

A Radio Control Publication for Beginner & Advanced Modeler

VOLUME 6 NUMBER 2

# GRID EAKS

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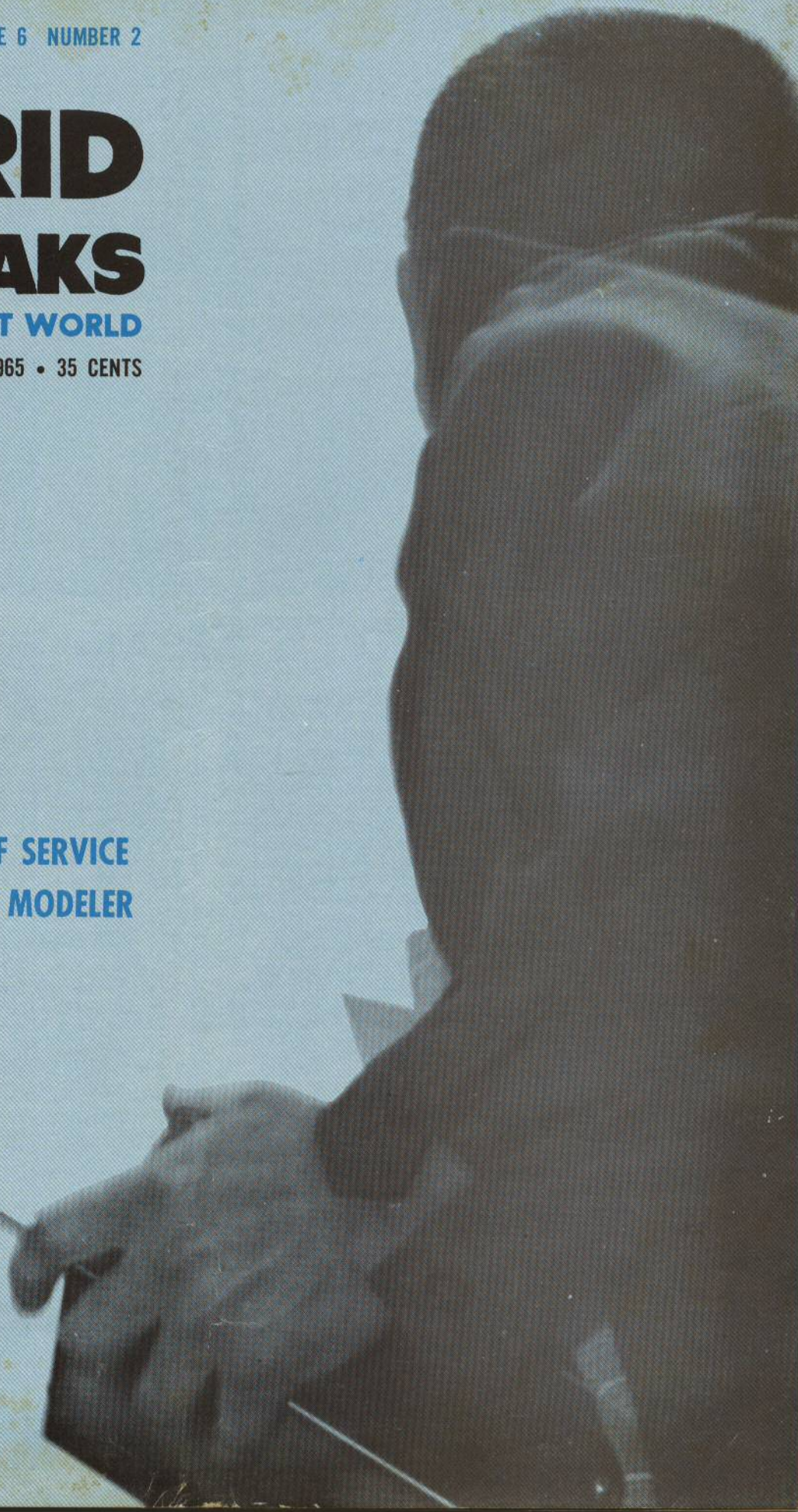
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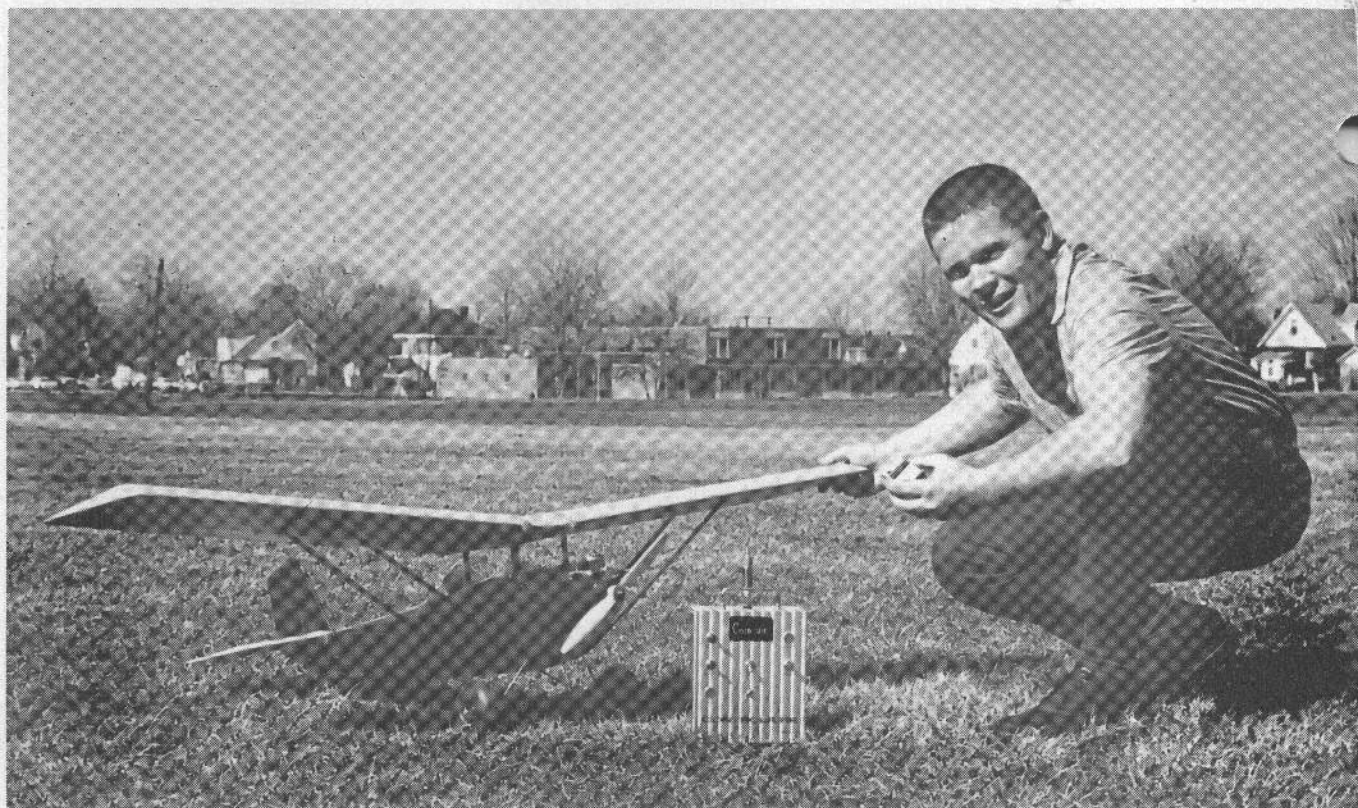
IN THIS ISSUE

● HOW RC WORKS!

Exclusive in "GL"  
this comprehensive  
briefing will prove  
a boon to novices.







## CONTROLAIRE 6 CHANNEL SUPERHET

The Controlaire 6 channel Superhet is the result of many years of pioneering and research in the field of all-transistorized superhets. Controlaire offered all-transistorized superhet receivers back in the late '50s when others still clung to tube type configurations. Through the years this circuit has been improved and miniaturized and incorporates a novel cube shape mechanical design which results in an extremely compact cube shape which is easy to mount and with plenty of room for foam rubber to isolate vibration. This configuration which has made our 10 channel famous is now being employed in our new 6 channel superhet receiver. This receiver incorporates six transistors, separate local oscillator, one mixer, two I. F. stages and two stages of audio, and about 60 db of A. G. C. to insure no overloading and to give linear amplifier response.

The transmitter is non-simul, operates with a 9 volt dry battery or 8.4 volt nickel cadmium batteries. The power output is approximately 150 milliwatts radiated. The modulation is 85% to 90%. Average RF and audio power doubles during modulation. The RF section is M. O. P. A. using "Silicon Epitaxial Planer" 2N-706 transistors. 3rd overtone oscillator and RF amplifier. Uses a series tuned center loaded antenna. Audio section uses a torroid stabilized Hartley oscillator, stable within 1/2 cycle from 9V down to 3V.

### About the Model

Controlaire 6 channel is used to control this Pietenpol Air Camper. 6 channel gives you motor control, elevator and rudder. The scale tail surfaces on the Pietenpol are so large that a special motion reduction linkage system was built into this model to maintain the scale effect. The model incidentally is Jess Krieser's design which may be appear-

ing in this issue of Grid Leaks if Bill Winter is on the ball. The original has been flown quite a bit. The model is a fairly gentle trainer as it is slow in the glide. We have ground looped our model on take-off attempts and do not recommend cross wind take-offs. Inverted flight is not bad, outside loops not recommended with the true scale elevator and stabilizer. The model shown is powered with a Series III Max 35 and, if anything, it is overpowered. The new OS "S" Series Max 35 (\$19.98) with throttle should be plenty of power. Our model was finished with Aero Gloss Curtis Blue on the fuselage. The wings and stabilizer are Taylorcraft Cream. It is the writer's opinion that the addition of ailerons would not add much to the flying of this model as with this wing cross section models tend to yaw in the opposite direction before they roll — rather appalling.

### SPECIFICATIONS

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## GRID LEAKS AT PLAY

• This month's column is dedicated to the experimenter, the tinkerer, the do-it-yourselfer.

There seems to be a tendency on the part of some to look down their noses at this side of the RC hobby, classifying experimenters as "off-beat," and sometimes in even more derogatory terms.

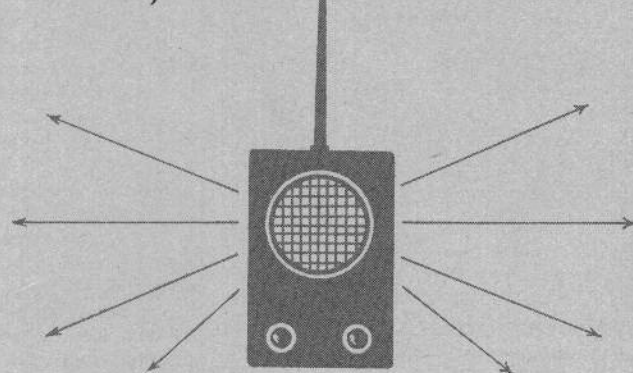
The experimenter and tinkerer is the one who has worked many long hours with Mickey Mouse systems, Kicking Duck, and Galloping Ghost, and other ideas, and he could easily be labeled as being in the impractical and unproven realm. However, we venture to say that this basement workshop artist has probably done as much, or more, to advance the art than has the average contest flyer. Our hats are off to the experimenter who pursues the will-o'-wisp idea, and converts his dreams into something practical.

Many tinkerers choose this course deliberately, because they love it. Limited finances may have something to do with it, since they feel they cannot afford the increasingly high costs of some of the commercially available gear. But it is also a sort of adventure for them. For each dozen of ideas attempted, possibly only one may bear fruit, and that one only partially. But it is an accomplishment of which they can be, we feel, justifiably proud.

Theirs is the solid feel of accomplishment, culling the best of ideas that they can glean from (Continued on page 4)

# THE MONITOR

Regular round-up of new and overlooked aspects of the growing R/C field • Shop talk and just talk • A discussion corner.



■ FROM THE BEGINNING OF RC TIME, the ultimate in model aircraft always has been a realistic looking machine with proportional control of all the primary functions found in a real airplane. But is the "full-house" machine, on proportional or reeds, really the ideal?

For those who demand unrestricted aerobatics and have the money for the fully equipped bomb and its support equipment, the "ultimate" aircraft is full-house. One suspects, however, that many of us must, and sometimes may prefer to, settle for a lesser degree of control matched to some desired performance—leading (everybody's good fortune) to a great deal of clever developments to get the most from the least. Experimenters, long may they live, have laid the groundwork for everything we fly today.

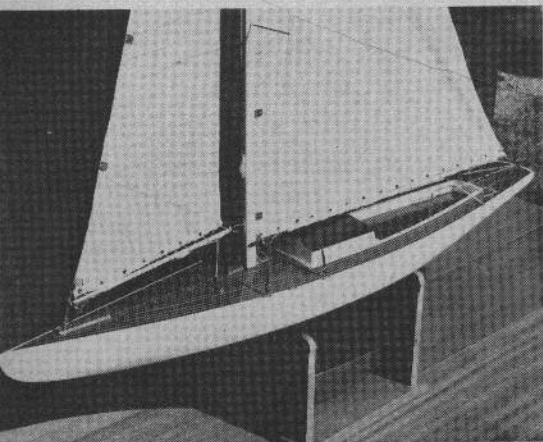
The proponents of "rudder only," the many forms of single-channel proportional, dual proportional, the intermediate number of channels, and of special or small, economical aircraft, greatly outnumber those whose only problem is what brand to select and how to fly without cracking up too badly or too often. Without detracting from the satisfaction and enjoyment which multi (we mean 10 or 12 channels hereafter) does afford—and most of us would like to have it if we could—the efficient, neutrally stable stunter is deficient in certain attributes required by those who prefer a more leisurely, pretty, or "buoyant" type of flight, or who like to experiment and develop more radical configurations (well, you can do that with any equipment), or who like things small and simple—attache case stuff, for instance.

While those among us who have tried a great many things are well aware of the attractions of more rudimentary designs, too many who possess no such yardstick unfortunately have little patience with the curious sport flying crowd who just "mess around."

Two years ago GL raised the question of what was going to happen to Class I under the then-proposed rules that the three classes should have respectively an equivalent number of axes of permissible control. It was a fact that virtually no true single-channel contest modelers, regardless of the actuation system, saw the overwhelming advantage which would accrue to those who could now transfer their 10- or 12-channel receivers with a couple of servos—at \$30 a throw—into Tri-Squires, and so on. And if the Class I rules now effective were for a time considered the answer to the problem of, believe it or not, how to identify a Class 2 machine, some people are now doing a double-take.

It is not to be questioned that those who do fly multi in contest rudder jobs are content—no one wishes to take their fun away. But we are hearing now that "something must be done for the escapement people." One wonders what can be done for them! For competition, (Continued on next page)

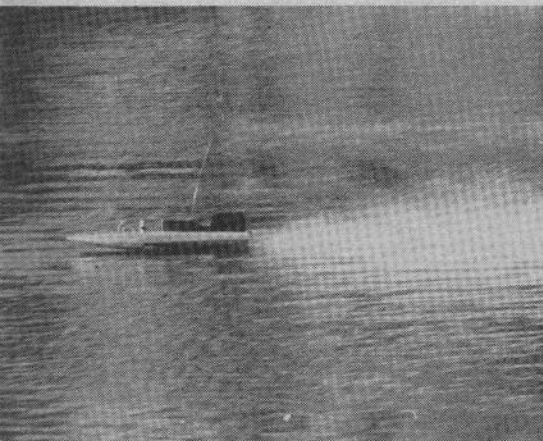




Hartman's radio controlled sailboat, the Olympia. Uses 8 of 12 channels.

very few people thought a few years ago, that the escapement could stand up to the single-channel pulse stuff which had started the trend to high-powered, ballooning craft which could do the loops, and struggle into the wind when throttled back. Perhaps what awakening critics really mean to say is: "give it back to the single-channel people!" Taking no sides, we can ask for sober realism.

In multi competition, the gap also is wide between sport and contest flyer, but only because the average chap thinks he doesn't stand a chance. (He should see how close he can come to the expert, and not go into hiding.) AMA is attempting to deal with this problem with a Novice/Expert breakdown. Doing something for the escapement people would offer no



Octura's three-pointer. Note antenna bent in breeze—and that roostertail!

contest remedy—but if there is a school of thought favoring an escapement event (perhaps as an addition), it would be mulish to stand in the way of the experiment. It seems more likely that what is worrying the exponents of the scheme is the vast chasm that has grown (regardless of number of channels) between the contest and the sport flyer, who live in different worlds, and go their separate ways.

There are complex overtones. The average age of the contest flyer—and of all multi flyers—is terribly high. Multi

control primarily is a grown man's hobby and, with such price tags, is not for all the men either. What can radio contribute to American modeling as a movement, as an ingrained hobby which always appealed to youth, and which was instrumental in making modeling a tangible benefit to full-scale aviation (and that benefit, to our danger, grows harder to maintain, if not to prove, with every passing day)? Can radio so contribute? Must it so contribute? Dare we each just enjoy ourselves?

Were they more articulate these worthy worriers could tell us that they really wish to make the radio division of our hobby more universally enjoyable and attainable, and that means, more than anything else, the perfection of reliable, simple equipment more perfectly suited to the totally inexperienced, at a price that a young man does not immediately judge to be so hopeless that he turns to slots, if not control-line models. There are no easy answers.

We shall be plagued by the question, "Which comes first, the mass of radio oriented modelers, or the radio systems for a hoped-for market?" Every time someone thinks in terms of really mass production—essential to price reduction—they fall flat on their faces. We have had some notable attempts, but only one hobbyist in a hundred can even remember the ill-fated brand name(s).

If we are to consider ourselves realists, we must concede the serious short-comings of much in radio—which we are content to suffer with; in almost everything that passes for simple, cheap radio control.

It would be nice if any editor could speak his piece without being blindfolded for execution. People damn escapements right and left—but some escapements are not bad at all when considered separately from the systems in which they are involved by manufacturers or customers. Others cry for a decent proportional poor-man's proportional actuator for the larger models. For simplification of the transmitter/pulser bit. (Is a charger, and nickel cads, an unavoidable expense, in order to have reliability?)

What, we can ask ourselves, is the best simple system, that makes it easier to fly more reliably at reasonable cost? What needs to be done to make it better? Even if a mixed committee of interested manufacturers and experienced modelers could pin down proper objectives, and possibly thereafter went in for a real research and development program (it will cost temporary losses of one kind and another, investments and loss of sales on outmoded things) modeling stands to gain. Dare we speak out about the short-comings we all note here and there? There is no disgrace in making necessary improvements—bugs are found every day in all manner of production items in every field, cars for one. If we already had the answers, there could be no progress. Since progress is obvious and inevitable, why not give it a nudge?

Multi—technically speaking—is not in trouble. One can expect with reasonable luck to fly a season without loss of an airplane. Where we must apply ourselves is in the improvement of simple, "cheap" stuff, discarding accepted methods which

might be outdated—but which we continue using because what was good enough for dad, is good enough for us. Ignoring everything that does not have ailerons, or a 45 or 56 or now a 60 in the nose, can have serious consequences. All kinds of radio models offer pleasures which other types do not offer.

The magazines seem to have published enough multis for every man, woman and child in America. Multi, we've got it made. It is all that we have dreamed about from the days of the mysterious tuning of the pioneering Good Brothers receiver, or the gas tubes which we baked in ovens to make sensitive (for perhaps only a few flights before the tube gave up the ghost).

These days we multi flyers are often called a "cult." We are, in fact, a bit wrapped up in ourselves. No multi flyer is an expert, if he flies nothing else. He does not know his subject. There is work to be done.

The fine art of sail boat racing is making a come-back, thanks to radio control, states John Reynolds who authored the report elsewhere in this issue.

"Model sail boat racing is conducted in the same way as small boat racing," he comments. "Three or more of a class of boat in an area and actively sailing together, form a fleet. Skippers keep in contact through clubs and newsletters and meet at regattas to race their boats and take home trophies, ideas and experience.

"When modelers or amateur radio bugs get a racing sloop, they become part of a club. They get together, compare equipment, and test their skills. The models depend on RC equipment—without it, they are toys."

John tells us that the boat boys paralleled airplane radio developments, using carrier on-off, then tone, for channels functions from three (gadgets) and finally four-channels—but read about it in his article. Locally, in Florida, one system called "old reliable" consisted of a cheap Lafayette Walkie Talkie.

"If sail boats catch on, we'll need RC for 15 to 20 boats simultaneously."

And speaking of sail, friend D. R. Hartman, the fiberglass man, has an Olympia (mast is six-feet) kit at \$100.00. (Reynolds, too, is in the sailboat business—letters will be forwarded to both these people (so please don't hesitate to write us).

Says Dwight, "RC gear will be mounted in a watertight box that fits down in the hull and keel. A 12-channel Min-X super-het will control three things: four channels for rudder, two for the main boom winch, and two for the jib boom. On rudder we have positionable, yet with neutral, so one Transmits is for left and one for right.

"This can be worked out with a spring-loaded tiller set-up. If we can't find a winch we will build our own with the Transmits as a base. Anything that will wind in one line and let out the other, will work."

Due to heavy Zeus fuselage production, Dwight has been three years developing the Olympia. He is impressed by the speed—bear in mind he knows how a multi flies!

Space does not permit, but correspondence with Vis Smeed on the British *Model Maker* mag, brings out the fact that a

(Continued on page 4)



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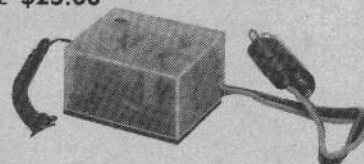
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## THE MONITOR

(Continued from page 2)

simple sheet-balsa boat with rudder steering is lots of fun. That contest-sport conflict again?

Another RC magazine has been announced, this time *Radio Control Systems*. The publisher, ED Electronic Developments, Bath Rd., Hounslow, Middlesex, England, calls it "The British GRID LEAKS."

Two sample kits on the bench. One, Carl Goldberg's Half-A Cessna Skylane, should please scale-like fans. There's a bit of building in the fuselage, but Carl wanted windows without a weak structure and used die-cut ply for framing and inserts. Having partly assembled it for a check, recommend it as a nice addition to your stable—rudder and/or rudder and engine, escapement or magnetic actuator. It's pretty.

The second kit is Lou Andrews' much awaited Hi-Ray. This is a good, basic, all-round Class I—elevators optional for more thrills and Class II—for .15's and up. Lou is conservative on his powerplant selection—a good thing—but many builders will want contest-type flying, and oversize engines. Personally, we prefer it low powered to fly prettily.

The wood, cutting, production and the organization of the plan and building procedures are excellent. Some aspects of the fuselage construction impressed us highly. They will be copied! Now, if we had an oversize Adams actuator for a .19, and something for MC, the writer would surely fly it. Or if our Marcy three-channel was superhet. There's two more overdue ideas!

## G/L AT PLAY

(Continued from page 1)

Other experimenters whose ideas have been published, and coming up with their own practical and perhaps still better version. Not all experiments are doomed to failure, and certainly not all of the Mickey Mouse systems that have been evolved are to be sneered at.

We feel strongly that RC owes much to the tinkerer. Without his independent research and development going on simultaneously, outside of the commercial establishments, we doubt seriously that radio control would be where it is today, for the enjoyment of the contest flyer. The contest flyer owes much to these "impractical dreamers."

So GRID LEAKS—R/C DATA SERVICE promises to these experimenters that we will continue to offer to them the columns of our publication as a medium for the exchange of ideas.

May your tribe increase, and may just a few of those ideas you have work satisfactorily for you. If they do, we know you will feel as great a sense of satisfaction as if you had won the biggest cup in the largest of regional contests.

We don't downgrade the contest goer; we do want to upgrade and hold high the hand of the experimenter, the tinkerer, and the do-it-yourself fan. We offer him our deepest thanks for the help that he has given the advancement of the radio control field.

# Readers Write

## IT'S DEEP BUT HE IS DIGGING

I'm not one for writing letters to the publisher but I want you to know I enjoy GRID LEAKS very much. Quite a bit of it is much too deep for me but I'm learning. It's been a big help into the world of the "Unknown." I've just gone from single to six channel and am having a ball.

JOHN ARMSTRONG, Redondo, Calif.

## CHALLENGERS—LIVE!

There are three of these full-size airplanes at the Reids Hillview Airport, San Jose, Calif. (See GL Nov.-Dec. '64)—KR-21, KR-31, and KR-34, all owned by Bob and Ran Reid, avid Antique Airplane Assn. members of Northern California, Chapter A.A.A. I saw these airplanes at the June National West Coast A.A.A. Fly-In at Merced. I have color slides (35 MM) of all of them.

I am the keeper of the slide library and Chapter Historian of the San Diego Chapter Inc., Antique Airplane Assn. I have 5,000 scale prints and plans of antique airplanes, Waco, Travelaire, Eaglerock, Great Lakes, Porterfield, American Eagle, Rearwin, Arrow Sport, Brunner-Winkle Bird etc.

Also enclosed is a picture of my recently restored Porterfield 75C (1939) N32315, the only one that is licensed and flying of this model, an 85-hp, Continental. A beautiful flying ship, all white with orange and light blue trim. To find more information on KR-34 airplanes, see Juptner-U.S. Civil Aircraft, Vol. #2, pages 176, 177 and 178—a complete listing of 19 of these airplanes still in license and flying.

I'm a scale model airplane "nut," build all kinds of stuff when I find time, make all the West Coast Fly-Ins and Airshows in the old Porterfield, and have about 1,000 color slides of old antique airplanes.

Will subscribe to your magazine. Let's have some more articles like the KR-34!

W. L. "BILL" HAWES, San Diego 17, Calif.

## DOUBLE—TAKE

I wager that you are probably wondering why I want to go to all this trouble, especially since I have a 10-channel receiver and transmitter already. The answers are easy, first, I am getting fed up with contest run-of-the-mill airplanes, and I hope to build some scale jobs for a change. Now that I think of it, this is one of the major reasons I went into RC in the first place; when, as a boy flying free-flight and U-control, I always had hopes of RC scale. Second, I have built several receivers, and find this part of the hobby most enjoyable. Third, being married with two children, I can afford another matched set like a hole in the head.

VIC MIDGLEY, London, Ontario, Can.

## HE'S HAD IT!

I'm asking you to permit poor old me back in the fold. Don't—please don't—attempt to recommend a couch doctor. I know I'm not ready for that yet.

I have just completed my first season of multi flying—and I am not too impressed. I yearn for the good old honest-to-goodness "Poor Man's Proportional." Oh, I've been in contests; I've won some prizes; I learned to do the eights, inverted loops, etc., etc., but, I can't for the life of me get proportional out of my system.

It could be that proportional offers a different kind of challenge. I won't deny that multi offers challenges—it does.

Give us some more articles on proportional. I intend to sell my 6-channel receiver and transmitter and get back into good single proportional.

BILL STEINHAUSER, Pittsburgh 23, Penn.

## WANTS MORE SCALE

Received your copy of GRID LEAKS recently, since you joined with *Model Aircraft World*, and am very pleased with the magazine. Its charm to me rests around the scale model features, since scale model aircraft are the type that really appeal. It would be very

pleasant to realize that perhaps GRID LEAKS could be dedicated to the radio control scale model fan. Please have more and more scale model aircraft feature. I hope you can make scale model aircraft the main theme of your magazine. I have built and designed and flown scale models since 1934, and their charm and appeal seem to grow as the years go on.

I've always wanted Drigg's Skylark plans.  
GERALD J. VELTRE, Elizabeth, N.J.

## A SNAP

With the search for small switches, a lot of us are over-looking a strong, lightweight, and positive action device. A dress snap! I use the #2 size for antenna connections, and as switches. They are inexpensive and strong, witness the work they do on clothes.

GORDON LAUDER, Springfield, Ill.

## CORREX GEMINI SWITCHER

I helped Bill Campbell extensively in flight testing his Gemini Transmite switcher. I was very happy to see the circuit published after more than two years to testing. I can attest to the excellence and reliability of the system.

However, a short time after the circuit was published, a friend of mine brought to me a unit that he had just built to be checked over, because it was not working properly.

The leads of one jumper and of one 22K resistor were transposed. The jumper from the collector of Q11 should go to the junction of the 10K resistor with the two .05 capacitors of the first motor flip-flop, while the free lead of the 22K resistor shown connected to this point should go to the base of transistor Q13.

If fired as shown the first flip-flop becomes nonstable instead of bistable, and you would get slow and fast engine, no middle speed.

DR. JULIO QUEVEDO, Iowa City, Iowa

## ATTENTION MANUFACTURERS

The Monitor speaks for many of us. I would like to suggest to the manufacturers that they print a descriptive pamphlet on their actuators, escapements, and servos and sell this for a small price. This should give new RC'ers more details of the equipment and a better chance of finding something we can use without buying until we find it.

WM. J. SMITH, Tampa, Fla.

You make it so easy for me to part with two bucks that I simply can't resist. Please renew my subscription. I enjoy your publication very much, and marvel at the consistent improvement in quality from issue to issue. Your recent articles (e.g. The Monitor, May-June '64 and Phil Krafts P/C in Perspective) have struck a real chord. I built a North American gas-tube receiver, a Live-wire Kitten, and a single-tube transmitter in 1952—never got it airborne before I went into service in 1953. Started over again in 1963—Septalett Mark 5 actuators, and Tee Dee .020 but no flights 'cause no transmitter. Been looking for a high-power all-transistor proportional for reasonable price. I'm an Electrical Engineering graduate, but not a ham. Haven't had the guts (or the \$40 to \$50 that seems necessary) to follow one of your construction articles on a transmitter. How come no one states the power output of their transmitters? Seems to me the best way to rate two units of similar features. Percent modulation might also be helpful. Maybe you could include some of these "vital statistics" next time you do an RC Equipment Survey. Looking forward to more copies of "the greatest" in RC information.

GERALD E. GERSTNER, Phoenix, Ariz.

## COMPUTERS TO RC

I have been in electronics for 12 years and only mildly interested in RC. However, since I have started to receive GRID LEAKS this has changed. My present capacity is the responsibility for five computer systems which have stimulated my outside interests in RC. I have designed and built my own Quad-Prop system with discriminators.

EUGENE A. PULACHI, Houston, Tex.

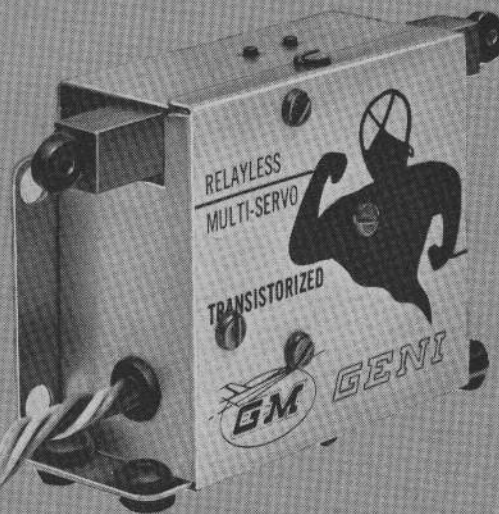


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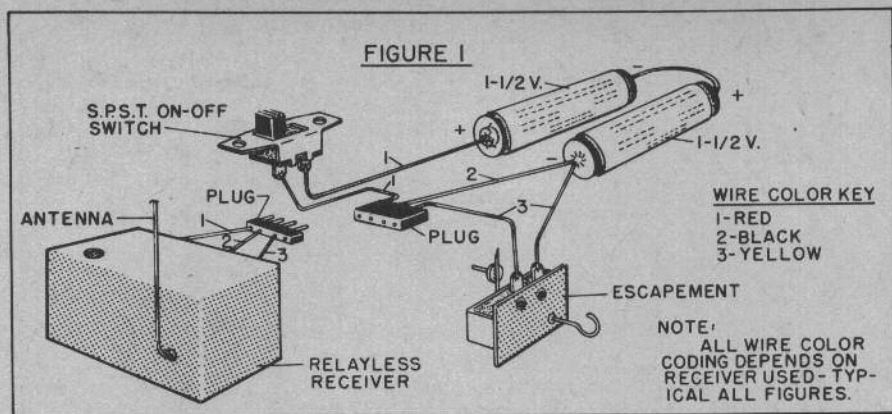


Figure 1: This is the classic system schematic from the point of view of simplicity, the "three-wire" single-channel relayless receiver with escapement. Below, Figure 2, same system—but four wires and magnetic actuator for proportional.

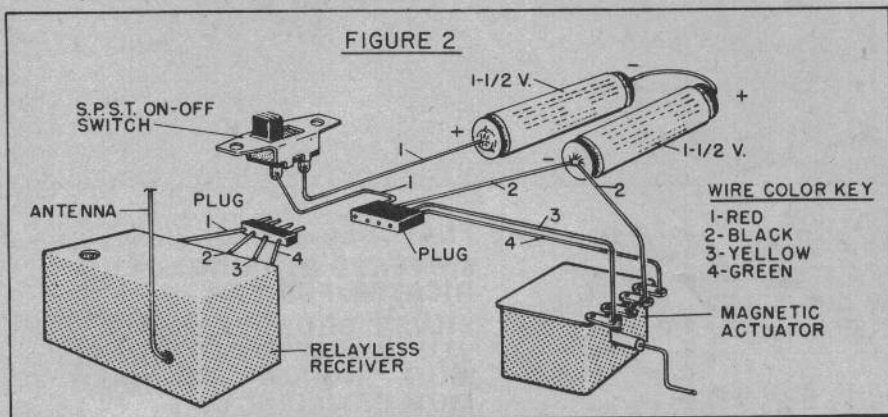


Figure 3: Another variation on the simple theme (below), this time a "compound" escapement with a second escapement (self neutralizing) for the motor control.

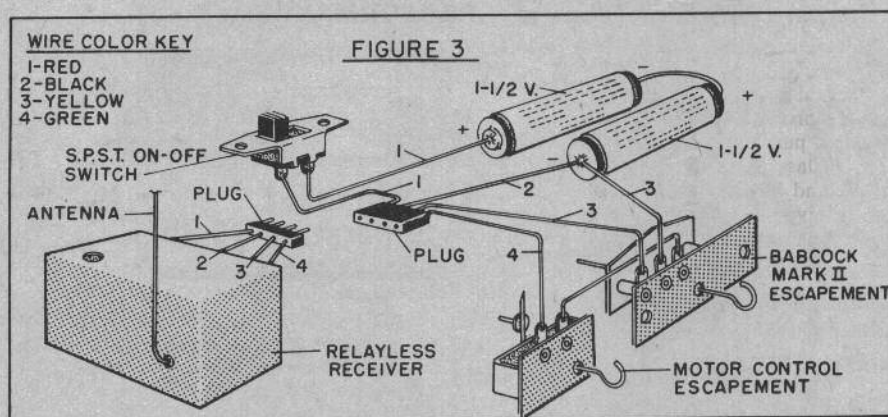
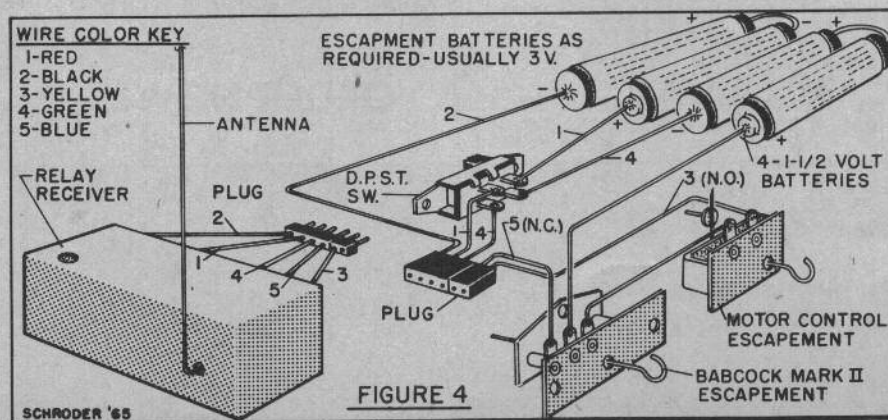


Figure 4: The basic difference below is the use of separate batteries for the actuators (escapement shown) and presence of relay in receiver. If weight and space available present no problems; the reliability should be increased.



Neat low wing by Rolls Royce club member (England)

# Radio Control

## How it Works

by BILL WINTER  
with PAUL RUNGE

For those who are newcomers or dealers harassed by endless questions, this outline of our complicated hobby is a welcome assist. It is intended only as a simple but comprehensive briefing. . . .





England) called the Rip Roar, uses ETA 15 Diesel, Grundig 8-channel. (RCM&E)

■ ONLY A DECADE OR SO AGO the possibility of controlling a model by radio was, for most people, an impossibility. Radio itself was something that belonged to licensed amateurs and those skilled in electronics. Today "RC" is commonplace. It is easy to arrange remote control for miniature airplanes, boats, and all sorts of ground vehicles, ranging from cars, trucks, to bulldozers and tractors—and, incidentally, a great many readily available plastic models and realistic toys lend themselves to modifications for such control.

A complete range of radio equipment and necessary accessories are available by mail order, or through hobby dealers and other retail outlets. Some hobby-type transmitters, having very low output, require no license from the Federal Communications Commission (the F.C.C.). Most readers probably are aware that on the six frequencies provided for this purpose by the F.C.C. under the Citizen's Radio Service (Class C), all one must do is obtain Form 505 from the F.C.C. and fill in out. No written test or code test is required. You receive your license upon mailing in the properly filled out form—it is easy with directions given—and the payment of an \$8 fee.

The frequencies you can use under the Citizen's Service Class C are 26.995, 27.045, 27.095, 27.145, 27.195 and 27.255 megacycles. The output of the transmitter is limited but no commercially available hobby equipment comes near the allowable output. (Limit is 5 watts input to the final stage—one watt output is considered more than necessary.) Naturally, those seriously interested in electronics, either have, or can get, some type of "ticket" from the F.C.C.—examinations are necessary for them, however—and operation is then permitted on other specified wave-lengths. (Six-meters—50-54MC—is popular for hobby use, with the appropriate ticket, of course.)

The Form 505, in fact, may come with your equipment when you buy it. Some hobby dealers have a supply for customers, but it may be surely obtained from the F.C.C. at Gettysburg, Pa., or from any F.C.C. regional office.

*How the Transmitter Works:* Hobby-type transmitters usually are quite small and can be held conveniently in the hands. They usually have a whip-type antenna. They may utilize tubes and/or transistors and have modest power supply requirements.

Virtually all hobby transmitters function by sending out a carrier wave on a particular frequency—one of the six spots mentioned above. Thus, 27.045 MC (megacycles) corresponds to 27,045,000 cycles per second. Upon this primary radio frequency (RF) the transmitter imposes one or more tones—within the hearing, or audio, frequency range (AF)—of, for

(Continued on next page)

## GLOSSARY OF RADIO CONTROL TERMS

FOR YOUR CONVENIENCE THESE DEFINITIONS WERE ARRANGED IN PANELS WHICH CAN BE CUT OUT WITHOUT DESTROYING YOUR COPY OF GL.

- AC: Alternating current. Current that flows in one direction and then in the other direction.
- ACTUATOR: Device for moving or operating a control or surface.
- AF: Audio frequency, which see.
- ALKALINE BATTERY: Generally the same size and configuration as zinc-carbon types (pen, medium "D"), these usually have longer shelf-life, deliver higher amperage with constant output over longer period, service over wider temperature range.
- AMPERE: A unit of measure for establishing the amount of electrical current flow.
- AMPLIFICATION: An increase in voltage or current of a signal. The signal may be an audio frequency (up to 16,000 cycles), or a radio frequency. In radio-control, amplification often refers to an increase in relay-operating current.
- AMPLIFIER: One or more tubes or transistors, and associated circuitry, used to increase signal strength.
- AMPLITUDE: The strength of a radio wave or signal. For example, 6 volts is of a greater amplitude than 5 volts.
- ANTENNA: In radio-control, a music wire "rod", or a stretched wire or telescoping "mast", for propagating (emitting) or intercepting (receiving) radio waves.
- ARC: Visible electrical spark between electrical contacts, such as in a relay, due to the collapse of the magnetic field of the actuator when signal is cut off.
- ARC SUPPRESSION: Arrangement of a capacitor (condenser) and/or resistor or diode "across" the relay contacts to reduce or eliminate arcing.
- ARMATURE: A hinged or movable portion of a relay or escapement which is attracted to an electromagnet (magnetic core) when the electro-magnet is energized.
- AUDIO FREQUENCY: Sound frequencies that can be heard by the ear. This is usually considered the range between 20 and 16,000 cps.
- BATTERY: A combination of two or more cells. Its function is to produce an electrical voltage.
- BIAS: A voltage that is applied to an electrode of a tube or transistor to make that device operate in a desired manner. In a tube, grid bias is most common.
- BYPASS FILTER: A combination of resistors, coils, and capacitors used to pass certain frequencies and prevent the passage of others.
- CABLE: Group of wires twisted or grouped to follow a common path.
- CAN: Metal box, housing, or container (usually aluminum) enclosing receiver or other circuitry.
- CAPACITANCE: The property of a capacitor to hold or retain an electrical charge or voltage.
- CAPACITOR: An electrical combination that can hold or retain an electrical charge. Its capacitance is usually measured in microfarads.
- CARRIER WAVE: Transmitted radio frequency, or r-f, turned on and off for control, and upon which audio frequency transmitted signals may be imposed.
- CASCADE: To join certain actuators to increase the number of sequential controls.
- CATHODE: The electrode or filament in a tube which, when heated, emits a stream of electrons.
- CB: CITIZEN'S BAND: Frequencies where radio control and communications are accomplished without need of an Operator's test (Station License is required).
- CELL: A device for converting chemical energy into electrical energy. Two or more cells make a battery.
- CHANNEL: An avenue of control intelligence to the actuator.
- CHARGE: The process of restoring the electrical energy available in a secondary battery.
- CHARGER: A device to restore secondary battery voltage.
- CHASSIS: Base of a receiver or transmitter on which components are mounted.
- CHOKE: A coil of wire used to choke off or obstruct certain frequencies.
- CLOSED LOOP: Usually a servo in which the electronics is a definite complement to the receiver (also called feedback servo); servo used in multi-control proportional, aligns control surface with transmitter stick position—not an averaged left-right (for ex.) action typical of single-channel magnetic-type actuator.
- COIL: A winding of wire on a core, or of heavier wire on a form (which may be removed). Examples: relay coil, tank coil.
- COMMON: A wire or point used as a reference point for all voltages in a circuit. Very often the metal chassis of a receiver or transmitter acts as the common point. This term is often used interchangeably with "ground."
- COMMUTATOR: A device for changing the direction of a current in an electric circuit.
- COMPOUND ACTUATOR: An actuator having an electrical or mechanical means of operating a second, auxiliary circuit or control.
- CONDENSER: Common term for a capacitor, which see.
- CONTACT: A point at which an electrical circuit may be closed or opened, commonly the relay contacts.
- CONVERTER (Power): A circuit and component arrangement that supplies a higher d-c voltage output than the original a-c voltage—possibly eliminating B batteries in tube-type receiver or transmitter.
- CORE: Normally understood to mean the iron inner piece, center, etc., upon which a wire coil is wound to develop a stronger magnetic field when energized, as in a relay or escapement. Also, movable iron piece in frequency tuning coil.
- CPS: Cycles per second.
- CRYSTAL: Precisely shaped and sized quartz used to control the frequency of an oscillator, or as frequency-selective filter in superhet.

Glossary continued on next page



## GLOSSARY OF RADIO CONTROL TERMS

**CURRENT:** Electrical flow measured in terms of amperes.

**CURRENT CHANGE:** An increase or decrease in amperage in receiver (or relay) circuit as a result of signal reception.

**CYCLE:** Period of time required for an alternating or oscillating current to repeat original flow direction.

**CW:** Carrier wave, which see. (Its more precise meaning is continuous wave. Often, these terms are used interchangeably.)

**DC:** Direct Current. Current that flows in only one direction.

**DETECTOR:** Section of receiver that picks up signal. (In electronics, the detector is the receiver circuit that separates the modulation on a carrier wave from the carrier wave itself.) In radio-control work, the entire tuner is sometimes referred to as the detector.

**DIODE:** Tub or crystal designed to pass current in one direction only.

**DISCHARGE:** Expenditure of electrical energy—as from a battery.

**DRAIN:** Current drawn or consumed by a tube, actuator, or other electrically operated device, considered in terms of battery capacity.

**DROP-OUT:** That point at which electrical current flowing through a relay or escapement does not overcome spring tension, thus permitting the armature to pull away from the core piece.

**ELECTRODE:** An operating element of a tube or transistor.

**EMISSION:** The process of sending or transmitting radio signals from an antenna.

**END-VOLTAGE:** Minimum voltage below which battery failure takes place, usually well below useful minimum voltage.

**ESCAPEMENT:** Mechanical-electrical device or actuator for moving controls or control surfaces.

**F.C.C.** Federal Communications Commission.

**FIELD-STRENGTH METER:** Simple circuit arranged with a meter to give relative reading of signal strength. For transmitter tuning.

**FILAMENT:** An electrode in a vacuum tube heated electrically to cause a flow of electrons to the plate of the tube.

**FILTER:** A component or coil permitting passage of only desired currents or frequencies. Also, capacitors and/or inductance coils to smooth out electrical currents, as in transmitter power supplies.

**FINAL STAGE:** Output stage of the transmitter, coming after oscillator amplifier stages: relay stage of a receiver.

**FREQUENCY:** An oscillating current expressed in cycles per second. (See Audio Frequency; Radio Frequency.)

**FREQUENCY TOLERANCE:** The plus or minus variation from a stated frequency given as permissible limits for transmission by FCC.

**FRONT-END:** A tuner for frequency selector section of a receiver.

**FSM:** See field-strength meter.

**GALLOPING GHOST:** Simplified form of dual proportional control, giving rudder and elevator action.

**GAP (AIR):** Distance between armature contact and fixed contact on a relay, and between armature and coil piece on an escapement.

**GRID:** An element placed between the filament and plate of a vacuum tube to control current flow between the two.

**GROUND:** Rarely refers to actual connection to the earth; ground point in a circuit is usually considered to be common point where many other parts of circuit connect; in vacuum tube circuits, almost always point (or wire) to which the negative side of B battery, and one side of A battery (either positive or negative) are connected; referring to transmitter antenna circuits, sometimes actual connection to earth.

**GROUND CHECK:** Checking and tuning of receiver for range by walking it the desired distance away from transmitter.

**HARD TUBE:** Vacuum tube.

**HARNESS:** Complete wiring system when arranged as a removable unit, prewired and connected outside the vehicle.

**HORN:** A fixed arm attached to a control surface—connects to pushrod.

**IDLE:** Plate current of the receiver when no signal is received.

**IMPEDANCE:** A characteristic of an electrical circuit to oppose the flow of current.

**INDUCTANCE:** Electrical property of a coil to oppose a change in current flow through the coil.

**INPUT:** Voltage or current fed into power supply receiver, transmitter, power converter, etc.

**JACK:** A kind of "socket" placed in an electrical line to receive a phonoplug, etc., for reading of current, or for attachment of earphones, etc.

**KEY:** Loosely speaking, any form of switch used to make and break the transmitted carrier and/or audio frequencies.

**KEYING SWITCH (AND LEAD):** The key, and any cable and plug connection to the transmitter.

**KICK-UP:** Mechanical feature of some compound actuators to move an elevator to the up position.

**LEAD:** A wire or other conductor, connected to battery, component, receiver, etc.

**LEAD-ACID CELL:** An electrical cell using dissimilar lead plates and acid. This cell is a rechargeable or secondary type, and has a voltage of approximately 2.

**LINKAGE:** Mechanical arrangement between actuators and controls.

**LOAD:** The amount of current being drawn from the battery or other power source.

**MA:** Milliampere, which see.

**MAGNETIC ACTUATOR:** Control moving device (usually rudder) incorporating permanent magnet(s) which slaves to variations in pulsed signals from transmitter.

**MAGNETIC FIELD:** Magnetic lines of force produced by a permanent magnet or current flow in an electromagnet.

**MAH:** Milliampere-hours.

**MC:** Megacycle.

**MEGACYCLE:** A frequency of 1,000,000 cps.

**MEGOHM:** A resistance value of 1,000,000 ohms.

Glossary continued on next page

## ..... Radio Control.....



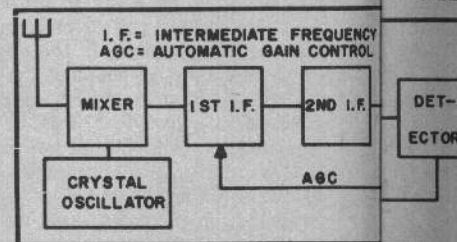
Just a suggestion of the many types and sizes of radio models you can build is made by this picture taken at 1964 Toledo Conference.

example, 400, or 600, etc., cycles per second. Commonly, up to 12 tones are transmitted, usually one at a time, to obtain one control function—but two tones, often can be broadcast simultaneously so that two controls can be worked at once. (Advanced proportional-type transmitters have as many as four or more simultaneous tones.)

Depending on how many tones the transmitter is equipped to send out, your equipment may be known as single-channel, four-channel, six-channel, eight-channel, 10 or 12 channel. Naturally, cost varies tremendously, possibly from less than \$20 for the cheapest single-channel unit—which can be obtained as a kit as well, as can the receiver—to \$200 or more. Including the receiver and actuating devices, and according to the type of radio, cost varies from perhaps \$75 to \$1000 or more.

*How Does the Transmitter Send Out Signals?* By closing a keying switch or switches, the operator completes a circuit

## HERE'S HOW THE SUPERHET



When two signal frequencies are combined, two additional frequencies are created. One is the sum of the two combining frequencies, the other is the difference between these two frequencies. In a superheterodyne receiver, the incoming frequency is combined in the mixer with the frequency generated by the crystal-controlled oscillator in the receiver. The difference between these frequencies is called the intermediate frequency (IF), and this is amplified by the intermediate frequency amplifiers. For example, suppose the operating frequency is 26.995 MC and our intermediate frequency amplifier is designed to work at 455 KC. The local oscillator in the receiver must operate on a frequency which is 455 KC above or below 26.995 MC. Thus, we may use a crystal in the receiver of 26.995 minus 455, which equals



# 1. . How it Works . . . . .



Something for the real experts, a multi-engined flying scale ship. This Liberator World War II bomber won scale at '64 LIDS contest.

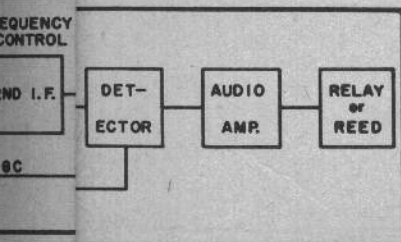
which causes the carrier and/or tones to be broadcast. In the single-channel transmitter—that is a unit sending out but one tone—a pushbutton usually serves as the keying switch. On multi-channel units, the appropriate number of lever switches is employed as keying switches. Moving a lever switch (right or left) used for ailerons, would create right and left turns of an airplane.

*Three Types of Systems:* The single-channel transmitter normally operates an escapement device, via the receiver, which moves a rudder on an airplane. Many escapements include mechanical and/or electrical features which allow operation of a second or auxiliary escapement, as for motor control (when the proper number of signals are sent in rapid succession) by operating the keying switch as many times as necessary. Single-channel escapement devices also are appearing which are operated by electric motors. These should not be confused

(Continued on next page)

ET

## RECEIVER OPERATES . . . . .



26.540, or 26.995 plus 455, which equals 27.450 MC.

In most radio control receivers, the local oscillator frequency is generally operated below the signal frequency. Therefore, for a transmitter frequency of 26.995 MC, the receiver crystal's frequency will be 26.540 MC. However, for ease of identification, as a general rule, the top of the receiver crystal will usually be marked with the operating frequency of the receiver, rather than the actual frequency of the crystal.

In receivers of this type, there also is another transmitter frequency which may operate the receiver. This is known as the image frequency, and will be 910 KC (two times 450 KC) below the main frequency. Remember that the intermediate frequency is 455 KC, and that our local oscillator (Continued on page 25)

## GLOSSARY OF RADIO CONTROL TERMS

- MERCURY-CELL:** An electrical cell sometimes used, having long life, but not rechargeable.
- METER:** Device to measure and read voltages, currents, resistances, etc.
- METER JACK:** See Jack.
- MICROSWITCH:** High sensitivity precision switch of small size suitable for keying purposes.
- MILLIAMPERE:** Abbreviated ma or mil. A measurement of current 1/1000 of an ampere, which see.
- MIL:** Short for milliamper.
- MINUS:** Negative voltage.
- MODULATION:** Imposition of an audio frequency on carrier frequency.
- MODULATOR:** A circuit used in a transmitter to superimpose an audio or low frequency signal on the carrier wave. In radio-control work, the modulator often consists of an audio oscillator.
- MOPA:** Master-oscillator power-amplifier circuit used in transmitters.
- MULTI:** Radio-control class of operation using more than one channel.
- MULTIMETER:** A test-meter permitting reading of voltages, resistances, currents, etc.
- MV:** Microvolt, a millionth of a volt, usually a measure of receiver sensitivity.
- NEUTRAL:** No-control position of an actuator or surface.
- NICAD:** General term used to describe nickel-cadmium cell. The word Nicad is actually a registered trade-mark of the Nicad Division of Gould National Batteries, but it is frequently used as a term to describe nickel-cadmium cells.
- NICKEL-CADMIUM BATTERY:** Sealed secondary wet cell, rechargeable; has high discharge rates and long life.
- NOISE:** Random, audible (on earphones), scratching sounds resulting from electrical discharges—as between vibrating metal parts—which interfere with receiver operation.
- NO-LOAD VOLTAGE:** Commonly understood to mean the voltage reading of a battery, part of a circuit, when no work is being performed, hence, no current flow (drain) is evident.
- NPN:** Type of transistor (negative, positive, negative).
- NULL:** Certain areas in which transmitted signal is weak, or cannot be detected by receiver, due to the antenna type and position—as over-head, with a whip antenna.
- OHMS:** A unit of electrical measurement for resistance.
- OSCILLATOR:** A vacuum tube or transistor circuit capable of generating a continuous stream of alternating current.
- OUTPUT:** The outgoing voltage, current, or signal from an electrical circuit, battery, or generator.
- PACK:** An assembly of batteries, taped together as an integral power supply for a receiver, servo, etc.
- PADDING:** Generally refers to special tailoring of a circuit, usually addition of capacity to an audio circuit.
- PARALLEL:** The joining together of batteries, plus, minus to minus, not to increase voltage, but to increase battery life. Components may also be mounted in parallel, or in series, but not necessarily within the precise meaning of this definition.
- PENTODE:** A tube having five electrodes—namely, cathode, control grid, screen grid, suppressor grid, and plate.
- PHONOPLUG:** Metal plug, as used in telephone switchboard, earphones, etc., that can be inserted into a jack. (As with meter jack, transmitter keying cable, etc.)
- PIN:** Metal prong, as on tube base, for insertion of object in socket.
- PLATE:** The electrode in the vacuum tube to which electrons are attracted.
- PLUG:** A device for connecting a cable (as from receiver) into a current—providing tabs for soldered wire connections, and pins for insertion into socket.
- PLUS:** Positive voltage.
- PNP:** Type of transistor (positive, negative, positive).
- POSITIONABLE SERVO:** One which moves to desired control setting, without self neutralization; used for motor control and elevator trim adjustments. (Also called trim servo.)
- POT:** Short for potentiometer.
- POTENTIOMETER:** A kind of rheostat for varying resistance of a circuit, as when checking relay operation. A voltage divider.
- POWER CONVERTER:** See converter.
- POWER SUPPLY:** Any device used to supply power to an electrical circuit. Most commonly, this is in the form of a cell or battery; it could however, also include a generator.
- PPS:** Pulse rate per second.
- PRINTED CIRCUIT:** An etched circuit upon suitable base or chassis eliminating wire connections between components.
- PROPORTIONAL CONTROL:** Movement of control surfaces, positions corresponding exactly to degree of control stick movement.
- PULL-IN:** The current value at which a relay or escapement armature will be attracted to the magnetic core piece.
- PULSE:** Quick, brief signal, either carrier or audio.
- PULSE OMISSION DETECTOR:** A circuit, either part of receiver, or complementary thereto, used for actuation of motor control in many pulse and proportional systems.
- PULSER:** Mechanical or electronic device generating as required, transmitted signal pulses of varying widths and rates.
- PULSE RATE:** Number of pulses per second (pps).
- PULSE WIDTH:** Duration of individual signal-on pulses.
- PUSHROD:** Dowel or balsa wood strip, or metal tubing, connecting actuator with control surface.
- QUICK-BLIP:** Very brief signal used to trip motor control, etc.
- RANGE:** Distance at which receiver reliably detects signal and provides adequate current change for actuator operation.
- RECEIVER:** The "radio"; detects, amplifies, and routes signal to appropriate actuator.

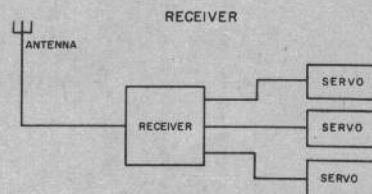
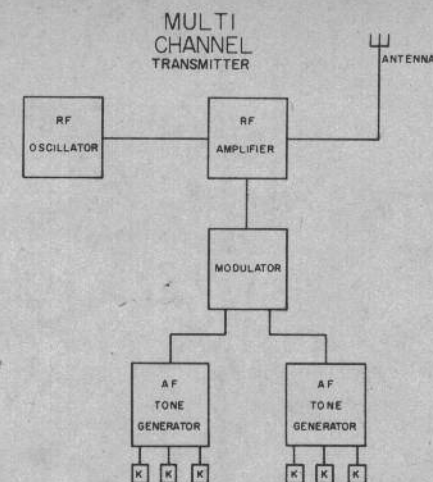
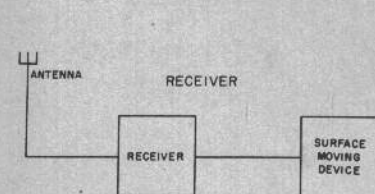
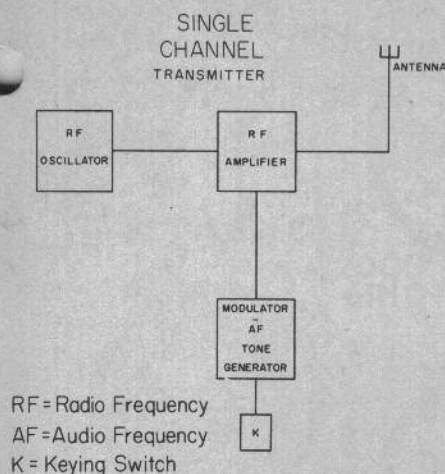
Glossary continued on next page







# 1...How it Works



with the multi-channel type of servo. They may also be called servos, but they are clearly defined for single-channel action, and perform a function similar to that of the ordinary escapement.

The multi-channel transmitter operates, via the receiver, an appropriate number of electric-motor driven servos, each of which provides motion in two directions for one control, triggered by sending the proper two tones when required from the transmitter. With six-channels, two tones would be required to move a right and left, two more for the up and down movement of the elevator servo, and two more for the engine throttle control servo. With eight channels an aileron servo is added—with ten channels, ailerons plus elevator trim. With 12, wing flaps or some other device becomes possible.

Most of these devices provide full movement of the control when the proper signal is held; when the signal is discontinued, the device returns automatically to neutral. If precise amounts of control are required in between full and neutral, a proportional control system serves. With proportional, controls assume a corresponding position to the control stick or sticks on the transmitter. Proportional systems exist which duplicate any and all of the control movements possible with any other system—only proportionally (that is, in any degree), of course.

**Receivers:** Like transmitters, these vary in size, complexity, capability, and cost. While some utilize a tube detector stage, with transistor amplification, most are entirely transistorized. Of the two basic types—superregenerative and superheterodyne ("superhet" for short), the latter is now virtually standard because its far superior selectivity of signal reception very greatly reduces interference from other modelers, from CB Class D phone radio operators,

etc. In well populated areas, the superregen is not very practical because of extensive interference. Voice interference is evidenced as unwanted control movements. A strong carrier wave will "block out" the model receiver, if the invading transmission is on or even near your frequency, thus causing a complete loss of control. Therefore, superhets, though somewhat more expensive, are recommended. Also, there have appeared some superregen receivers which are highly selective in their audio (AF) range. They are less interference prone than are the ordinary superregen receivers. These are known as *highly tone selective*.

The receiver has a device to tune it exactly to your transmitter RF frequency. Superhet receivers and transmitters are sold as matched pairs, as for 27.195 MC, etc. The same make of transmitter and receiver are recommended, to insure that the units are compatible—that is they use the same cycles per second of tones AF for controls.

Receivers sort out the tones, amplify them, then apply them through either tone filters or a reed bank, to the appropriate servo. Filters also are used to limit the range of cycles per second of tone, the receiver will respond to, thus reducing interference. (This explains the use of a filter on some single-channel equipment, as gone into in the previous paragraph.) A reed bank has a series of graduated-length reeds, each of which vibrates in resonance to the corresponding tone received from the transmitter. Each reed actually is a switching device which, when agitated, closes a circuit to the correct relay or actuating device.

In addition to being either superregen or superhet, a receiver either has a relay(s) or is relayless. A relay is a switching device which closes when the amount



Typical single-channel outfit. A Controlaire Mule transmitter; superhet relayless receiver.



of current flowing through its coil is increased enough to pull in its armature, which then touches the appropriate electrical contact, thus completing the circuit to the actuator. A single-channel receiver does not have a reed bank; the relay or transistor(s) being the only switching device. A multi-channel receiver which has a reed bank, will have a relay corresponding to each reed—as many as 10 or 12—if it is of the relay type. All types of receivers can be relayless as well, (not optionally, but by design) the switching to the actuators being done by transistor circuitry.

Naturally, relayless receivers are lighter, smaller, and require less servicing. They are generally ideal for planes. However, when high-drain devices must be worked, as in boats or cars and trucks, the relays are usually required to handle the currents involved without burning out radio or switching devices. Even so, when drain exceeds relay capability in the re-

(Continued on page 23)



2 CHANNEL

IN B

(GND) OV

IN A

200 OHM

1K

2N1305

2K

300 OHM

-6V or -4.8V

200 OHM

2N1308

2N1309

OUTPUT TO SERVO

15 MF

15 MF

51 OHM

150 OHM

300 OHM

IN270



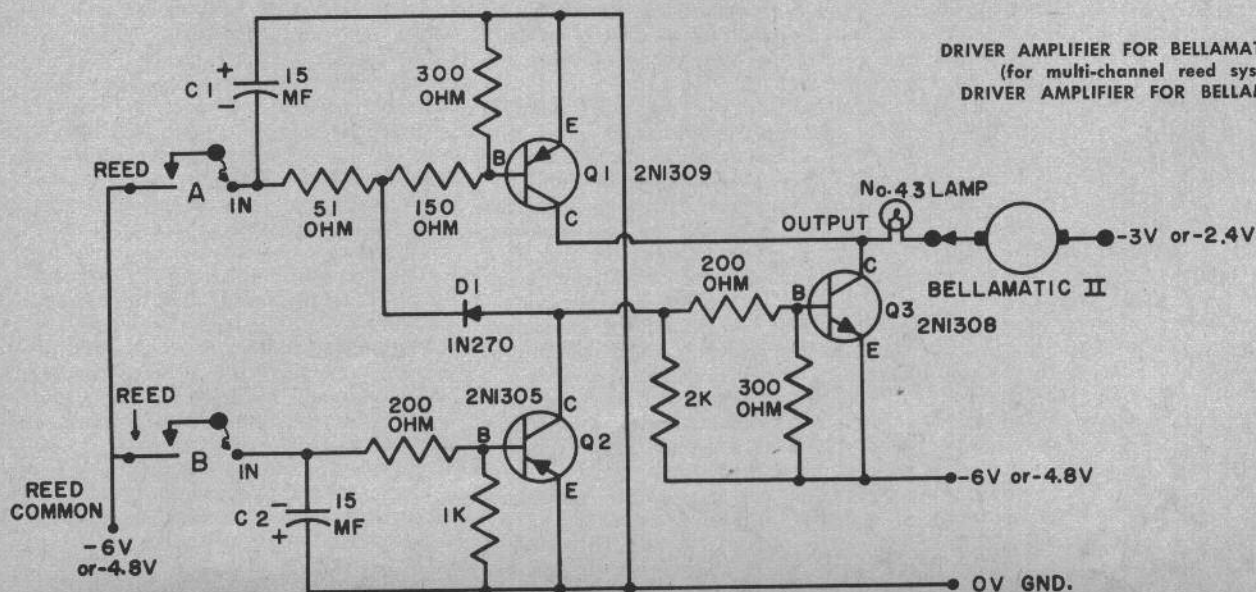
If small 15-mf capacitors are used where shown, then holes 1, 2, 3 can be used for IN-B, OV, IN-A and the board shortened. If larger 15-mf capacitors are employed, use desired combinations of holes 1 and 4, 2 and 6, and 3 and 5 for capacitors, and the position shown for IN-B, OV and IN-A.

# Relayless Driver for Bellamatic II

The printed circuit is laid out with four channels on one board (for two servos); however, the circuit can be cut in half if only two channels (one servo) per board are desired.

When reed "B" is vibrated it generates negative pulses which are stored in C causing Q2 to turn on. When Q2 turns on, its collector goes to ground and turns on Q3 which drives the output to  $-6V$  (or  $-4.8$ ), causing the Bellmatic servo to run the opposite direction. Diode D1 does not conduct under these conditions either.

**DRIVER AMPLIFIER FOR BELLAMATIC SERVOS**  
(for multi-channel reed systems)  
**DRIVER AMPLIFIER FOR BELLAMATIC II**





# PIETENPOL AIR CAMPER

by R. JESS KRIESER



Jess and his Air Camper. "It's quite a sight to see it come floating by, engine idling, to touch down for a three-point landing."

If this .35-powered oldie doesn't send a real thrill running through you, then you don't have any scale blood in your veins.



Williams pilot head in rear pit adds a note of realism.

**H**OMEBUILT AIRPLANES HAVE REACHED an all-time high in popularity. During the past few years each of the annual fly-ins held at Rockford, Ill., by the Experimental Aircraft Assoc., have broken participation records set the previous year. However, the homebuilt airplane is far from a new idea. During the late 1920's and early 1930's, a large share of private flying was done in "homebuilts." During this era, undoubtedly the most popular of the homebuilts was the Pietenpol "Air Camper," designed by B. H. Pietenpol, of Spring Valley, Minn. Contributing significantly to its popularity was the fact that it was powered by a converted Model A Ford engine. These engines were plentiful, and conversion was quite simple.

The engine was simply turned around so that the propeller could be attached to the flywheel flange by means of a pair of adapter hub plates. The cast-iron valve cover plate was replaced by a lighter one made from sheet metal, and so was the timing gear cover. A simple metal shelf was attached to the timing-gear end of the motor to hold the magneto, and a

simple coupling to drive it was attached into the end of the crankshaft where the old hand crank normally was inserted. The oil system was modified to insure good oil flow and scavenging in all flight attitudes, and the converted mill was ready to go.

Plans for the Air Camper were originally published in an aviation magazine, and their appearance sent many an aviation enthusiast scurrying into his workshop to toil lovingly until his craft was ready to go. With the 38 to 40 horsepower put out by the converted Model A engine, it was no fireball. It cruised at 60 to 70, stalled from 35 to 40. Rate of climb varied from 200 to 500 feet per minute, and it had a range of 200 miles. But it was fun to fly, for its parasol wing gave it great stability, and the generous wing area, coupled with light weight, gave it a low wing loading. It just floated lazily along at low speed, nearly flying itself.

The Air Camper became so popular that B. H. Pietenpol went into production at his Spring Valley plant, delivering them ready to fly for around \$750. (Continued on page 28)

**DETAILED PLANS FOR THE PIETENPOL AIR CAMPER ON NEXT TWO PAGES**



By the time he ceased production in 1939, quite a few were around the country. Today, there are still a number in existence, some having been restored without major rebuilding, others having been virtually rebuilt throughout. Pietenpol Air Camper serial number 1, first off the production line, is still flying today, and is the proud possession of Allen Rudolph, of Juneau, Wisc. It still has its Model A engine, and the only modifications made were the substitution of a tubular landing gear and balloon wheels, in place of the original wooden gear and narrow tire wheels.

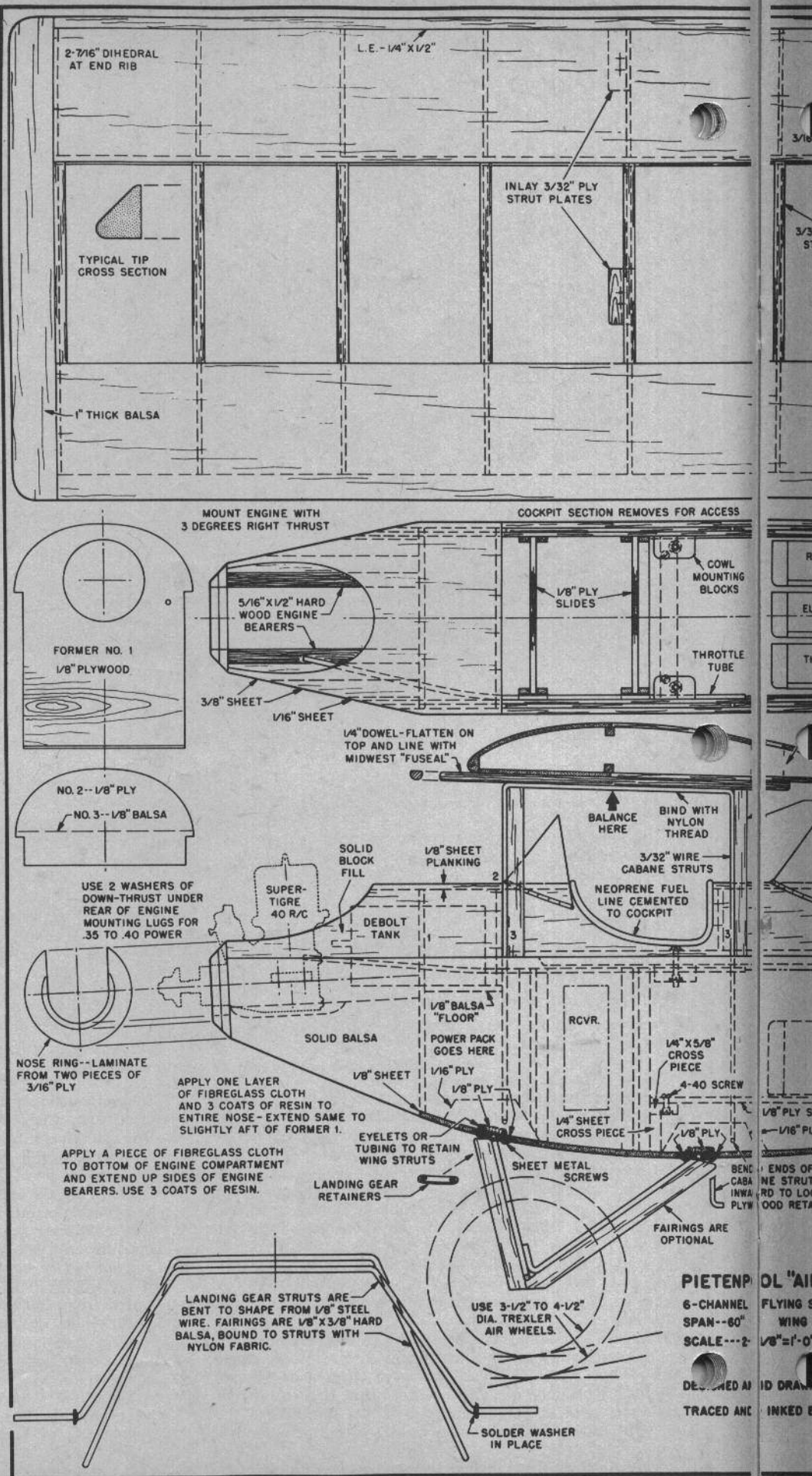
Our RC Pietenpol has been scaled accurately to  $2\frac{1}{2}$  inches equals one foot. A few concessions to scale were made in the interests of practicality, but these have been minimized. The stringer extending along the side of the fuselage was eliminated, as it would have complicated construction and covering of the model; the engine and radiator details were omitted as we didn't want to have a built-in headwind. The axle on the landing gear was left off, and the wing was given five degrees of dihedral, while the prototype had none. Tail areas were kept to scale, but a streamline section was put in the stabilizer instead of the flat plate of the prototype. I also added a tail wheel for ground handling ease, but most present-day Pietenpols are sporting tail wheels, so this is still somewhat to scale. The model is based on the plans of the Pietenpol Air Camper by James Triggs, published in *Air Progress* a few years ago. While in Seattle this past summer I had an opportunity to spend some time with Pete Bowers, who is an outstanding authority on antique aircraft, one of the pioneers of the Antique Aircraft Association, and Early Planes Editor of *Air Progress*. I discussed the Pietenpol project with Pete, and he told me that, while the Triggs drawings were fairly good, there were some inaccuracies in them. So you flying scale "purists" who may detect some deviations from true scale can charge them off to this fact.

The completed ship is a beautiful flyer. Its first test hops were under the control of a skilled multi pilot, Bob "Delta" Baldwin. The ship virtually flew off the board. Only changes needed were an increase in the right and down thrust to that now specified on the plans, and an increase in the stabilizer angle of attack from zero to one degree. On its first flight, Bob was stunting it all over the sky, and then turned it upside down and flew it all over the place inverted. By the end of the third

(Continued on page 28)

### FULL-SIZE PLANS FOR PIETENPOL ARE AVAILABLE

COMPLETE ON ONE LARGE SHEET. SEND \$2.00 TO GRID LEAKS, BOX 301 HIGGINSVILLE, MISSOURI. OUTSIDE THE U.S. ADD 50 CENTS EXTRA.

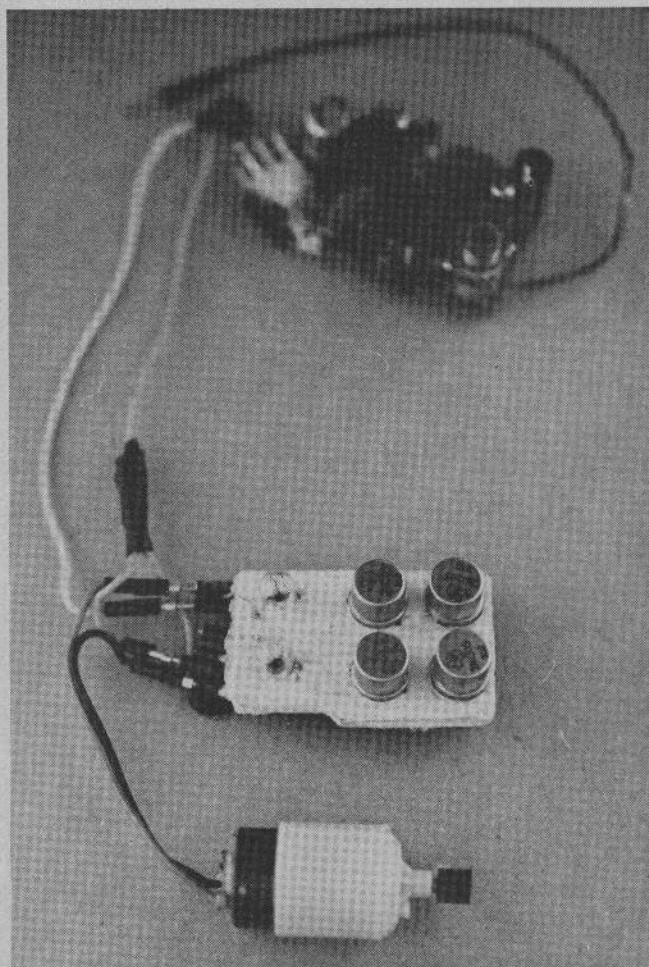




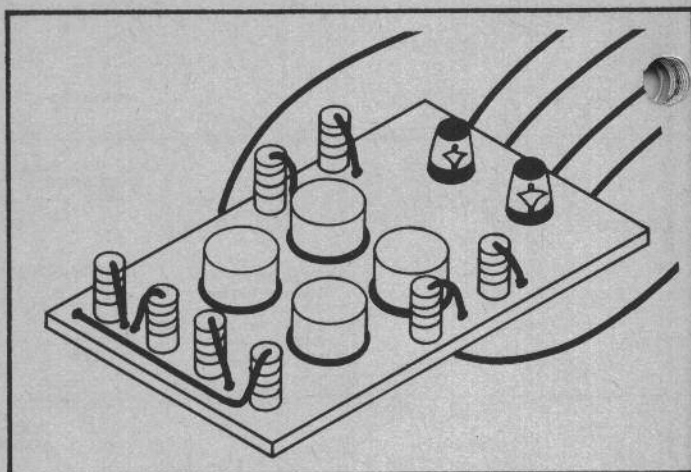




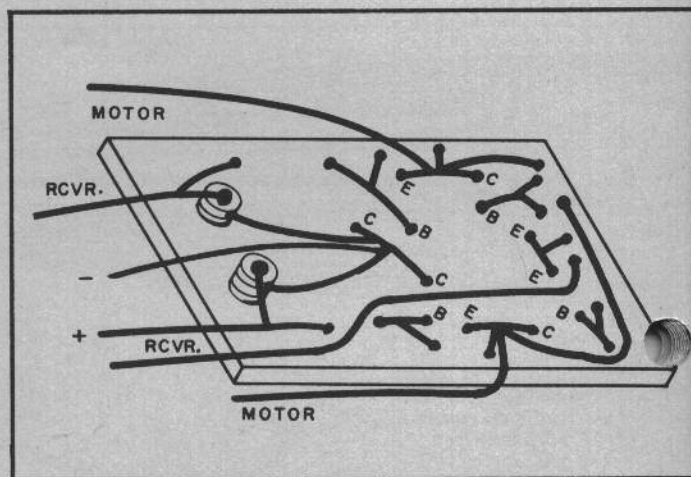
# .....A SERVO AMPLIFIER



The test units were built on 1/8-in. sheet balsa with components standing on end. Receiver at top, the servo at bottom of photo.



Drawings above and below illustrate schematic in Figure 1.



FOR THE RESEARCH AND DEVELOPMENT MINDED—ANOTHER IDEA TO TRY.

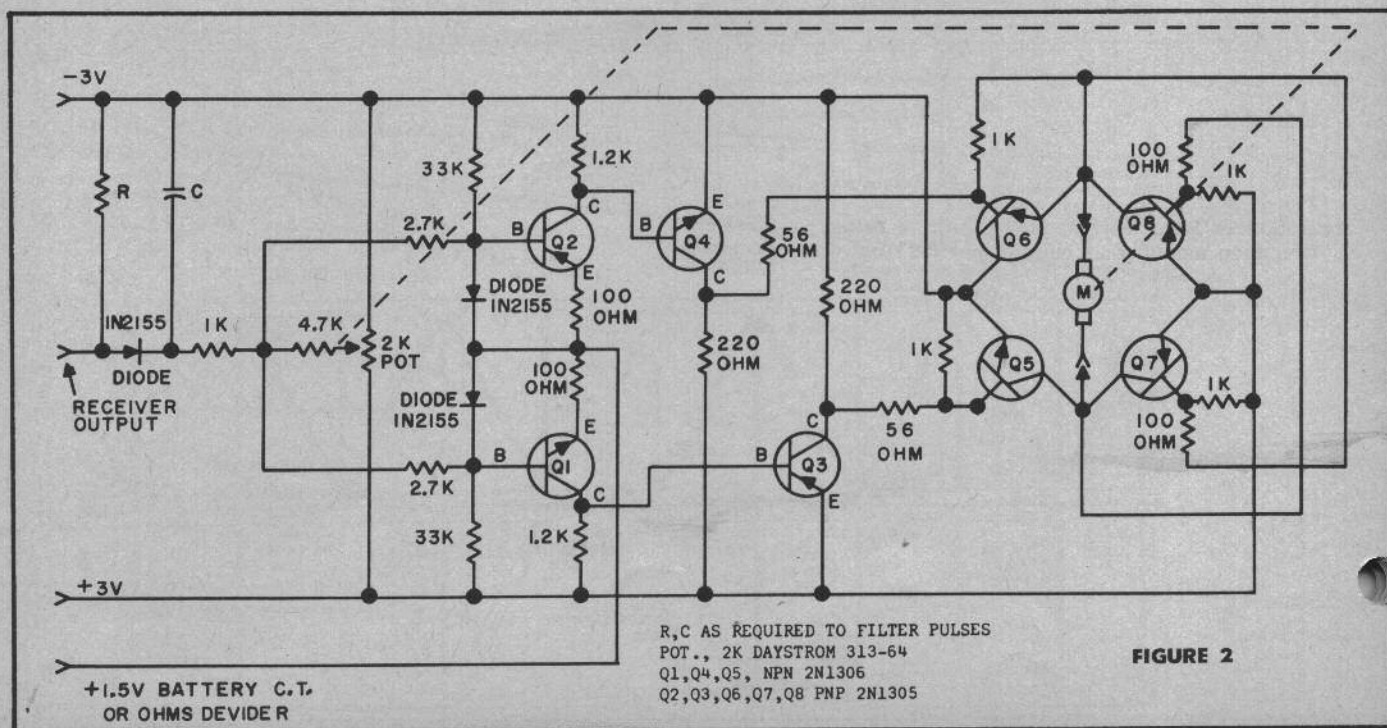
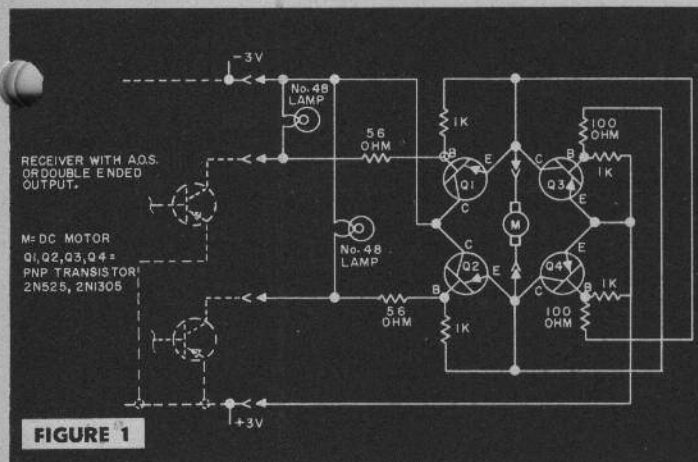


FIGURE 2





by JOHN H. STONE

THE CIRCUITRY SHOWN on the diagrams developed out of a search I made for the answer to a problem connected with proposed transistorization of the amplifiers used in the main balance of the Transonic Windtunnel, Boeing Airplane Co., Seattle, where I am employed.

The system offers a weight saving in those RC systems using a motor, such as the Mighty Midget, in a two-battery pulse setup. The weight saving achieved by substituting four transistors plus circuitry for a pair of penlite cells is 0.90 oz., which for a confirmed 3/4-inch-to-the-foot scale modeler who has half a dozen Cleveland kits stockpiled awaiting the day of a light enough RC unit, is a cause for joy!

I have an old three-foot-span free-flight, high-wing, gas model which has installed in it an Otariot 0-21 (should have been a K3VK), plus ACE A.O.S., plus "Stone bridge," plus Atlas "Snap" motor and two pencils. There are some long glide tests to its credit but weather, work, hamming, etc., combining to keep it grounded. This is per Fig. 1. It worked OK in those glide tests and in many bench tests.

At the time I felt that the servo arrangement with electrical filtering of the pulses, instead of aero-mechanical, should be investigated. I built up the single battery DC servo as shown in Fig. 2. It also incorporates the output bridge. One of these is being built in the Wind Tunnel shop for use as a repeater indicator for use in an area cramped for space.

In connection with the weight problem the lightest unit would be a K3VK and AOS or double-ended K3VK with TO-23 size transistors (2N207 ?) substituted for the 2N224 output transistors now used and with light components and the output bridge. The two #48 lamps used as Rcvr-AOS load are not essential, witness their absence in the servo—they draw too much current, but they do give a lock-on action due to their resistance change and give a visual check on Receiver-AOS operation. A lower current bulb would be better.

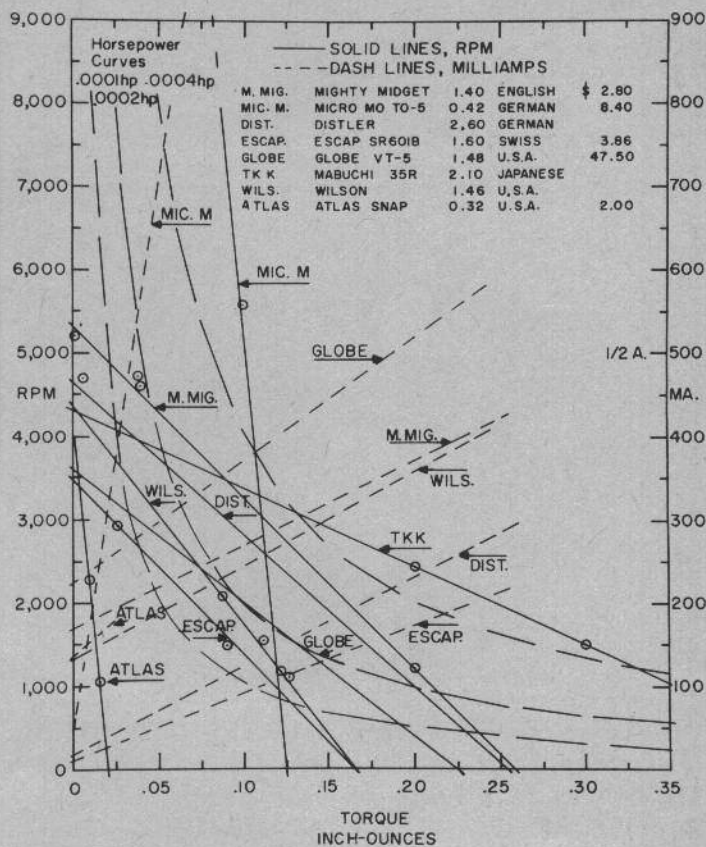
My servo amplifier as built weighs 0.93 oz. which is much too heavy even though it includes the bridge. Approximately it breaks down this way:

20 resistors	.25 oz. (1/2 watt)
8 transistors	.20 oz.
8 sockets	.16 oz.
	.61 oz.

Thus, the remaining .32 oz. must be solder, wire, etc. This can be blamed on the experimental assembly procedure, a lot of it extra solder. These units all are built on 1/8-in. balsa sheet with the components standing on one side as though it were a PC board.

The mechanical portion of the servo is a TO-5 Micro Mo motor with 141:1 gear ratio coupled to a Daystrom 313-64 "Squaretrim" pot by the worm of a plastic Strombecker worm-and-crown-gear set. It weighs .72 oz. More reduction is needed prior to control surface connection. Actually, some of the 141:1 ratio in the motor gear box should be on the output end after the feedback pot. Wishful thinking: I have not the equipment to fit a gear to couple into the input end of a Micro Mo's

## ELECTRIC MOTOR RPM-AND-TORQUE CURVE CHART



Data shown here will assist in picking a motor if you can relate it to some requirement. Either measurement of the torque needed under air load—such as a fan blowing on the surface—is required, or comparison can be used if some actual experience exists with one of the motors, most likely the Mighty Midget. In general, the steep rpm-torque-curve motors will work best under servo conditions—that is with electrical feedback—flat-curve ones with pulse systems.

Data for Globe is from spec sheets. For the Escap and Micro-Mo motors spec. sheet values checked with good agreement by test-bench measurements; others are entirely test-bench data. All were tested at 2.85 to 2.95 volts measured at motor terminals. All are ungeared; since some reduction is almost always used it must be taken into account in figuring torque. Curves of constant horsepower are included as a guide. Note the maximum horsepower is developed at about the middle of the motor curves. It is important not to either over or under load the motor if the output for the weight invested in the motor is to be had.

gear box, but at \$2.25 retail it is silly to consider making gearing!

The servo is still a ways off, I don't really know how far—it's got to lose some weight. It's the bridge to replace batteries that I think should go now. In these pic's the second unit is shown which uses a pair of smaller, more expensive Chicago Miniature Lamp lamps #2181 in place of the #48's. No difference in operation.

(Editor's Note: The above information came to GL in letter form and subsequent correspondence produced the additional interesting comments below. We have not undertaken to organize these from time-to-time comments into a formal article but with Mr. Stone's approval, have included everything almost as it came from his note book. His later choice of a test vehicle type lead to an investigation of many electric motors. The painstaking chart at the right no doubt will assist others in their pursuit of such facts. Now back to Mr. Stone. . . .)

Old AMA 527 first flew in about 1941 as a "Flying Cloud" by Henry Struck. A new wing was built and a Huskie engine mounted in a hollowed balsa block nose was added to make a free flight gas model. Then a few horizontal tail with elevators and control horn under the wing made it a control-line model. Any little breeze blew it right back over me so it had solenoid actuators installed and ailerons added and linked to the rudder with a trailing wire of around a couple hundred feet of #32 enameled wire in a bundle (Continued on page 31)

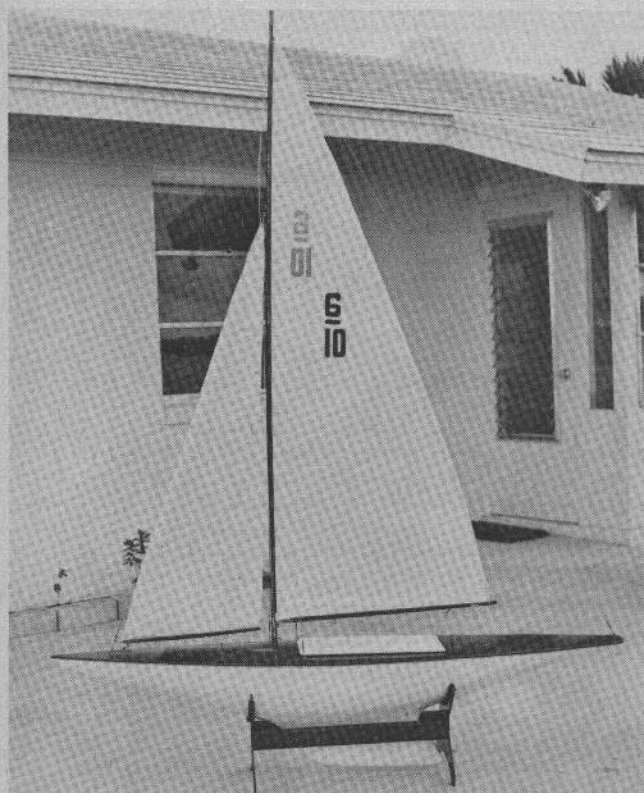


# HOW TO RC A SAILBOAT

by JOHN W. REYNOLDS

**RADIO IS INFUSING NEW INTEREST INTO THE ONCE POPULAR RACING OF SLOOPS. FOUR CHANNELS IS IDEAL—AS FOR THESE SCALE 6-METER BOATS. YOU CAN USE TWO—OR 12!—CHANNELS WITH SUCCESS.**

Running before the wind, a scale 6-meter racing sloop makes a pleasant picture for both spectators and skipper. Craft weighs 30 pounds.



"Class" boats are raced against each other under same rules used in America's Cup races and yacht racing. Boat is 7½ feet high.

PEOPLE HAVE BEEN CONTROLLING model sailboats with radio as far back as 1947, perhaps earlier. A club started up in Tampa, Florida right after the war. They had some fiberglass Marbleheads (racing sloops) and several 3-mast schooners. The fad died out though because RC was expensive, not too reliable and required large and expensive batteries that went dead too fast.

Today's modern RC for airplanes is economical to operate, reliable and compact enough to operate a 3-foot sloop. The old idea of sailing a model boat by RC is now practical. Furthermore, "class" boats can be built and raced under the same rules for the America's Cup races and yacht racing.

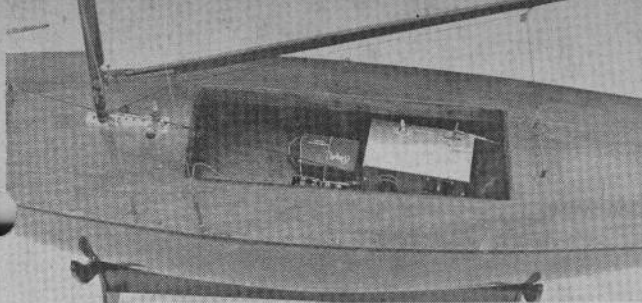
Former model airplane builders, who now race RC model sailboats, are relieved to find that a "boo-boo" at the controls of a get-away doesn't crack up the ship and damage the RC equipment.

The boats shown in the pictures are scale models of a 6-Meter racing sloop. They stand about 7½ feet high, weigh about 30 pounds and are constructed of fiberglass. The 6-Meter class is rigidly controlled as to size, weight and sail area. This provides the skipper with a model he can race and test his skill at sailing. He knows that his opponent has an equal, not faster boat, so he can compare and learn by sailing with others. The boats' design has been modified for RC so that they will respond quickly and carry the RC equipment safe and dry. They won't capsize because of the lead keel and watertight deck.

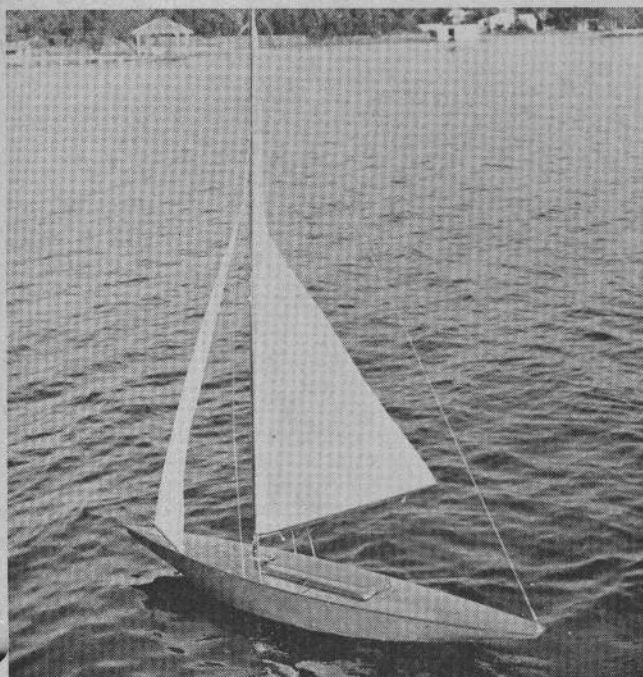
The RC equipment required need not be complicated or high powered. The boats will sail well with rudder control only, but it's more fun to have sail control, too. When two or more boats are to be sailed simultaneously, superhet equipment is required to prevent one boat interfering with another.

Exceptionally good results have been attained with the moderately priced Kraft 4-channel (Continued on page 32)

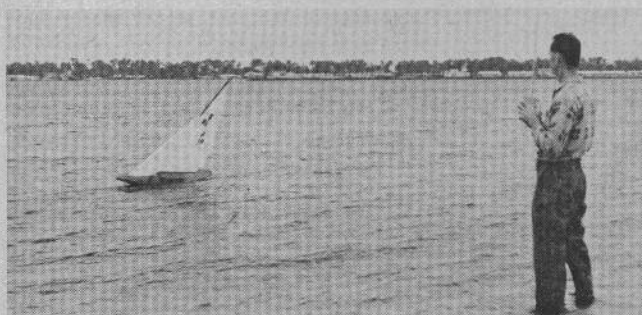




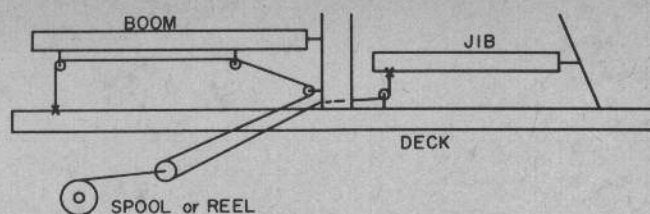
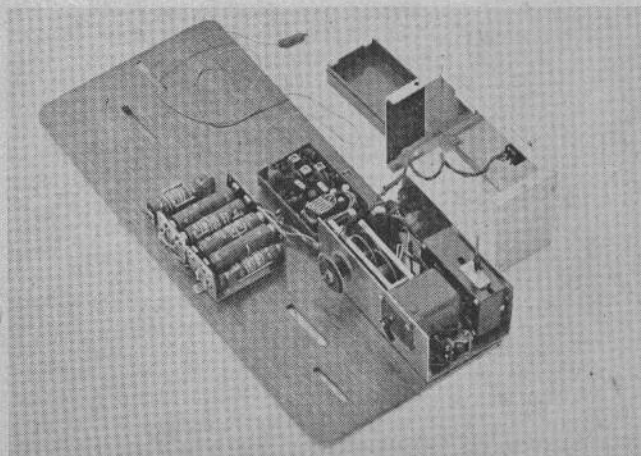
Four-channel receiver and servo-winch shown provide steering and control of jib and mainsail. Boats can operate by steering alone.



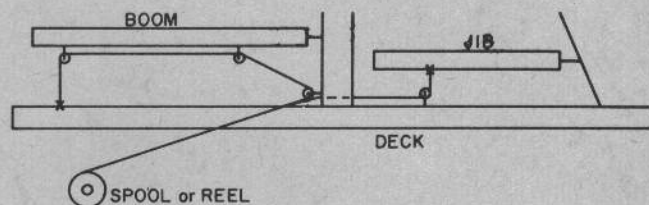
Six channels permit individual operation of jib, mainsail. Hulls are fiberglass, and watertight to protect the gear. Boat can't capsize.



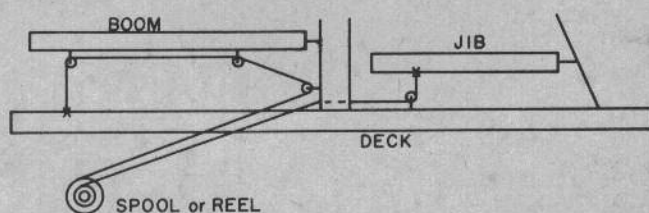
Designations on sails aid identification in races. Size, weight, sail area are limited by rules. Winch drum is driven via gear train.



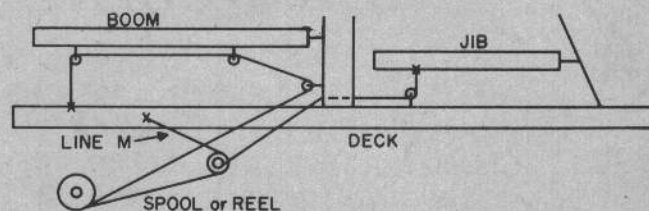
Spool or reel: Pressure on mainsail pulls in jib. Boat goes leeward until mainsail pressure slacks. Self-adjusting sails controlled by single line and one reel.



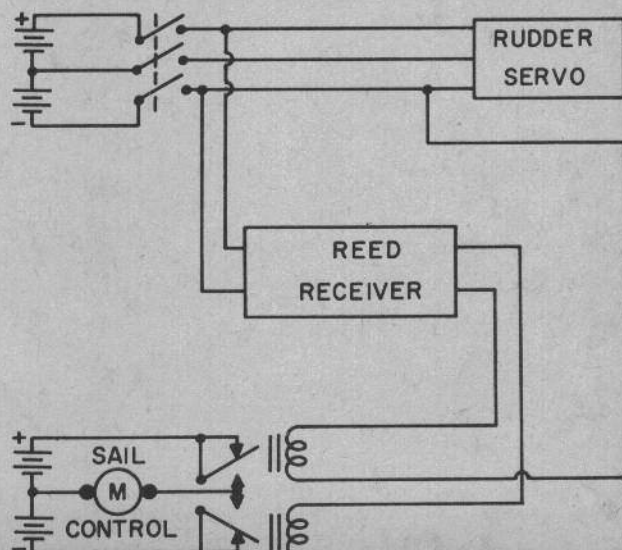
Spool or reel: Both jib line and main line go on one reel or spool. Lines are attached to boom and jib bat so that each require the same amount of line from full out to full in.



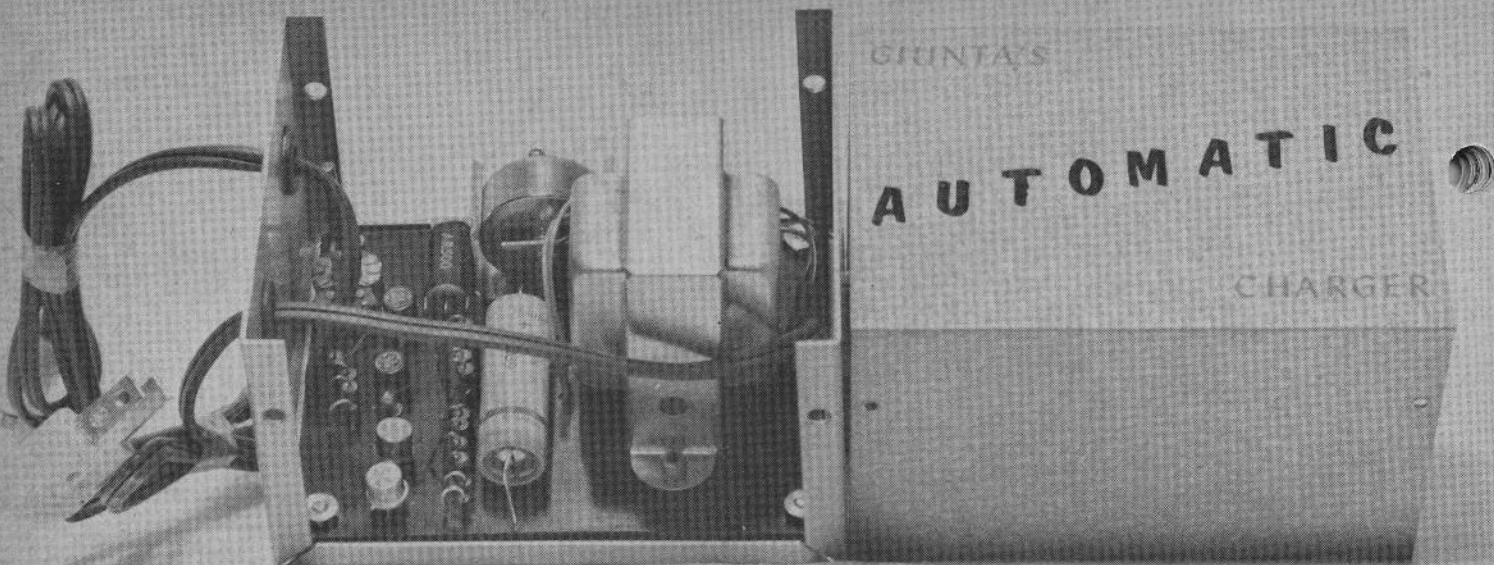
Two-to-one ratio: Another 2:1 hookup requires double reel on single shaft, one reel on single shaft. One reel is twice the diameter of the other. Mainsail line goes to larger reel and jib to small one. All diagrams are for four channels. From two to 12 can be employed.



Two-to-one-ratio: Jib line runs from jib through traveler to block (pulley). Main sheet (line from boom) runs from traveler, through boom blocks and mast block to servo reel. Same reel takes in third line connected to cockpit frame, runs through block on end of jib sheet and block to reel (line M).





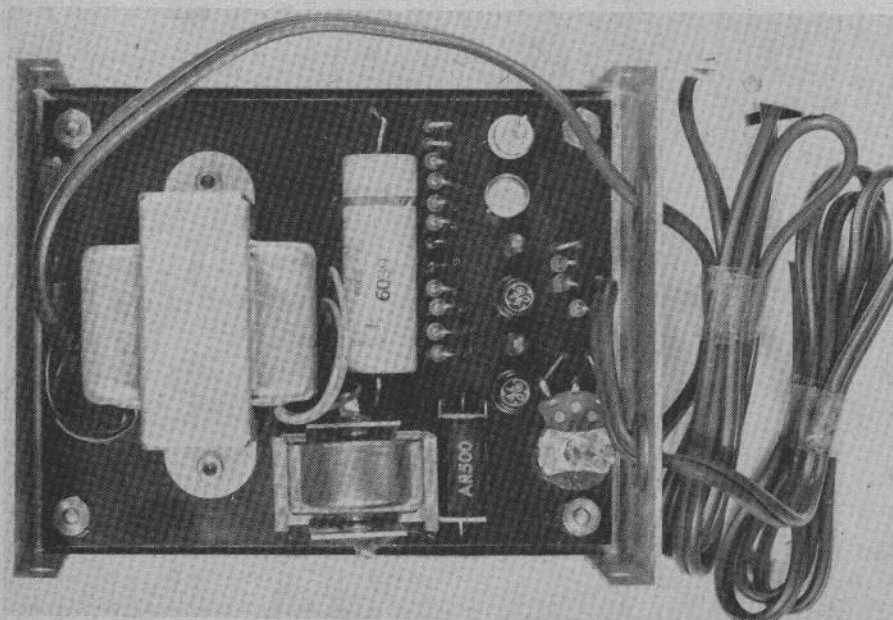


By HANK GIUNTA

Definitely a stride ahead of the diode, resistor and lamp units, the author's charger can be duplicated for approximately \$20 expense.

# AUTOMATIC CHARGING A Stepping Stone to Reliability

NICKEL CAD BATTERIES CAN BE DAMAGED BY THE ORDINARY CHARGING PROCEDURES. THE AUTOMATIC CHARGER INSURES AGAINST UNWELCOME FAILURES.



Although assembly on a circuit board simplifies things, ordinary construction will suffice.

■ The charger to be described may appear to be a considerably more complex project than most RC enthusiasts would like to tackle. It also may seem to be a "luxury" item insofar as support equipment is concerned. However, it is almost a sure bet that once you have used an automatic charger such as this one, you will wonder how you ever got along without it. This unit, when properly setup and adjusted, is very stable and will *positively not* damage nickel-cadmium batteries by overcharging, even if the batteries are left connected for a year!

Much has been written in the past on the properties of the sealed nickel-cadmium cells—such as the type presently in extensive use by the RC fraternity—but a brief recap of those properties which have a direct bearing on the charging methods may be helpful to those who have not read any of previously published articles.

The cells are sealed to prevent leakage of electrolyte and subsequent deterioration of battery performance. Normally, oxygen is formed during charge which is vented from the open-vent type of cell, but the sealed cell cannot vent this gas and it must be contained within the case. This is accomplished by a chemical reaction at the cadmium electrode of the generated oxygen to form a new compound equivalent to cadmium oxide. This process prevents free oxygen from being produced at a rate sufficient to rupture the seal of the cell *provided the cell is not subjected to either an excessive charge rate or a definite overcharge at the normal charge rate.*

It is very unlikely that many RCers realize how little charge is drained from a 5-cell pack such as the Medco during a normal day's flying. (Assuming reed equipment.) In most cases, the cells still have almost two-thirds of their capacity remaining. Of course, if you are an extremely active flyer, this figure may be considerably reduced, but in general the battery still has much life left after a good



## PARTS LIST

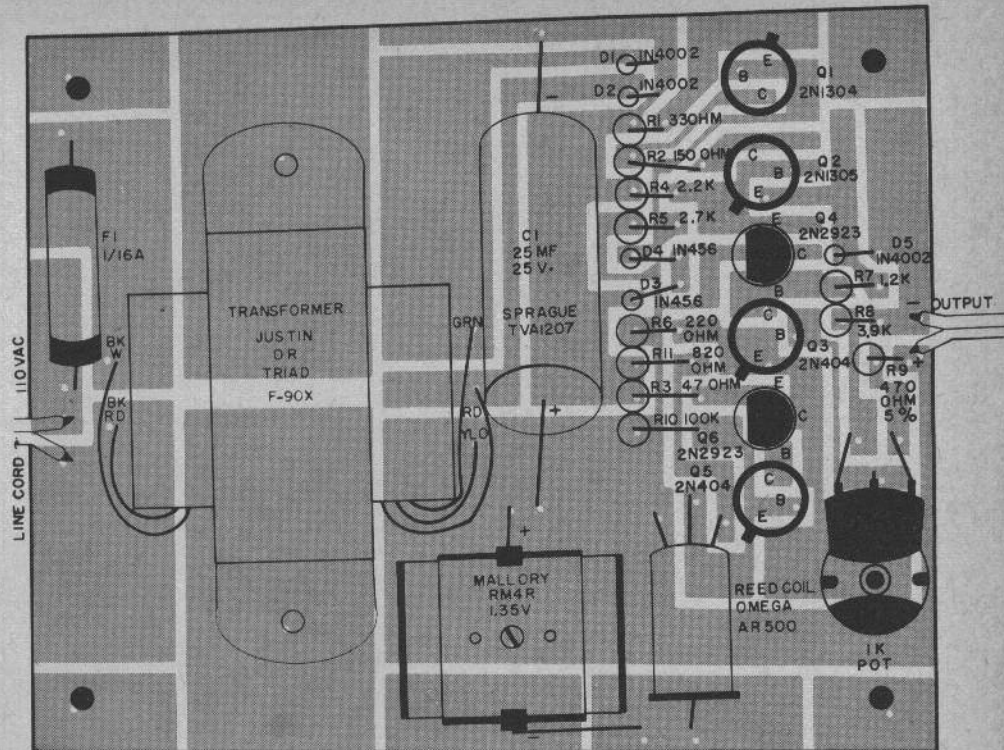
CABINET:	4 × 5 × 3 MINIBOX
T1	TRIAD F-90X OR JUSTIN TYPE
F1	LITTELFUSE 1/16 AMP (ADD PIGTAILS)
D1, D2, D5	1N4002 MOTOROLA DIODES
D3, D4	1N456 GEN PURPOSE SILICON DIODES
RLY-1	OMEGA REED SWITCH SPST AR 500
Q1	2N1304
Q2	2N1305
Q3	2N1374 OR 2N404A
Q4, Q6	2N2712, 2N2923, OR 2N2926 (G.E.)
Q5	2N1374 OR 2N404A
P1	1000-OHM POTENTIOMETER LAFAYETTE "DIME SIZE"
BT-1	MALLORY RM-4R
R1	33 OHMS ½-WATT 10%
R2	150 OHMS ½-WATT 10%
R3	47 OHMS ½-WATT 10%
R4	2.2K ½-WATT 10%
R5	2.7K ½-WATT 10%
R6	220 OHMS ½-WATT 10%
R7	1.2K ½-WATT 10%
R8	3.9K ½-WATT 5%
R9	470 OHMS ½-WATT 5%
R10	100K ½-WATT 10%
R11	820 OHMS ½-WATT 10%
C1	ADJUST FOR 10 MA THROUGH REED SWITCH COIL
	25UF 25V, SPRAGUE, TVA 1205

session at the field. The normal practice is to charge the cells overnight before flying again. This 12- to 14-hour charge can, if repeated often enough, gas the cells and rupture the cases. Once this is done, electrical continuity is lost and the cells are worthless. (Also pains can be felt in the region of the wallet!) At best, the battery life is considerably shortened by repeated overcharge even if the cells do not rupture.

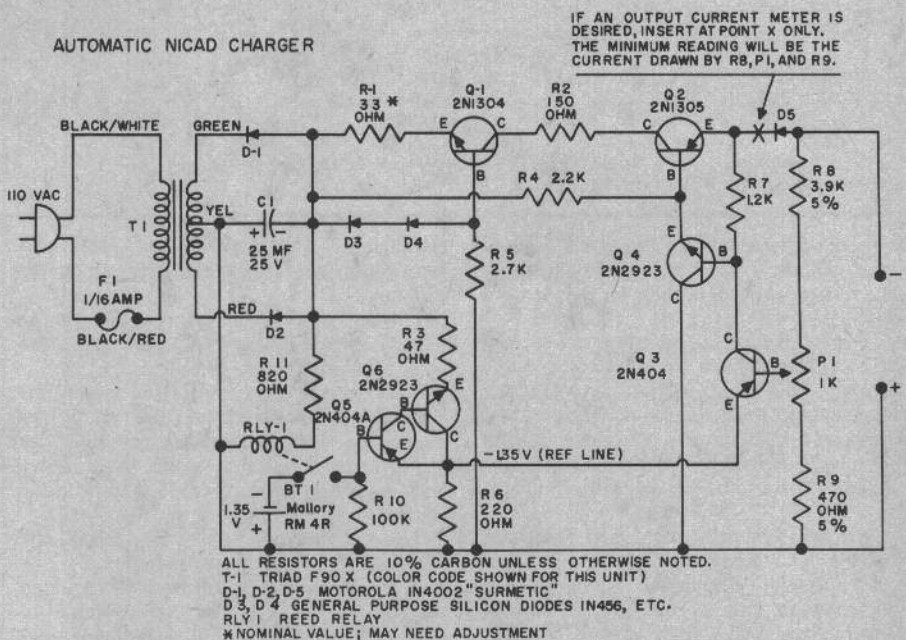
The automatic charger was designed and built as an answer to this potential problem, and to this end performs very well. It is not a cure-all which will guarantee perfect operation of the batteries for 20 years, but it is definitely a stride ahead of the "diode, resistor, and lamp" units.

The concept behind this charger appears to violate the recommendations of the manufacturers insofar as the mode of charging is concerned. Most manufacturers recommend constant-current charging for the cells, and in the case of the 500 Series, the charge rate is not to exceed 50 milliamperes. Closer inspection of the cell properties, however, indicates that the terminal (end of charge) voltage is about 1.35 to 1.4 volts, the reaction of the oxygen at the cadmium electrode cannot keep up with the oxygen generated; pressure is produced within the cell by the gas, ultimately resulting in physical rupture of the seal. This charger was designed to limit the terminal voltage of the cells to a predetermined voltage, nominally 1.35 to 1.4 volts, and regulate the current to the amount needed to maintain this voltage.

When the charging current of the cell is plotted against time, a curve closely resembling an exponential decrease is obtained. The voltage curve is also exponential during the constant-current portion of the charge cycle, then is linear during the remaining portion. When the charging current drops to 3 ma or less, the batteries may be considered to be in a state of full charge. The advantages of



### AUTOMATIC NICAD CHARGER



the automatic charger are self-evident: all the monitoring of cell voltage is done by the charger, leaving you free to worry about other items. If you go on a vacation and remember that you left your batteries on charge after driving a few hundred miles, you don't have to return to a bulging, worthless mess, neatly contained (we hope) in a nylon cylinder!

If you have read this far, you are probably going to finish this article anyway, so while our attention is focused on this page, a description of the circuit and its operation follows:

A transformer supplies 28 volts AC, center-tapped, to the input of a full-wave rectifier and capacitor filter (D1, D2, C1). The resulting DC voltage (approximately 20 volts) is applied to Q1, which acts as

a constant current regulator with diodes D3 and D4 providing the reference voltage for the stage. R1 is the current adjusting resistor. R2 is also a part of the current regulating and limiting system and serves to reduce the power dissipation in Q1 by providing an additional voltage drop. Adding this resistor approximately halves the voltage drop across Q1 and also furnishes a degree of protection to the cells under charge in unlikely event of a short circuit developing in Q1, Q2 or both. Q2 is a conventional series voltage regulator driven by error amplifier Q3, and emitter follower Q4. Reference voltage for Q3 is obtained from the reference source formed by mercury cell BT1 and the bootstrap amplifier consisting of Q5 (Continued on page 26)



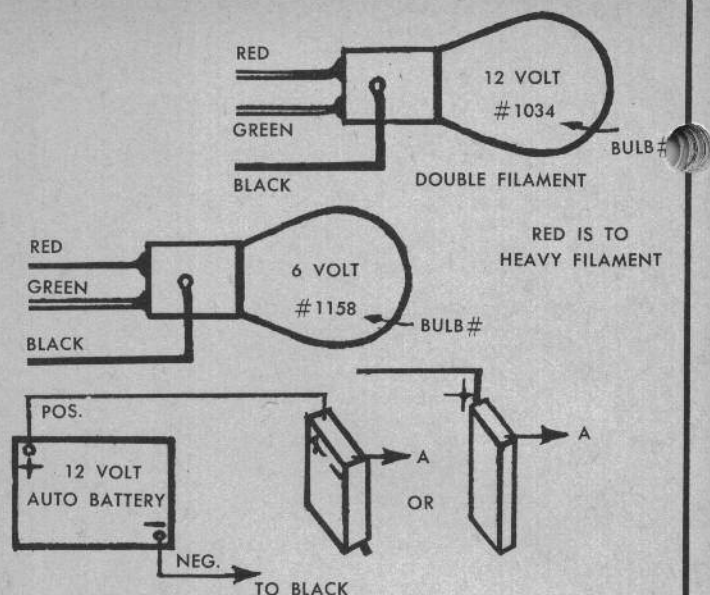
### 12 VOLT BATTERY

A — To Red and Green	— 2.0 Amp. Rate
A — To Red Only	— 1.5 Amp. Rate 1 Cell—
A — To Green Only	— .5 Amp. Rate 1.2 Volts
A — To Green, Red to Black on 12 V. Bat.—	.4 Amp. Rate
A — To Red and Green	— 1.8 Amp. Rate
A — To Red Only	— 1.45 Amp. Rate 2 Cells—
A — To Green Only	— .45 Amp. Rate 2.4 Volts
A — To Green, Red to Black on 12 V. Bat.—	.38 Amp. Rate
A — To Red and Green	— 1.7 Amp. Rate
A — To Red Only	— 1.4 Amp. Rate 3 Cells—
A — To Green Only	— .4 Amp. Rate 3.6 Volts
A — To Green, Red to Black on 12 V. Bat.—	.35 Amp. Rate
A — To Red and Green	— 1.5 Amp. Rate
A — To Red Only	— 1.2 Amp. Rate 5 Cells—
A — To Green Only	— .35 Amp. Rate 6.0 Volts
A — To Green, Red to Black on 12 V. Bat.—	.30 Amp. Rate

### 6 VOLT BATTERY

A — To Red Only	— 2.15 Amp. Rate
A — To Green Only	— .65 Amp. Rate 4 Cells—
A — To Green, Red to Black on 6 V. Bat.—	.60 Amp. Rate
A — To Red Only	— 1.85 Amp. Rate 2 Cells—
A — To Green Only	— .55 Amp. Rate 2.4 Volts
A — To Red and Green	— 1.85 Amp. Rate 3 Cells—
A — To Red Only	— 1.50 Amp. Rate 3.6 Volts
A — To Green, Red to Black on 6 V. Bat.—	.40 Amp. Rate
A — To Red and Green	— 1.4 Amp. Rate 4 Cells—
A — To Red Only	— 1.05 Amp. Rate 4.8 Volts
A — To Green Only	— .35 Amp. Rate

It is not possible to fully charge five 1.2 volt nicads (6 volts) from a 6 volt automobile storage battery.



DON'T FAIL TO REMOVE VENT SCREW WHILE CHARGING. REPLACE VENT SCREW AFTER GASSING HAS STOPPED—ABOUT TWO HOURS AFTER CHARGING.

## HOW TO CHARGE WET NICKEL CADMIUM BATTERIES

By Wint Tribble

● These tips apply to the care of wet nickel-cadmium 4- and 7-ampere-hour cells. They do not apply to dry, sealed cells.

The performance you can expect from these cells is typified by a test of a single 7-ampere-hour cell, chosen at random, fully charged and connected to a one ampere load for five hours continuously with the voltage remaining in the range of 1.25 volts at the start to .8 volts at the finish of the test.

This cell was fully recharged from this point at a 1.5 ampere rate in four hours.

A completely discharged 1-ampere-hour cell, showing little or no voltage, can be fully recharged at a high ampere rate, according to the chart, in about five hours. It would be well to reduce the charging rate during the last part of the charge to avoid violent gassing.

Both the 4-ampere-hour and the 7-ampere-hour cells will be fully charged, when connected as per chart, when using a 6 or 12 volt automobile battery, when the cell is gassing freely with a voltage reading across the cell of 1.75 volts while on charge at high charted rate.

Do not run your auto engine while charging these cells from your battery in the automobile. If you charge while traveling, reduce charge rate about 25%.

Any one of the low charging rates shown on the chart can be used for over-night charging.

At the end of any charge, check the level of electrolyte and by the addition of distilled water bring the level of electrolyte to 5/16" above the red line while

the battery is still on charge. This will insure that the plates are covered during discharge.

Do not use ordinary tap water in the cells as some impurity might cause the cells to foam during charge.

The foam we are discussing is not the normal gas bubbles that form on top of electrolyte during last part, but it is like a detergent foam that won't break down and disappear into the electrolyte after charging.

The cells should not foam using the charging rates shown on the chart.

A practical rule to follow is to recharge the ampere hours plus 30%. Refer to chart to estimate the charging rate and time.

Do not use any of the charted rates for a continuous trickle charge because the cell vent must be left open during all charging and too much electrolyte evaporation would take place.

There is no real point in trickle charging these cells since they can be so quickly fully charged.

If a cell should foam, it should be flushed out with distilled water through the cell vent and a 1/16" diameter hole drilled in the bottom. It should be allowed to drain for several hours, then plug the hole in the bottom with a polystyrene cement or clear airplane glue (not ambroid) and allow to dry.

The cell should be filled with an electrolyte compound of potassium-hydroxide crystals dissolved in distilled water, known as a chemical solution KOH (C.P.) 1.3 specific gravity—a 30% solution—this can be obtained at a drugstore.

After standing for about 30 minutes it can be recharged, as per chart, and the cell will be back in business.

If the cell should be dropped and cracked or develop craze cracks from strain or other causes, the cell case can be repaired with any of the polystyrene cements or clear airplane glue and re-filled with electrolyte.

Use a hand scrub brush to clean the potassium-hydroxide crystals that form on the cell terminals.

A hydrometer cannot be used to check this electrolyte.

Using a 6 or 12 volt, standard automobile battery for a current source the charging rate will be practically constant, due to the low internal resistance of a nicad cell.

Again! These cells will rupture, without fail, if the vent plug is not removed while charging. Do not replace vent plug in cell until gassing has stopped.

An extension light plug can be purchased that can be plugged into the automobile cigarette lighter socket on the dash and be wired with alligator clips to conveniently charge these cells.

If a commercial battery charger is used instead of a charged automobile battery as a source of charging power, the charging rates can be used. Use an ammeter to determine the best combination of auto lamps for use as resistors.

After they are selected, the ammeter is no longer needed.

Use a 50 volt, 50 M.F. electrolyte capacitor across the battery when using a commercial charger. ●



## RC — HOW IT WORKS

(Continued from page 11)

ceiver, special appropriately rated extra or additional relays are placed in actuator circuits—as for boat electric-drive-motor speed changing.

**Actuators:** As we've noted, two types are common, escapements and servos. For boats and other special vehicles, there's a variety of other kinds, generally called steering machines (they include electrical circuits to pick up auxiliary controls when the proper sequence of signals is sent by the transmitter). Escapements are useful for single-channel airplanes, usually of smaller size and power. Servos are better for larger, faster planes having more than one basic control. A servo is more dependable than an escapement, has far more driving power, and may cost two to three times as much.

**Escapements:** Two types are popular, the SN or self-neutralizing, and the compound type. The SN is smaller, cheaper, more rudimentary, and good for the smallest planes for rudder, or as an auxiliary device for working the motor control. The compound is preferred when conditions permit its use.

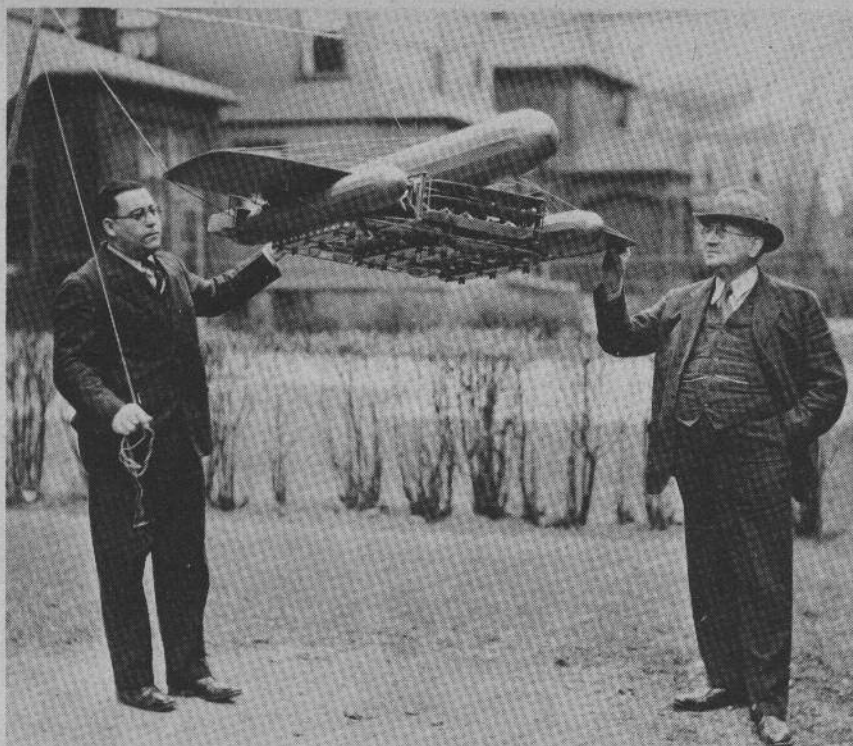
**How Does It Work?** All escapements share a family resemblance in that, compound or SN, they are powered by a twisted loop of rubber. The escapement consists of a wire-wound coil, an armature which pulls in when the coil is energized, and a rotating long-armed wheel which moves to the next position each time it is released by the armature. In principle, it operates much like a clock escapement.

When a signal is sent and held on, the SN escapement advances one position and holds that position until the signal is cut off—it then returns to neutral. Upon the next signal sent and held, it moves to the next position—on a plane this gives a rudder position opposite to the position last used. Thus, if the position coming up is incorrect, the signal must be quickly released so the device can return to neutral, so that another signal can be transmitted to move it on to the correct position. To clarify: The SN gives two opposite rudder positions in sequence with a neutral between each—as neutral, right, neutral, left, neutral, right, etc.

The compound is easier to operate. It has only one neutral. Hold one signal as before and you find one rudder (position always the same with this type unit). Relax the signal and send another quickly and hold it and the compound can be stopped easily on the opposite rudder position. No matter what position it is in, relaxing signal will cause a compound escapement to neutralize. There is nothing for the operator to remember.

The word compound comes from the fact that there are one or two electrical wipers or finger contacts which close another actuator circuit(s) when three rapid signals are sent, the third held on. This stops the escapement in a position where two contacts are held together. Normally, this feature is used to open and close a throttle by means of an auxiliary SN escapement.

Escapements do not possess sufficient  
(Continued on page 24)



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### RADIO CONTROL— HOW IT WORKS

With the exception of the terms that have been added or deleted to update these definitions, we are indebted to Hayden Book Companies who specify this credit: From Radio Control for Model Builders, by William Winter; John F. Rider Publisher, Inc.; a division of the Hayden Publishing Company, Inc.

The glossary begins on page 7. Terms are printed on back-to-back panels—those on the right, are backed by a non-text item. Cutting out these panels will not disturb text.

### GLOSSARY OF RADIO CONTROL TERMS

(Continued from page 10)

**VOLT:** A unit, or measure of electricity indicating pressure.

**VOM:** Volt-ohm meter, a measuring instrument with multiple ranges and scales.

**VTVM:** Vacuum tube voltmeter.

**WATT:** A unit or measure of electricity indicating power consumed (volts × amperes).

**WAVE:** An actual diagrammatic representation of a radio wave to illustrate frequency, amplitude, etc.

**WET CELL:** A form of battery, rechargeable.

**WHISKER WIRE:** Tiny contact wire attached to revolving shaft of an escapement to close auxiliary circuit.

**YOKE:** Formed steel wire, as a loop, placed about a drive pin inserted into the surface to be moved.

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force to reliably control most boats, because water places a higher work load on the rudder than air does on the airplane's rudder.

**Servos:** We have mentioned servos which can be used in single channel in place of the escapement. However, for this particular paragraph we are going to be concerned mostly with multi-type servos. The normal multi-type servo operates in either of two directions according to the polarity of the current—this is selected by the transmitted tones, and the decoding circuitry, relays and reed banks, etc. in the receiver. There are two popular types of servos—the relay servo and the relayless servo. The former is much cheaper, but the receiver must be of the “relay” type, or a relay pack must be inserted between receiver and servos. The relayless servo has self-contained transistor amplification in its own case. Relayless servos are most popular in planes; the relay type generally is needed in boats, etc.

**Proportional Servos:** With multi-channel proportional radios the manufacturer usually packages his own servos, so no more need be said here. Each, of course, can move right or left, and in any desired increment of movement. Most proportional servos are of the feedback or closed-loop type, in that they include a variable resistance element (like a potentiometer) which varies with the servo movement, and the current variations feed intelligence

back to the receiver which “knows” whether the servo is in alignment, or if it must be moved to be brought into alignment with the transmitted signal.

In multi-proportional control, the servos provide the necessary graduated rudder, elevator and engine control, and almost always ailerons as well, for large, powerful stunt models.

Most single-channel proportional work on planes having more than an .049 size engine, is done by modelers who often work up their own equipment using either commercial servos, or homebrew units, all of which usually make use of such popular electric motors as the Mighty Midget. This area of the activity is not described because of its infinite variations and the fact that it is generally, but not always true, that more skill is required to make the system work reliably than the rank beginner possesses.

However, at .049 or less power, a simple proportional system can be recommended to the beginner as being easier than escapements. This makes use of the “magnetic-type” actuator, such as the Adams, Septalette, or Southwestern actuator. In this ingenious system, a continuous series of signals is sent out at relatively high speed by the transmitter. This is done via a “pulser” which is hooked up across the keying switch, and thus becomes a mechanical or electronic thumb. Some recent transmitter designs are appearing

with pulsers incorporated in them.

The actuator, which has an arm which swings back and forth in agreement (caused by rapid reversing of polarity in the wire-wound coil or coils of the actuator), slaves to the movements of a stick at the transmitter pulser. Right and left movement of the stick (a knob or wheel may be substituted) causes variations in the signal pulsing. The plane rudder assumes a position corresponding to the position of the control stick. Various pulsers exist, such as Pulsitran, Phelps, Shows. The Pulsitran comes as part of a proportional system made by C & S, and is meant for operation with the Septalette actuator. Another system having made recent appearance on the market is by Babcock, and this includes a complete pulser in the transmitter case, and the receiver and actuator are sold as one package. This covers most of the simpler proportional systems. The more highly complicated proportional systems will not be covered in this article; neither will be the feedback proportional systems using the Digital and the Analog type of proportional systems. Each of these vary to some degree, and they are not subject to generalization in one article. As a rule, they are not designed for the rank beginner.

**Power Supply:** The source of electrical power for the equipment—transmitter, receiver, actuators—may be generalized for our purpose as the “power supply.” In the recent past, dry batteries sufficed for all purposes. Today, we use dry batteries, alkaline batteries, and nickel-cadmium rechargeable batteries. Various power packs and converters in older units are common.

**For Transmitters:** There is a trend to a single-voltage battery power source for the new transistorized transmitters, and although this is very notable in single-channel equipment, it is reflected also in the multi-channel equipment. However, for multi-channel, many hobbyists substitute nickel-cadmium cells for dry batteries, since they put out a more constant voltage, and which, once the fairly costly initial investment has been made and overcome, can be used indefinitely when properly recharged after usage. Nickel cadmium batteries are available in a variety of physical sizes, and capacity ratings. The capacity ratings are generally specified as either milliamper-hour ratings or ampere-hour ratings, and refer to the normal amount of use that may be had from a nickel cadmium battery under continuous drain conditions. For instance, a 225 milliamper-hour battery will supply 225 milliamperes for one hour. This is approximate, and is considered the capacity size of the given cell. If you know the drain condition in the application that the battery is to be used, you can estimate the length of time that the battery can be used under your intermittent use without recharging.

The sizes of nickel cadmium batteries that are used for model work run generally from the 100-milliamper-hour size to the 4.0-ampere-hour size.

Some of the chargers available for nickel cadmium batteries have variable outputs, and by use of charts or tables, can be set so that their output is limited for the charge rate that is specified for

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the particular size of batteries in use. The directions as given by the manufacturers of the batteries should be followed religiously, as they mean what they say, and to tamper with the recommended charging rate is to invite trouble. Nickel cadmium batteries require little maintenance and are among the most trouble-free devices used by the radio control modeler, but they are finicky as to the rate of charge that they receive.

For the older style transmitters requiring both A and B voltage—such as 1½ and 135 volts—active users prefer a power converter, which, when powered with one battery voltage input (such as either a 3.6 or 4.8 or 6 volts, depending on the manufacturer), supplies both the required output voltages.

**Receiver Supply:** Needs vary greatly, ranging from two pencils in some single-channel relayless receivers, which suffice for both actuator and receiver. In general, alkaline batteries are preferred to normal dry batteries for single-channel receivers—especially with relayless types where one set of batteries serves both receiver and escapement. Nickel-cadmium batteries are better still when voltage and capacity are appropriate.

For multi-channel planes and boats, servo requirements almost compell nickel-cadmium batteries, and all forms of dry batteries are inferior to them for these specialized applications.

In multi-receivers having tube-type front-ends, modelers can eliminate the need for separate A and B batteries by using a receiver power converter which has one battery voltage input, and the two required voltages as output.

**General:** Newcomers always want to know how far the radio will work. The answer is that it will work at greater distances than you can see to properly control the vehicles—provided the devices are properly tuned and have adequate voltage. Tuning of the receiver the first time is checked on the ground—it ought to work for at least 600 feet on the ground—with the smallest plane, and for at least 1000 feet for larger planes. Air range is much greater. For boats, range reliably should be more than the width of the pond or, if a large body of water, the same as for a small airplane. Simulated range checks are also recommended in some of the manufacturer's literature that is included with his transmitting and receiving equipment. This will vary, and the instructions in each case that are supplied should be followed closely.

**Operational Procedures:** Directions with radio equipment describe tuning, how to connect with wiring, batteries, etc. Hobby shops carry magazines and books on the subject. Soldering is the one thing presumed of you. Good soldering is essential to success. Wiring should be united into a harness wherever possible. Wires must be fastened down, all connections to battery boxes, switches and various soldering lugs must be made secure against fatigue from the continuous vibration and the handling that they will be subjected to. You can learn the techniques of good installation procedure by inspection of successful models that you see at the field or pond, or in many hobby shops.



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## Superhet - Receiver

(Continued from page 9)

generates a signal this amount below the operating frequency of 26.995 MC. Naturally, it also operates 455 KC above the frequency of 26.085 MC. This is known as the image frequency. The mixer stage is tuned to 26.995 MC, but at these high frequencies, the tuned circuit is not sharp enough to give very much attention to the image frequency. Fortunately, the image frequency does not create a problem, because the part of the frequency band which they fall in is not widely used.

The reason the superheterodyne receiver is able to reject other nearby transmitter

frequencies, is because the high frequency is converted to a low intermediate frequency of 455 KC. This signal is then amplified through several sharp tuning stages, which narrow the band-width of the receiver to the point where it will reject all but the desired frequency.

Most superhet receivers will reject signals 5000 cycles per second, or less, away from their operating frequency. However, with your transmitter off, you may notice that your receiver can be operated by transmitters which are 50 KC or more away from your receiver's frequency. This has nothing to do with the receiver's selectivity. It is caused by the square wave or other chopped form of modulation used

(Continued on page 26)



in many radio-control transmitters. This type of modulation can be caused by a transmitted signal which splatters over as much as plus or minus 100 KC from the actual frequency of the transmitter. Generally, this splatter is not a problem at the low power levels used in radio control. The carrier wave signal from your own transmitter usually will be sufficient to turn on the AGC (Automatic Gain Control) System of your receiver, reducing its gain and eliminating this adjacent channel interference. However, some transmitters may splatter so badly that you can be risking your aircraft to fly when they are in use.

It is highly recommended that you utilize the transmitter that was designed to work with your receiver for most effective and the best control, under all conditions.

## AUTOMATIC CHARGING

(Continued from page 21)

and Q6. The amplifier reduces the drain on the mercury cell to less than 15 microamperes, and insures operation of the charger for at least one year per reference cell. In addition, the amplifier prevents reverse (charging) current from flowing in the reference cell as would be the case if the cell were connected directly in the emitter of Q3. The reference cell is switched out by the reed switch when the charger is unplugged to prevent discharge through the base-emitter junction of Q5 and emitter resistor R6. This combination becomes a very low impedance which essentially places R6 across the reference cell, if the reed switch were not present. The drain on the reference cell under this condition would be about 5 ma, which would discharge the reference cell in about 30 days.

When the unit is in operation, the voltage across the cells under charge is sampled and divided by the divider formed by R8, R9, and P1. This voltage is applied to the base of Q3, where it is compared to the reference voltage present at the emitter of Q3. When the battery under charge is low, the terminal voltage is low, and the resulting error voltage is

amplified, inverted, and appears at the base of Q2 as a more negative voltage, causing Q2 to conduct more heavily. If the battery under charge is low enough, Q2 goes into saturation, and the current is regulated by Q1, R1, and R2 to the preselected safe value (45-50 ma for 500). As the battery charges, the voltage across it rises and Q2 then comes out of saturation and regulates the voltage across the battery. Q1 then conducts more heavily as it tries to supply the current dictated by the drop across D3, D4, and the value of R1. Since this current is blocked by the now higher impedance of Q2, Q1 eventually goes into saturation, and the charger enters the voltage-regulation mode. This transition is complete when the battery voltage is equivalent to 1.4 volts per cell, and typical regulation with a well-filtered DC source is less than 5 millivolts. With the simple rectifier-filter shown, ripple is about 20 millivolts at the output, and the regulation is then within the ripple voltage excursion.

The original circuits were designed around a Triad F-91 X transformer (300 ma), and four regulators were driven from one transformer-rectifier-filter combination. The printed circuit was laid out for the smaller Triad F-90X transformer driving one regulator. The unused taps were taped off to prevent shorts. (A transformer made by Justin also will be available.) Setup and calibration of the charger is quite simple and straightforward. For a typical set of requirements, the following example will illustrate the procedures: *Battery to be charged: Medco 5-cell pack*

1) Determine safe terminal voltage by multiplying the number of cells to be charged by 1.4 volts. ( $5 \times 1.4 = 7.0$  volts)

2) Connect a voltmeter across the output terminals of the charger and adjust P1 until the output voltage is 7.0 volts. The voltmeter used for this measurement should be accurate to at least 3 per cent. If you do not have a voltmeter available with this accuracy, the output voltage should be set about 0.25 volts low or 6.75 volts in order to avoid a possible high terminal voltage due to meter in

accuracy. (Simpson 260 or equivalent is O.K.)

3) Connect a 0-100 milliammeter across the output terminals and check for a current between 40 and 50 ma. Do not leave the meter connected too long for this measurement, as there is an additional 7-volt drop across Q1 during this time which increases the power dissipation in Q1. When a battery is connected, Q1 is operating well within its capabilities. If the current is less than 40 ma, R1 will need to be decreased in value. For the diodes and transistors specified, 33 ohms has been found to be satisfactory in almost all cases.

4) Recheck the output voltage as done in #2, and be sure it is accurately set.

This completes the setup and calibration, and nothing more needs to be done before the unit is put into service. It is recommended that the reference cell be replaced once a year, although the drain on this cell is low enough that it will easily last 18 months. It is not absolutely necessary that a recalibration be done at the time of replacement, but it certainly is advisable. The reference cell should be stabilized before insertion in the circuit by connecting a 1000-ohm resistor across it for about 16 hours. The purpose of this slight discharge is to get the reference cell voltage down to the plateau of its discharge curve where the voltage is more stable. This operation is important as the output voltage of the charger is ultimately referenced back to this cell.

For those who have a fairly good "junkbox", here are a few words of caution regarding parts substitutions. Q5 should be a low-leakage unit; a leaky transistor at this point will produce reference voltage not dependent on the reference cell. Q6 is not too critical and substitutions here will not normally be difficult. Q4 need not be a silicon unit. P1 and the associated divider resistors may be juggled to obtain either greater resolution or greater adjustment range. The greatest resolution and least range will be obtained when P1 forms a small part of the total resistance. With the values

(Continued on page 28)



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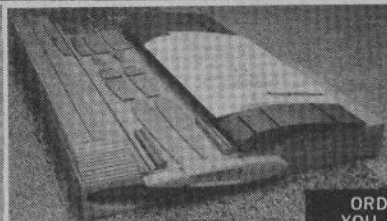


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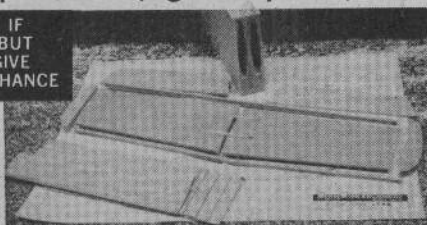
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## BITS AND ..PIECES..

**E. D. 2.46 Racer:** Manufactured by Electronic Developments (Bath Rd., Hounslow, Middlesex, Eng.) 2.46 cc (.15) Diesel features integral silencer which reduces peak rpm by only 300, has tick-over idle of only 700, yet is claimed to respond instantly. Your editor flew this engine 10 years ago, sans silencer, and found it above criticism, capable of running with nose straight up or down on a standard free flight tank. Glow plug version will be available. Water-cooled Diesel version has two exhaust stubs to take 1/4-in. neoprene tubing.

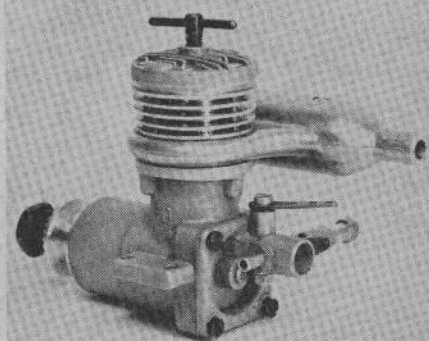
**Motor Control for B&D:** Gene Gagliardi uses Annco relay servo for simple control of motor—with electrical stops. The two 1N34A diodes must have low forward resistance for servo to operate well. Diodes and connections can be in servo case. (Drawing, right.)

**Acryjel Contest:** Idea of contest sponsored jointly by Acryjel and Ace R/C, is to uncover more specific uses for this product. To enter, use Acryjel compound in any color available—in a new and different way—describe use in less than 100 words, mail to Acryjel Contest, c/o Ace R/C, Box 301, Higginsville, Mo. Judges will choose monthly entry presenting most original use. Winner receives Acryjel color

kit, including five 4-oz. powders and liquid for each—value \$13.75. No entries returned; winners published in GRID LEAKS. If your dealer does not have powders and liquids, order direct.

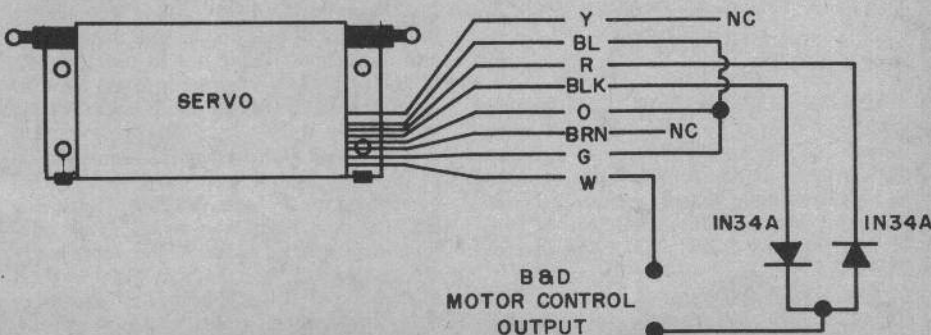
**PC Boards—Made to Order!** Acrygel Products (Box 306, Oklahoma City, Okla.) will make PC Boards from your black-and-white drawings. Write firm for information on artwork required, sizes desirable, prices—including negative—for one or more units.

**MIN-X schematics:** Because of demand for complete schematics of their line, MIN-X Radio, Inc. (8714 Grand River, (Continued on page 32))



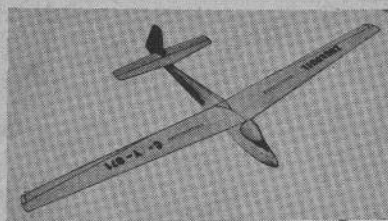
E.D. Racer Diesel from England has excellent performance, throttles to low idle, and a silencer which costs only 300 revs.

Below: This idea for simple motor control in the B&D system was developed by Gene Gagliardi. It provides electrical stops.

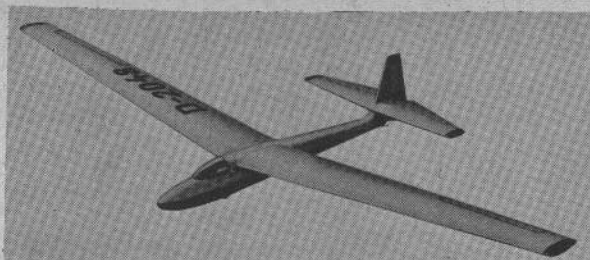




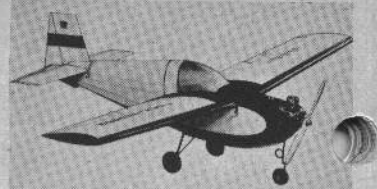
## —HEADQUARTERS FOR RADIO CONTROLLED GLIDERS—



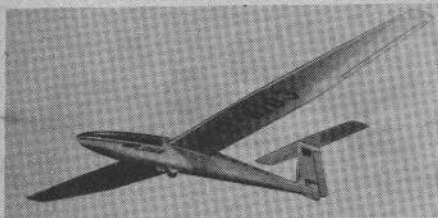
**Robbe ZUGVOGEL III**  
94 1/2" span .....\$25.00  
(10-12 channel aerobatic)



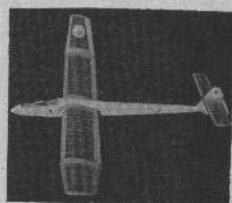
**Graupner SCHLEICHER K-10 79"** .....\$20.00  
(2-6 channel Thermal/Slope)



**Robbe TIPSEY NIPPER**  
58 1/2" .....\$27.50



**Hegi SB-7**  
90 1/2" —Foam fuselage .....\$21.00  
(4-6 channel Thermal/Slope)

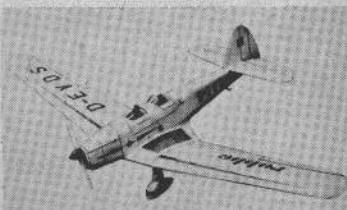


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-SB-1, 81"



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**Robbe KLEMM K-35**  
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**Robbe Ka-7 RHONADLER 74"** .....\$15.00  
Not shown (4-8 channel Slope/Thermal)

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Not shown —44 1/2" .....\$16.95

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shown, a range from about 4.5 to 9.5 volts is obtainable, and the resolution is adequate. If you find it hard to adjust P1 smoothly, make P1 500 ohms (or shunt it with 1K), change R9 to 680 ohms. This will give increased resolution.

Construction of the charger is simplified considerably by the printed circuit and the associated parts placement information. There is no need to construct the charger on a printed circuit, and normal, sound construction techniques will result in a reliable unit. The total cost of parts for the charger will be in the neighborhood of \$20.00 if the specified components and cabinet are used. This is less than the cost of one battery pack, and the unit may well save you many more than one pack. The least this charger will do for you is to increase the total life of your present battery pack compared to its life expectancy under conditions of repeated light overcharge.

### PIETENPOL

(Continued from page 13)

flight the ship was fairly well trimmed out, and proved to be a very docile airplane, but an excellent stunter. I believe that a Class II competition pilot could do a very creditable job in contests with this airplane. While it has a flat-bottom wing, it flies inverted easily, with good inverted stability.

The .35 up front gets it off the ground in nothing flat and hauls it out at a much

steeper angle of climb than the prototype with its Model A power. But by throttling back to about half power it settles down into a lazy flying airplane that will do about any stunt maneuver you wish. It has done all stunts to date in the pattern except for tail slides and spins. We simply haven't tried them yet. At about one-third power, it just hangs in the air and floats around, tame as can be. It responds well to rudder, making fairly steep turns with no tendency to drop the nose, and no need to apply up elevator to keep the nose up. It would probably make a good rudder-only airplane. It rolls nicely on rudder command, and executes the roll quickly and sharply, with no tendency to oscillate into barrel-like rolls.

Although a flying-scale airplane, construction is no more difficult than the average competition type multi-stunter. By using light to medium wood, weight can be kept under five pounds, to give a wing loading of around 17 ounces per square foot. I use 7- to 9-pound balsa throughout, and the original came out to four pounds, 12 ounces. Also, when completed, the CG fell right on the button, with no ballasting necessary.

**Wing and Tail Assembly:** Construction of the wing is straightforward, and follows presently used practices for achieving light, strong, warp-free wings. The reinforcement blocks in the center section are vital, however, as they provide a solid thickness for drilling holes for the wing hold-down rubber bands, and provide suf-

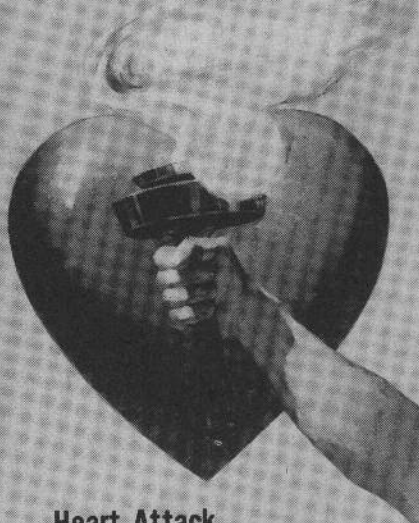
ficient strength in this area when the bands are pulled up tight. Tail structure is quite simple too, and practically falls together. I held the tail assembly in place on the original with dowels and rubber bands, but this was done only in the interests of being able to adjust tail incidence until we knew how the ship would fly. Since the right settings have been established through flight tests, the tail assembly can be mounted permanently, if you wish.

**Fuselage:** The fuselage is quite simple in its construction, but may take a little more effort than for the ordinary multi ship because of a few scale details, and the detachable cockpit area hatch—to provide access for the radio gear. Fuselage sides are cut from 1/8-sheet balsa, and doublers and triplers are from 3/32 stock, while the tail doubler is of 1/16 sheet. The wire cabane struts are sandwiched between the sides, doublers, and triplers, and anchored with small plywood plates, which also help anchor the ends to assure the correct incidence angle of both struts.

I built the sides by cementing the doublers in place, slotted for the cabane struts, then inserting the struts and cementing the triplers in place. Longer ons and uprights are then added to the rear of the fuselage sides, together with the tail doublers. Next, the 1/16- and 3/8-sheet nose pieces are cemented to the sides. Use a good grade of white glue for this entire assembly. Assemble the sides by installing the formers, cross braces, and tail post, then sheet the bottom of the fuselage from the rear



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of the cockpit back with 1/16 sheet with grain applied crosswise. At the very rear of the fuselage apply a piece of 1/16 plywood to provide a base for mounting the steerable tail wheel bracket. Next, install the 1/8-plywood landing gear mounts, and sheet the balance of the bottom with 1/8 sheet balsa. Sand a taper into the 1/8 sheet so that it blends smoothly into the 1/16 sheet.

Cement the hardwood motor bearers to the inside faces of the cowl blocks with white glue, and when firmly dry, mark and drill for mounting your engine, installing blind mounting nuts in the bottom of the motor bearers. Be sure to allow for the necessary side thrust. Cut and cement the cowl block in place, install the brass tubing for throttle pushrod, add stringers to the turtledeck, plank the forward section, and add the top cowl

ward section, and add the top cowl fairing blocks. Make the nose ring from two laminations of 3/16 plywood and cement to the nose of the fuselage. While this assembly is drying, cut a piece of 1/8 sheet to form the floor of the cockpit area and pin it in place on the top of the fuselage. Next, cement the cockpit formers to it, and while pinned in position, start planking it with 1/8 x 3/8 strips. Plank from both edges toward the middle, and when the first several strips have dried in place, remove it from the fuselage and complete the planking. Addition of two 3/16-sq. strips to key it in place into the fuselage completes this part.

When the fuselage and cockpit hatch is thoroughly dry, slip the hatch into place and sand the entire fuselage to finished shape. The nose will require a bit of carving to bring it to the right taper when viewed from the top, before sanding. Note that it tapers from the firewall forward, blending from a rectangular cross-section into the round cowl ring. When sanding is complete, apply three coats of fiberglass resin and one layer of cloth around the entire nose of the ship. Also, cut a piece of cloth to fit the inside of the cowl, across the bottom of the cowl and up both sides of the motor bearers. Install this in place with three layers of resin. Sand thoroughly between coats to assure a smooth, sleek nose. Use of the glass cloth and resin makes the nose indestructible.

**Covering and Finishing:** Sand thoroughly with very fine sandpaper, then give the entire ship two coats of clear dope. When dry, sand smooth and apply the silk. Cover (Continued on page 30)

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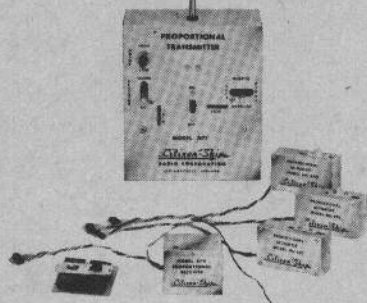
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(A third APC Servo may be purchased which can be paralleled with the rudder servo from a single output to obtain CAR.)

**1 APM Trimmable Servo**—Mechanically the same as APC above. Purchased separately—Suggested List Price.....\$25.95

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the entire ship, fuselage and all. Follow with three coats of thinned out clear dope to seal the silk, then three filler coats with talcum power added, sanding with extremely fine sandpaper between coats. When I finished this much, I added two more coats of thinned out clear dope to seal the talc, then sprayed on two coats of colored dope. After the color had dried thoroughly, this was topped with two coats of clear Aero Gloss, sprayed on, to add fuel-proofing qualities and to give a good sheen to the finish. As to color, the original model was finished in Curtiss Blue and Taylorcraft Cream. Most of the early Pietenpols, as near as I can determine, were finished in blue and cream or blue and silver, with the blue on the fuselage, fin, rudder, and all struts. Antique aircraft buffs, after rebuilding their Pietenpols, have finished them in a variety of colors, so most anything you choose would probably be somewhat authentic.

Make and install the landing gear, using 1/8 wire. If you wish the large, narrow-tired wheels of the original Pietenpols of the early '30's, use Williams Brothers 5-inch old-time wheels. If you wish balloon wheels, use either 3 1/2-in. or 4 1/2-in. diameter Trexler airwheels. I used the latter size, but either would be close to scale, for Pietenpols are presently flying with all sizes of balloon wheels, from small wheels from J-3 Cubs on up. Install the hatch hold-down blocks, windshields, and other details, and mount the equipment in the ship. Be sure to make the servo travel reduction set-up shown. With those big scale control surfaces, you don't want full servo travel transmitted to them!

Wing struts are added principally to complete the scale appearance, but I fly without them. You can fly with them if you wish, as they will knock off easily if the ship gets bumped. They are held in place by installing the wire on the lower end of them in eyelets at the bottom of the fuselage, and drilling pairs of holes in the plywood strut plates in the bottom surface of the wing. The U-shaped wires on the ends of the struts anchor into these holes and are installed by springing the wing gently upward against the hold-down rubber bands to snap them in place.

**Testing and Flying:** Little needs to be said other than that the CG should be located as shown on the plans, and decalage should check out accurately. A few test hops will probably be about all you need to trim the ship out. If the ship has a nose-up tendency under power, but glides well dead-stick, increase the down thrust. If it noses up under power and in the glide, put some down trim in the elevator. If a little trim doesn't completely solve the problem, increase the positive incidence in the stabilizer. If the ship tends to turn to the left under power and in the glide, trim with right rudder. If it tends to turn to the left under power only, and glides straight, add more right thrust. We trimmed the original in only three flights and were getting very satisfactory performance.

When you complete your Pietenpol and put in a half-dozen or so flights with it, beware! That old flying scale bug will probably bite you hard. It's quite a sight, with a Williams pilot head sticking up out

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of the rear cockpit, to see it come floating by you, engine idling, to touchdown for a three-point landing . . . then, a blast of the engine, pull it around, taxi over to your tool box, blast it around into the wind to bring it alongside the tool box, and kill the engine. If this doesn't send a real thrill running through you, then back to your hot contest ships—you simply don't have any scale blood in your veins!

### RELAYLESS DRIVER

(Continued from page 12)

both reeds were to vibrate at the same time (due to a malfunction of the transmitter, etc.), both output transistors would turn on simultaneously and burn out. However, under these conditions, diode D1 will conduct and prevent Q1 from turning on, by clamping its base to ground.

The letters A and B are chosen to represent any pair of reeds that are to be used for each servo, (right/left, up/down, slow/fast, etc.) and the connections are the same for each pair that is used.

A number 43 pilot lamp is shown used in series with the servo to protect the output of the flip-flop is a 50% On one way, and -4.8V are used instead of -3V and -6V, the bulb will probably have to be omitted in order to obtain enough drive. The maximum current for the 2N1308 and 2N1309 is 300 ma. General Electric recently came out with an inexpensive 500-ma PNP and 500-ma NPN (see parts list) that would probably work quite well in the outputs of this circuit, and they would



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4JX1C1132A—PNP type, TO-5 case	.85
4JX11C1847—NPN type, TO-5 case, silicon, complementary to above, replaces 4JX15A762	.85
2N2926—NPN silicon, epoxy encapsulation, 100 ma 18 volt	1.35
1N1671—Unijunction, for pulsers, etc.	3.95

## CENTRALAB TRIM POTS

These tiny units are just it for placing into transistor circuitry to determine final values of resistors which may be subject to variations. May be left in the circuit, or measured and replaced with fixed values. For trim use only. 7/16 x 7/16 x 1/16".

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No. 29A15—25K Centralab Trim pot	.69

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No. 30A14—AR 500 ohm, SPST, 4.5 to 10 ma	3.75
No. 27A31—HR-1 3,600 ohm, SPST, 1.5 to 2.7 ma	4.00
No. 27A25—300 DT, 300 ohm, SPDT, 6 to 10 ma	5.95
No. 27A30—HR-DT 3,600 ohm, SPDT, 2 to 3 ma	6.95

## ACE R/C 1965 CATALOG

OUR 1965 CATALOG IS OFF OF THE PRESS. We have in the works many new kits, many new items from other manufacturers, and we hope to give you a preview on these pages of some of the new items. However, no ad can hope to list all of the items in our new catalog. This more than 60 page catalog is still available to you, at only 10 cents—the cost of handling and postage.

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No. 17A38—3/8" diameter x 7/16" high. Used by Beeler and Dickerson in the B & D system. Complete. 1.50

No. 17A39—9/16" diameter x 7/16" high. Fine for audio filters. Two cores, bobbin and special mounting hardware. 1.95

No. 17A27—1" diameter and 3/4" high. Used in Ace 3.6, and by Beeler in his converter. Complete set. 1.95

## ACE RADIO CONTROL - BOX 301 - HIGGINSVILLE, MISSOURI 64037

not require the protection of the #43 lamp.

All of the components are standard available items with the exception of the printed circuit board which is not being produced at the present time. Notice that provision has been made in the layout for several different sizes of 15-mf capacitors (see note on parts layout drawing). The size of the board can be reduced if the size of the capacitor is similar to the one in the parts list. All of the resistors are 1/4-watt units (preferably  $\pm 5\%$ ); all components are mounted on end.

The parts are as follows: The 15-mf cap is (Newark Electronics Corp., 223 W. Madison St., Chicago, Ill.) catalog number 17F045 and are \$1.52 ea.; the resistors are Newark #12F205 (and list the values), \$.26 ea.; the 2N1305 is Newark #22F2641 at \$.57 ea.; the 2N1308 is Newark #22F2644 at \$.93 ea.; the 2N1309 is Newark #22F2625 at \$.93 ea.; the 1N270 is Newark #21FX4577 at \$.32 ea. The 500-ma PNP (see text) is GE #4JX1C-1132A (Ace R/C) at \$.85 ea., and the 500-ma NPN (see text) is GE #4JX11-C1847 (Ace R/C) at \$.85 ea. Most of the components listed are available from other suppliers as well.

Several of these drivers have many hours of flying time put on them in RC gliders without trouble of any kind, and the original breadboard even survived a dunking in the Pacific Ocean (but the reed bank didn't).

## SERVO EXPERIMENT

(Continued from page 17)

of 4. It flew off the end of them also, not a very pretty 90 degree maneuver. The Huskie was replaced by the Atom in it now. The Atom acquired a glow plug then it stayed in storage until the transistor receiver came along to give it another job of testing.

To check the new idea without the risk of crackups I bought an A.M.T. slot racing car for the steering mechanism and drive motor. This led into a rather extensive side street. Neither the steering nor the drive motor was suitable for 3-volt operation and all of the original car that is of any use turns out to be the shell and the king-pin steering arrangement.

The pulse duration basic signal as intended for rudder control is driving a Mighty Midget geared to the rear wheels. Left is reverse, center is neutral, and right is forward. The Mighty Midget is not powerful enough to be an adequate drive; the search for a better motor resulted in measuring the torque, RPM, and current values for seven motors plus looking up three others and resulted in the chart. This stalled the A/P effort most effectively!

The frequency discriminator works very well, however! I built my own transistorized pulser using the unijunction and flip-flop system with 6-volt supply and debugging it also took time, and it still isn't perfect. I should have taken my own advice and bought a pulser kit! It cannot

be one with a relay output; the trouble is I keep thinking just a little ahead of the kit availability. For instance, using the reversing bridge per the schematics, the receiver really should be capable of higher frequency pulse following. I have intended for some time now to see just how severely the higher frequency pulsing is cut off by that big 70mfd capacitor common to all of the current receivers. In any event, my pulser is relayless and pulses the TTX Citizenship transmitter through a 2N1306 and the receiver is the limiting factor.

This desire for higher pulse rates derives from the frequency change channel; it is easier to get a large change in pulser frequency at a higher midpoint frequency. The limiting factor is probably pulse frequency approaching the modulation frequency.

The frequency discriminator that I am using is a monostable flip-flop, this is the type that returns to its original state after a self-determined length of time after each triggering. It is triggered by the front-end of each pulse via capacitive coupling from the receiver and pays no attention to the duration of the received pulse. When the time of the flip-flop in the receiver is just equal to half of the time between the beginning of each transmitted pulse, the output of the flip-flop is a 50% On one way, 50% On the other way, a pulse duration signal which drives the same reversing bridge and motor arrangement as used for pulse duration control directly off the receiver output—in a neutral condition in

(Continued on page 32)



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the case just described. When the pulses come closer together (higher frequency) then the reversing bridge is more On one way than the other and drives the motor in the appropriate direction.

These flip-flops are apparently quite stable, although they must have some temperature dependence, being made of transistors; operating either full On or Off helps. This results in better stability than the usual L-C type frequency detector but probably is not as good as the old standard reed switch. They do lend themselves to



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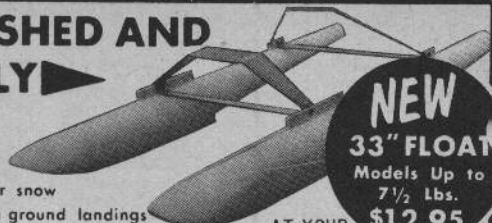
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driving the output bridge, have no contacts to get dirty, and are light!

When I made up this last flip-flop driven bridge I changed to NPN transistors in the bridge—the original and your schematics show PNPs. This is the better arrangement due to its being possible to get further "on" with the first reversing bridge transistor when it is Vce sat. voltage of the driving transistor from the plus side than when it is Ib (R of #48 bulb) from the minus side. Ib is the base current of the "on" transistor in the bridge, and Ib times the load resistance of the driver transistor can become quite an appreciable voltage. This is why the lamps work so well as load resistors. They change resistance in the right direction at the right time to reduce this effect. However, some transistors have large values of Vce sat., so discretion in choice of transistors is required.

## HOW TO RADIO CONTROL A SAILBOAT

(Continued from page 18)

superhet. The four channels provide right and left rudder and in-and-out control for both sails. Six-channel equipment would provide individual main sail and jib sail control. With 8, 10 or 12 channels your imagination and ingenuity are the limit.

The mechanics of the rudder and sail controls are simpler than airplane controls. Airplane rudder servos are powerful enough to operate the boat rudder. The servo simply operates a pushrod attached to a bellcrank on the rudder shaft. Sails are pulled in by strings and the wind pushes them out so all that is needed is a gear chain or clock works to give a Mighty Midget motor some muscle. Some rudder servos can be modified. Whatever mechanism is used turns a spool or reel to take in or let out strings that are fastened to the sails.

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## BITS AND PIECES

(Continued from page 27)

Detroit, Mich. 48204) has prepared folder of 10 schematics, including the Pulsemite series, \$2.00 postpaid.

**Colver Front-End PC Board:** Because of demand from GL readers, Frank Colver (434 Lenwood Dr., Costa Mesa, Calif.) is making superhet front-end PC of 1/32-in. glass epoxy for \$2.50 ea.—1/16, \$3.00. PC board for Bellamatic driver, costs \$2.00 on 1/32-in. board only. Order direct from Colver.

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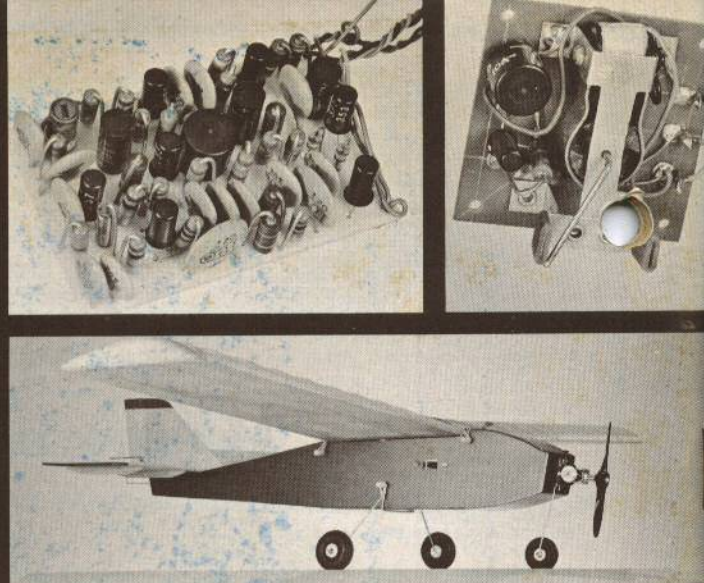
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