension handle also will have to be fitted on the reversing-switch. It is important that this switch be handy for any driver, as it can be used to brake the cart in an emergency. If the cart is to be driven on streets or highways, check with city and state officials for types of licenses required before constructing the cart. You may find that your state or city does not permit a vehicle of this type to be driven on the streets or on the highways. Next month will be shown the installation of wiring, battery hook-up and attachment of the body sides, front and seat.

This view of cart shows neat appearance of seat and rear deck. Note reverse lever at front of the seat.