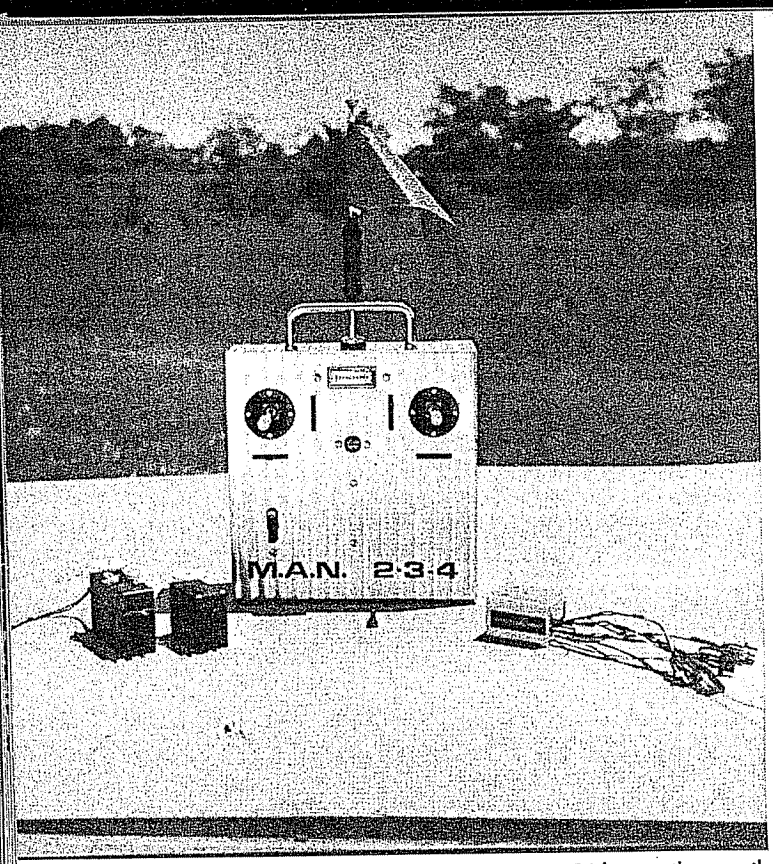
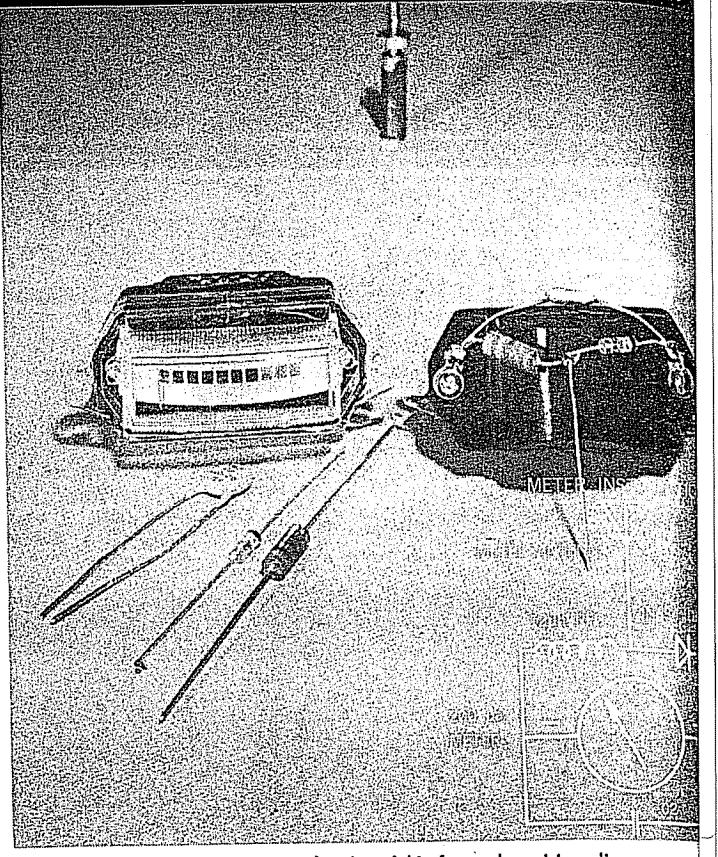


Completed M.A.N. 2-3-4 four channel transmitter. Sticks are the smooth functional O.S. types, burnished aluminum case, center loaded antenna.

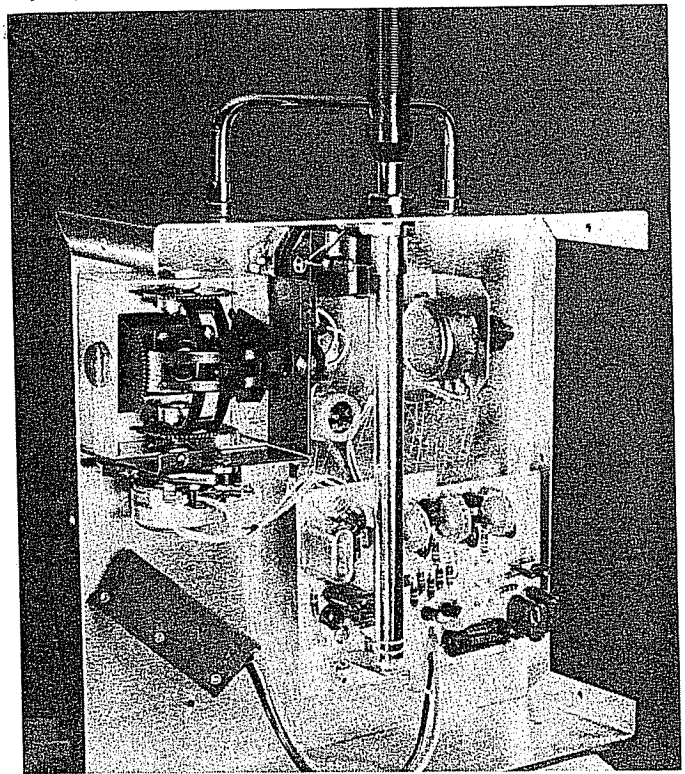


Meter package with unit in completed and kit form plus wiring diagram.

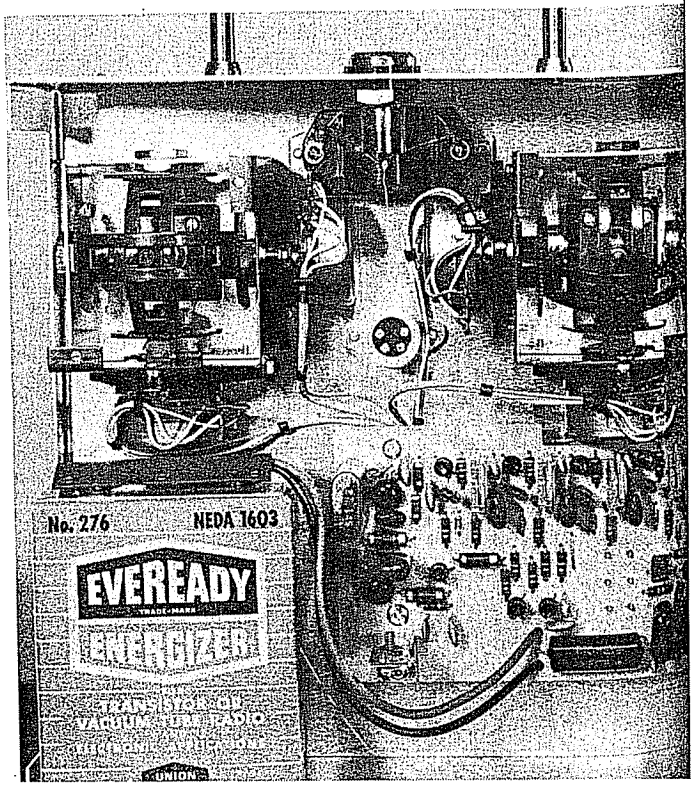
M.A.N. 2-3-4 DIGITAL SYSTEM

By DON BAISDEN . . . First installment in what we believe to be the best of the very many historic modeling firsts that we have presented in the past 39 years. Here we have the first miniature digital system in kit form, weight of 16¼ ounces comparable to all of the new small digitals. If you want it even lighter, you can build the tiny S-4 digital servo kit.

A look inside of the three channel transmitter shows the simplicity and expert packaging for compactness and accessibility—dry battery power.



A look inside of the four channel transmitter. Again we see the compactness but uncrowded interior. Antenna was left off so we could see more.



EDITOR'S NOTE

This month Model Airplane News is pleased and proud to present the first installment of the M.A.N. 2-3-4 digital system. This system is not the first that has been available to M.A.N. for publication. It is, however, the first that we feel offers enough to our readers to justify its sponsorship by us.

In printing a series of articles such as this, a magazine opens a Pandora's box. It was not our desire to lead our readers down a path of frustration, anger, dissatisfaction and wrecked airplanes. We are satisfied that the M.A.N. 2-3-4 system will lead you to none of the foregoing. Each element of the system will have been built and thoroughly tested by Model Airplane News. The instructions used by us will have been the same ones available to you as will all of the components and parts used by us. We think this system is unique in the following respects:

1. Reliability—Upon building this system, you will have exactly duplicated the Controlaire digital system. Your system on the flying field will be indistinguishable from a system purchased in ready to fly condition. There will be available to you the same service facilities and know-how that are available to the purchaser of a ready to fly Controlaire digital.

2. In all respects other than price, this is a deluxe system. This is apparent from the handsome burnished transmitter case, the inclusion of a true dual charger and R.F. meter.

3. This is a "modern" system with respect to size, weight, and circuitry. The receiver-decoder is extremely small. The S-3 servo is very fast and sports both wheel and dual rack outputs. The extremely small S-4 has only wheel output.

4. It is expandable. You may start with two channels and easily work your way up to four and possibly up to six.

5. This is the only system in the entire R.C. industry that has a fully fixed tuned transmitter with no adjustments to be made. In addition, the transmitter has an easily accessible pot for every channel whereby servo throw and centering can be varied.

6. This is the only system where you, the builder, will have the opportunity to build from either a semi-kit (all circuit boards completely wired and tested) or from a conventional kit (where you mount the components on the board) or from scratch. We do not recommend the latter since we do not feel that the small savings in cost, if any, justifies it. Nevertheless, we have included sufficient information for you, die hards.

7. Last but not least, an entire four channel digital system in semi kit form will be available at your dealer at $239.98 (list price) inclusive of dual charger and all nicad packs. All components of the system will be available separately and, of course, two or three channel versions will be less expensive. Conventional kit versions will cost less than semi-kit versions. If you so choose, you may economize by omitting dual charger and nickel cadmium pack from the transmitter and substituting therefore a nine volt dry battery.

Advertisements will appear in this magazine where all prices will be set forth. The construction of the transmitter semi-kit is featured in this issue. Necessary information for the conventional kit will appear next month. The list price, at your dealer, of the four channel transmitter semi-kit will be $114.98 complete with dual charger and nickel cadmium pack (dry battery version $88.50).

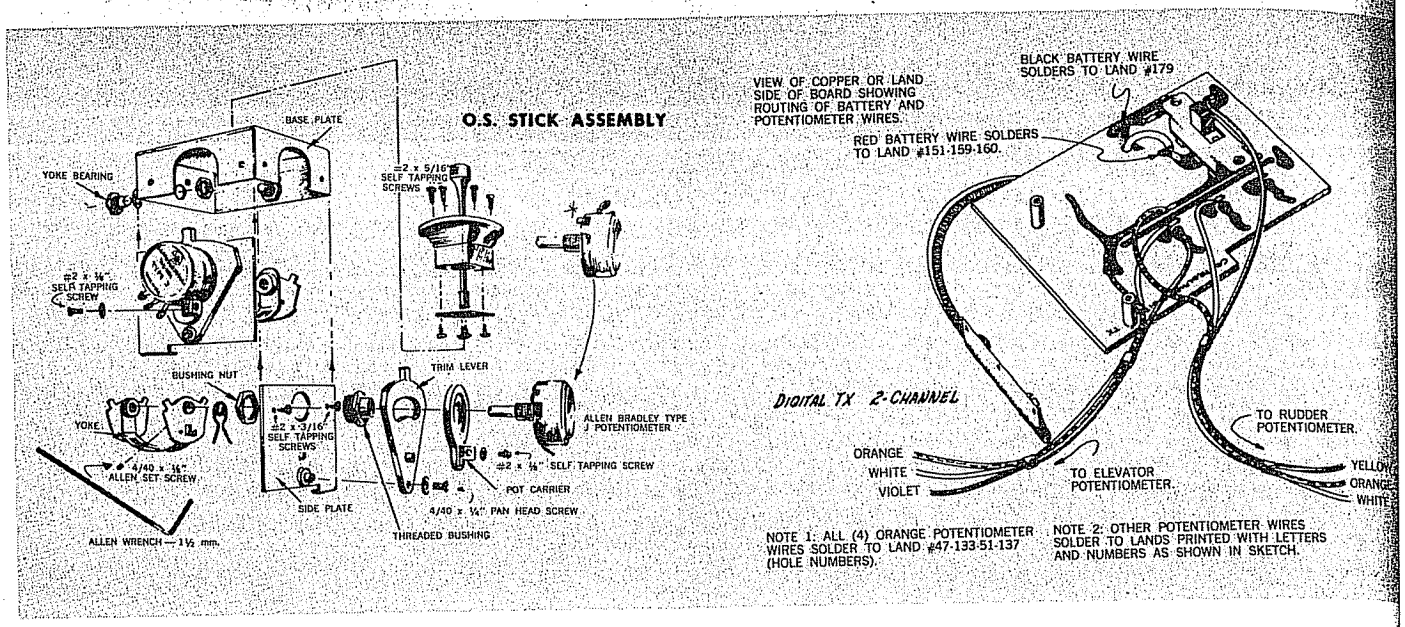
Editor

The 2-3-4 Digital System represents a current design point in the evolution of Controlaire Radio Equipment. The circuit and packaging are based on several years of experience in manufacturing, kitting, and repair of Digital Systems. The design concept was not only to make a general technological change toward a new smaller airborne package but also to engineer the project to allow the home builder to duplicate a factory assembled small system.

The presentation of the construction details of the various components in this and the following articles of the series will provide general technical information as well as all information necessary to complete the kit or semi-kit available from World Engines or to scratch-build from your own boards and parts. The articles will be primarily aimed toward semi-kit assembly and check-out but component placement diagrams, P.C. Board patterns and specific instructions on critical construction steps will be included. In the semi-kit configuration, all components have been installed on the P.C. boards and the separate units have been factory checked for correct operation. What is left to be done is the mechanical assemblies of the hardware and stick assemblies of the transmitter, mechanical assembly of the servos and adding the wires and plugs to the various components.

The receiver, which will appear in future issues, represents a substantial reduction in size over many current designs. Two deck construction was chosen for several reasons but probably the main reason is that it presents a cubical package which is easier to mount and foam-protect in a model than a flat packaging arrangement. The airborne power pack consists of four nickel cadmium pencells of the 600 MAH variety. If you really wanted to penny pinch on weight, 450 or 500 cells will do but that extra ¾ ounce is worth it in operating time. Flying weight with four S-3 servos is 16¼ ounces. Although the servos for the system are truly small, additional ultra small servos will be available and known as the S-4 servo. The transmitter is a very straightforward design employing fixed tuning in the RF portion and the currently popular half-shot principle in the encoding section. Integrated circuits are not highly utilized in this system since almost all of the current I.C.'s in the practical price catagory are ill-suited for R/C use. An I.C. is utilized in the servo, however, to handle the one-shot function and here the size reduction is an important factor in the "space race." Jim (Butch) Lanterman, the Chief Technician at Controlaire keeps a pretty close eye out on new I.C.'s. Through his efforts, this servo amplifier may be adapted to almost any of the currently available mechanics. It might be pointed out that the application of I.C.'s to the servo amplifier is probably of prime interest to R/C'ers since three or four servos are usually used in an airplane. Further receiver size reduction is going to be of little significance considering parts density and the fact that you only use one per installation.

Construction of the system will begin with the transmitter. As with any kit, it is a good idea to sit down, look over the parts, and compare them with the parts list. This may sound like a silly idea, but it will familiarize you with the different components and allow you to identify them when they are called for later. Note that on the assembled circuit boards in the semi-kits, the component leads have been bent flush against the circuit lands and the entire assembly has been machine soldered. After soldering, these boards are cleaned, checked for solder omissions and bridges and finally, checked for operation. In your inspection of your boards, it is wise (*Continued on next page*)



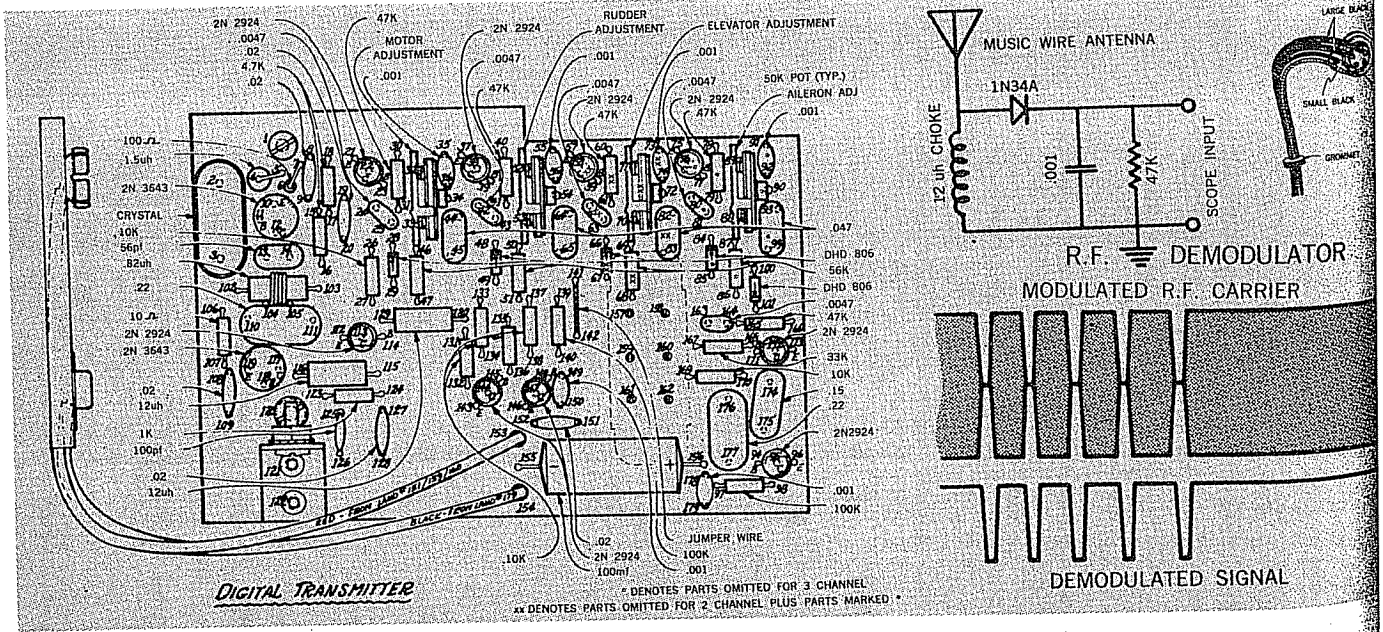
M.A.N. 2-3-4
DIGITAL SYSTEM CONTINUED

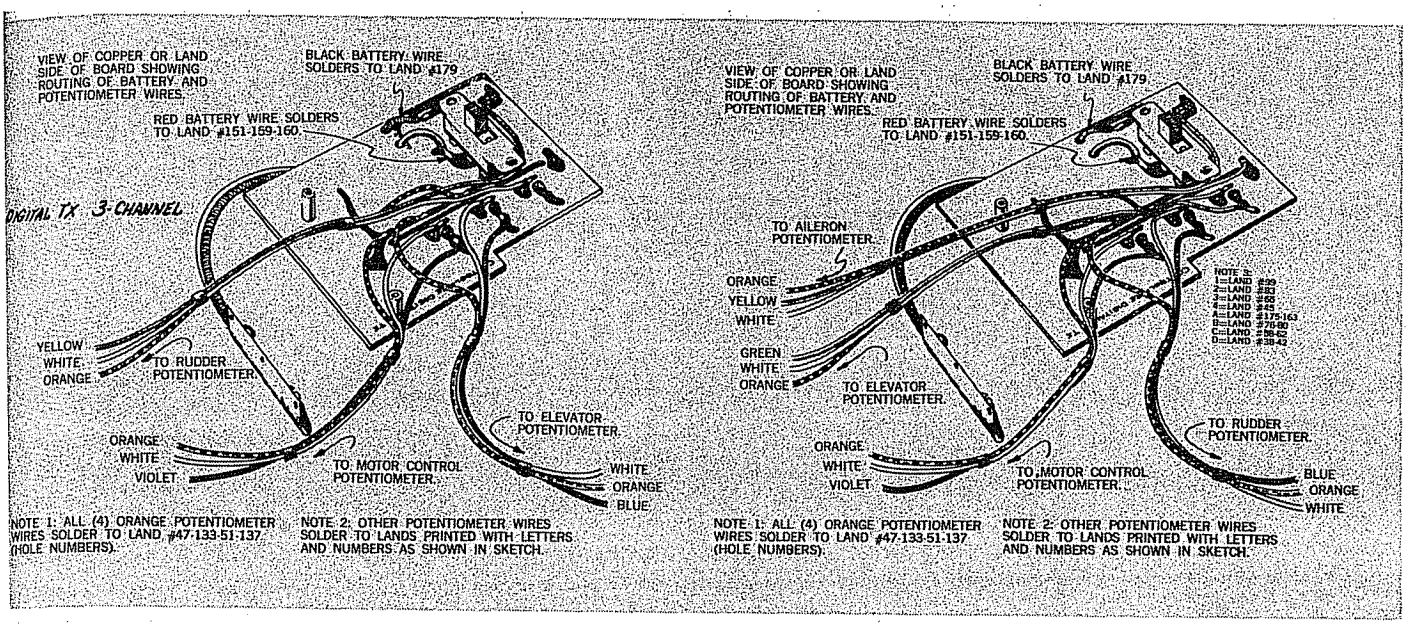
to remove anything that you feel might be a potential trouble spot by clipping or scraping. Under no circumstances should the leads be filed since this quite often causes undetectable open circuit (cold solder joints). Since the leads are soldered to the circuit lands for a length varying from 1/16 to ⅛ inch, it should not concern you that the solder does not completely fill the hole around an occasional lead. Bending the leads flush is normally not a good practice in kit building since it is almost impossible to remove a component without destroying it if you goof on the location; here you're safe since the boards are pretested and the result is a better than average solder joint.

The construction of the dry battery version and the "deluxe" rechargeable pack and dual charger version are both presented here. The external charging plug is installed in all transmitters to ease the conversion to the deluxe configuration. Conversion to five and six channels is also relatively easy and I'll try to work that into the Series for you flap, brake, and gear fans—perhaps in the last article of the Series.

CIRCUIT DESCRIPTION

It will be seen from the schematic, that the encoding portion is quite simple and repetitive. A multivibrator (Q1 & Q2) is the lead item in the chain; it forms the "clock" which determines the repetition rate of the information cycle. The aileron control pot serves as a collector load for one side of the multivibrator (Q2). The four stages following the multivibrator are called "Half-Shots"; notice that the first three have control pots as their collector loads. The Half-Shots are biased on by 50K trim pots and the 56K resistors going to the positive battery land. Now look at the mechanics of operation of a typical Half-Shot stage. As mentioned earlier, the stage is biased on so the transistor is acting like a closed switch. When the preceding stage generates a pulse, this voltage change is transmitted to the base of the stage under consideration by the charge on the .047 MF Capacitor. This charge drives the base voltage very negative (more negative than ground) which turns the transistor off, thus opening the switch. The leakage path through which the capacitor discharges is the trimpot and 56K in series. When the Capacitor discharges to a point where the transistor base is about ½ volt positive (measured from ground), the transistor switches on again. Now, thinking about this for a minute, the time the

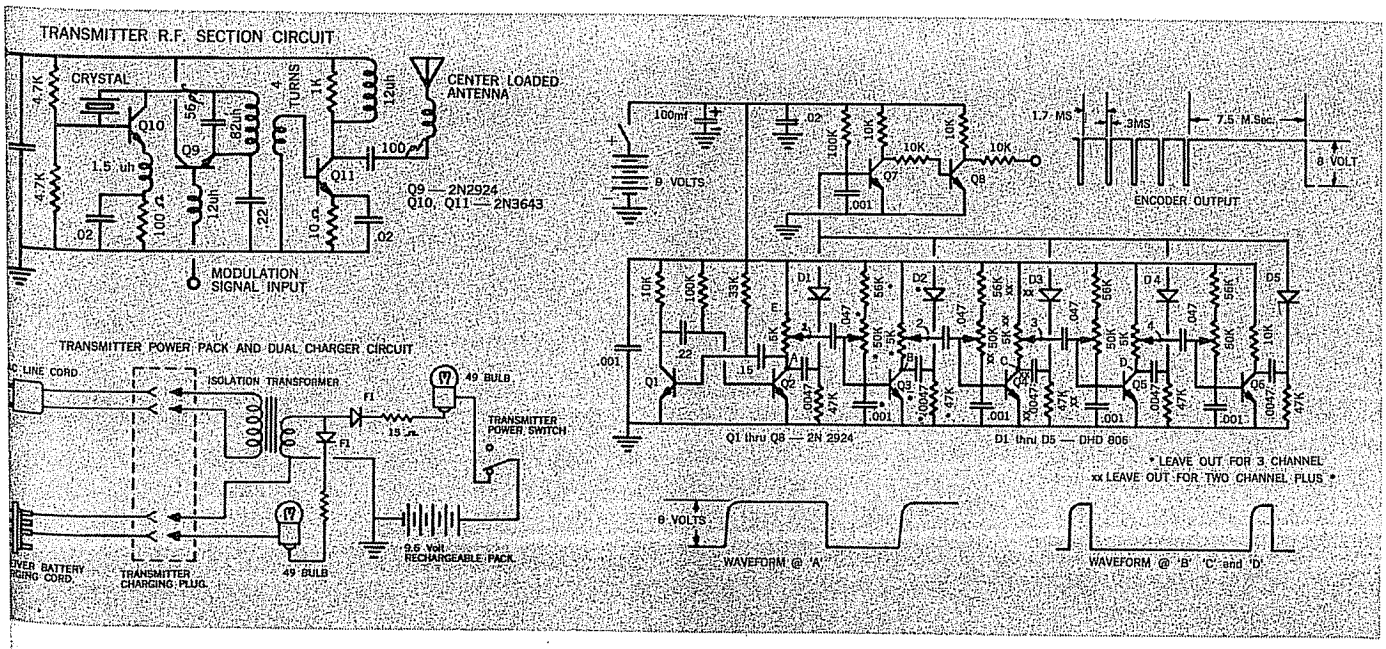




stage was turned off (the information pulse length) is dependent on two things: (1) how much charge was initially placed on the base and (2) how restrictive the discharge path is. The voltage transferred over is dependent on the position of the stick control pot since the pot acts as a voltage divider and the total resistance of the discharge path is dependent on the trimpot setting. As you'll see later when you're setting up your servo neutrals and travels, the neutral pulse length can be changed by altering the setting of either the stick pot or the trim pot. An infinite number of combinations of settings of these pots will give the same neutral but the total servo travel controlled by the stick will be different for each combination.

Looking further along in the circuit, you'll see a .0047 Capacitor, Diode and 47K resistor combination coming from the collectors of all the half-shots and one side of the multivibrator; these terminate at the base of the first transistor of the squaring amplifier (Q7). As each stage turns back on after its duty cycle, a negative spike is thrown on the base of Q7. Since this transistor is biased on by the 100K resistor to positive, the negative spike turns it off momentarily and this signal is amplified and squared by the following stage, Q8. The signal at the collector of Q8 is shown as the encoder output on the schematic. You'll notice that what you're actually doing is generating the short pulses which correspond to the off-time of your transmitter signal, variably and properly spaced to provide your control information. The width of these little pulses is .3 to .4 milliseconds but this is mainly controlled by the value of the base bias resistor of Q7.

Referring to the schematic for the RF portion, you'll note that Q10 is a fixed-tuned crystal oscillator which receives its collector current through the modulation transistor Q9. The modulator transistor is used in the high current "Emitter Follower" configuration. Since there is no signal inversion in this type of circuit, the signal at the Emitter of Q9 is identical to that on the collector of Q8 with the exception that the leading and trailing edges of each pulse are sloped by the .22 MF capacitor to ground. This sloping, by the way, is very important in obtaining a transmitter with a "clean" output, that is, one that doesn't "splatter" across the whole C.B. band. The fix-tuned portion of the oscillator consists of a .82 uh choke and a 56 pf capacitor. The drive for the power amplifier (Q11) is provided by four turns of #24 enameled wire wound around the body of the .82 uh choke. The 12 uh choke in the collector circuit of the power amplifier serves as an untuned load for this stage. (*Continued on page* 72)



hard ground with short grass. Don't give up gentle hand glides in calm weather until you are satisfied that the glide is flat with a gentle left turn (right hand throw) and near to stalling. When satisfied, try pushing the model a little harder, slightly up and with a little left bank. The model should climb at a shallow angle turning left. One dip or swoop should occur as the model transitions into its glide path. These "pushes" up to the left can become progressively harder until the model is reaching 20 or more feet in altitude from where the glide can be better observed. Again, only when satisfied, take a deep breath, grit your teeth and heave the model up in a hard right bank. I find it safest to start the hard throwing to the left of wind direction (I'm left handed), and then progressively throw closer and closer into the wind as trimming progresses. Even after careful initial trimming there is no guarantee that the model will recover off the top of the climb, so where possible try the first hard throws in long grass or over soft ground.

"There are two climb patterns that can be used. Only experience will indicate which is the best for your throwing style. The first pattern is not the most common, but probably the safest if you are anxious to avoid breaking the model. After launching, right handed, the model climbs in a right spiral, usually making between ¾ and one turn. At top of the climb model simply levels off into a left glide. This pattern calls for more wing washin than second method, which follows, and corresponding increase in nose weight and rudder to compensate for the extra incidence.

"The second climb pattern is spirally more unstable than the first, but usually gains more height. The model is launched in a slightly shallower right bank and the initial right turn straightens up as does the climb angle. Halfway up, the model starts drifting left and at the top of the climb half loops and rolls into its left glide. The "experts" overseas use this pattern in a more extreme form which is by all accounts very spectacular, but needs a very accurate as well as strong throwing arm. The model must recover at the top of the climb sideways on to the wind.

"I would not recommend any other trimming techniques to a beginner other than Nos. 1—3 listed, but if you have a couple of models, some experience and an urge to do better try the following.

"Very gently warp the left stabilizer trailing edge up and the right side trailing edge down. Next, remove a little nose weight and hand glide. These tail warps which are essentially the opposite to the wing, produce:- a) A tighter left glide turn. b) A strong tendency to roll left at the top of the climb.

"When properly used, which I find difficult, this trim produces a very straight climb with a snap roll off the top and greater altitude than the other methods. A spiral dive is often the result of an inaccurate launch however. A strong throwing arm is *not* essential for these models. It is far more important to trim patiently and achieve a good recovery at the top of the climb, coupled with accuracy in throwing. The recommendation is to take a mark on a cloud in the sky and aim at it. Any reasonably trimmed chuck glider will do two minutes plus if thrown into a thermal.

"TRIM SUMMARY.

1. Nose weight to balance as shown on plans.
2. Washin left inner wing panel for right hand throw, right inner wing panel for left hand throw.
3. Left rudder for right hand throw right rudder for left hand throw. If yo are keen to go further try for right han throw.
1. Remove some nose weight and
2. Bend left side tailplane up and
3. Right side tailplane down—*just little."*

M.A.N. 2-3-4 Digital Systen

(*Continued from page* 43)

This coupled with the center loaded an tenna provide a simple and very efficien output section. A 10 ohm limiting resisto is used in the emitter circuit as a protec tion device for the output transistor. Short ing this resistor will increase the powe output but it's more than adequate with i in and the output transistor is safe.

TRANSMITTER CONSTRUCTION

After laying out and checking you parts, begin assembly by removing th protective stripable coating on the cas front and installing the handle, antenn feed-thru (make sure the "shoulder" o one of the plastic washers is seated in th hole on the case top) and stick-on rubbe feet. Install the external charging plug t the case front using (2) 4-40 x ¼ sel tapping screws. Orient the plug so that th wide spacing between the pins is toward the case top.

Unpack the Meter Kit which contains the 0-200 Micro Ammeter, a .02 disc capacitor, IN 34 Diode and a 12 uh Choke. Refer to the photos and the schematic for parts placement.

The only critical point is to orient the Diode correctly. Notice that the meter lugs are marked (+ & —). Make sure that the end of the Diode with the identification band around the body is connected to the (+) lug, otherwise the meter will read backwards. Notice that one of the leads at the junction of the diode and choke is not clipped off and serves as the antenna. Mount the meter to the case front using (2) 4-40 x ¼ self tap screws. Take it easy during this operation because the plastic mounting tabs on the meter are somewhat brittle. If it appears that the strain is too great, withdraw the screw and ream out the holes slightly.

Unpack the stick assemblies and refer to the exploded view to identify the various parts. Make a few trial fits to get a general idea of how things go together. Prepare the 5K stick pots by removing any nuts and washers from the threaded bushing and locating the locking tab which keys into the plastic pot carrier. Notice that there are two tabs on the pot and two keying notchs in the carrier; normally only the notch closest to the slotted tab is used. Carefully peel or bend the pot tab back far enough to allow the pot to seat fully into the carrier. Bevel the notch slightly if necessary and clip off any excess tab material which extends thru the notch and will interfere with the sliding contact between the pot carrier and the trim lever. Fit the pot and carrier assembly to the trim lever and install the threaded bushing. Hold the pot and slide the trim lever back and forth to make sure that you haven't over tightened the threaded bushing. Install the #2 x ⅛ self tap screw and washer in the hole in the post on the trim lever. Do not screw these down tight since they will be used to set the tension on the trim levers after assembly. Attach the trim lever assembly to the side plate with the bushing nut and 4-40 x ¼ screw and washer. When tightening the bushing nut, watch the bushing to see that it doesn't rotate also, thus binding up the trim action. The previous steps should be carried out on the

(*Continued on page* 74)

M.A.N. 2-3-4 Digital System

(*Continued from page 72*)

remaining trim lever and side plate parts in the kit.

Inspect the two yokes and note that on one of each pair, the slotted cross piece comes up very close to the ratchet teeth; this is the outer yoke of the set. Either yoke may be either horizontal or vertical in the stick assembly. However, stick adjustment is a little easier if you maintain a certain yoke to side plate relationship. Start out by inserting the Allen set screws into the bushings at the tabbed end of each yoke. Do yourself a favor and screw the set screws in until they protrude into the ¼" hole in the bushing, then back them out of the way and clean off any burrs inside the ¼" bore. The reason for this is that you want to be able to move the yoke without turning the potshaft when the set screw is backed out during adjustment and a minute or two here will save a lot of sweat later. Slip the centering springs over the potshafts and engage the ends on the edges of the tab on the side-plate. Note the mounting tab in one corner of the side plate; this won't be used in the assembly but it makes a good reference point. Place one of the yokes on the potshaft and engage the yoke centering tab with the centering spring. Check to see if the Allen set screw is pointing toward the sideplate mounting tab, if not, switch yokes. (This is the yoke to sideplate relationship mentioned earlier).

Now check for two things. First, the yoke bushing should be a good slide fit on the potshaft. Second, there should be no play between either centering tab and the centering spring. Correct any play by bending the spring ends either in or out to close the gap. When you're satisfied with the centering, set the pot in the middle of its mechanical rotation, make sure that the centering tabs are not rubbing on the sideplate or ratchet plate, and tighten the Allen set screws.

Install the yoke bearings in the base plate with the washer placed under the head. In the case of a ratchetted control, substitute the ratchet spring for this washer and leave the centering spring out of that particular yoke assembly. The two little nylon tubes were designed to eliminate the slight engine speed change as the control stick is moved from side to side while motor control is at either extreme. They limit the travel of the stick slightly but this may be compensated for electrically. The choice of installing them or not is yours; they mount on the small ears on the ratchet plate and contact the base plate at the extreme stick positions.

You're now ready for the main step of mounting the side plates to the base plate. Grease the yoke bearings with vasoline and fit the side plate containing the inner yoke to the base plate. You won't have any trouble deciding which plate goes where on the base plate since they only fit in one position. The end-result is that the mounting tabs on the side plates are located in opposite corners of the box. Rotate the trim levers to one extreme and secure the side plates to the base plate with #2 x 3/16 self tap screws. Rotate the yokes back and forth to check for any binding or the two yokes contacting at extremes. If the outer yoke tends to drag or hang on the inner yoke at one extreme, loosen the Allen set screw on the inner yoke bushing and try to reposition the yoke slightly to gain clearance. Finally, adjust the trim lever and ratchet spring drag and pre-tin the pot lugs while all these points are accessible. Install the stick assemblies in the transmitter case with #2 x 5/16 self tap screws, trapping the case between the base plate and the plastic stick face plate. Before finally tightening these screws, shift the base plate to properly align the trim levers in their case slots.

On three channel transmitters the motor control pot assembly proceeds as follows: Mount the 5K pot to the metal bracket using a pot nut and washer and press the plastic lever on the pot shaft. Adjust the location of the lever on the shaft to position it in the center of the case slot when the bracket holes are lined up with the case holes. Rotate the lever on the shaft such that the pot will be in the center of its mechanical rotation when the lever is in neutral position in the slot. Mount the assembly to the transmitter case using the #4 x ¼ sheet metal screws. A plastic cover plate is installed over this motor control slot on two channel transmitters using #4 x ¼ sheet metal screws. This completes the mechanical assembly of the transmitter hardware.

CIRCUIT BOARD PREPARATION

Refer to the component placement diagram for the hole number locations which will be called out during this operation. Insert the (6) lugs of the slide switch into holes 157 through 162 from the foil side of the board. If these holes are blocked by solder, gently drill them out with a 1/16" drill bit. Make sure that the switch is bottomed out and straight before soldering the lugs to the circuit lands. Install a nylon stand-off at hole 1 on the foil side of the board using a 4-40 x ¼ self tap screw. Install a brass stand-off at hole 120 on the foil side using a 4-40 x ¼ machine screw. Make sure that both of these are tightened down well to preclude trouble while installing the board to the transmitter

older the brass stand-off to the land on which it is seated to in- good ground contact. Install a /16 machine screw and locking nut antenna bracket; solder the head screw to the bracket. Install the in holes 2 and 3.

to the wiring pictorial and attach tery snap leads at the locations (If you are building the charger see the appropriate paragraph be- case there is any doubt about the ar land, where a wire attaches, hole s located on the lands are also r reference. Strip ⅛" of insulation ie end of each of the control pot id pre-tin the ends. Refer to the of the particular model to trans- you are building and solder the the circuit lands shown. Notice the orange wires are attached to the rked "E"; white wires go to the d lands (1, 2, 3, 4) and the blue, reen and yellow wires to lettered A, B, C, D). After attaching all es, check to see that you haven't any solder bridges to adjacent ut the piece of heat shrink tubing in ¼" lengths and use these to the wires into groups associated particular control pot. Turn the ver and solder the 2" length of 16 wire on the bottom of the bracket adjacent to the right side crew head previously soldered to ket. This wire will form the sub- used for tuning and sensitivity on the receiver.

ASSEMBLY

the circuit board in the trans- sing a 4-40 x ¼ self tap screw in n stand-off, a 4-40 x ¼ machine the brass stand-off and (2) 4-40 x achine screws in the slide switch. Install the plastic switch guard on the upper screw of the slide switch. Refer to the photographs for a general idea on routing the control pot wires. Place the wires in their approximate final position, cut them to length, and strip and pre-tin the ends. It is suggested that all three leads of each bundle be cut to the same length. This will make it easier to swap the outside wires at the pot lugs to reverse control direction. Solder the white wire of each bundle to the center lug of its associated control pot. The two remaining wires of each bundle may now be soldered to the outside lugs of each control pot; which wire goes to which lug is not important at this time since you have preset the pots at the center of their rotation.

DUAL CHARGER, NICKEL CADMIUM INSTALLATION

Position the dual charger on top of one battery box as shown in the photo. Attach with No. 2 x ¼" self-tap screws. Position this combination in the bottom of the transmitter and attach with four No. 2 x ¼ self-tap screws through the holes in the case bottom. Solder the two large black and the small red and black wire to the existing charging plug in your case in accordance with the sketch. Note that the positions of the large black wires are interchangeable. Route the orange and black wires from the charger under the RF section and close to the case front. Solder the black wire to the perimeter land (land # 179) and the orange wire to the circuit land containing the bottom switch lugs (land # 161/162). Be careful not to create a short while installing the power leads from the battery pack. Solder the black wire to the perimeter land (land # 179) and the red wire to the circuit land containing the middle switch lugs (land # 151/159/160).

39th Year of Publication

MAN MODEL AIRPLANE NEWS

JAY P. CLEVELAND, President and Publisher

WALTER L. SCHRODER, Editor

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Nice time of the year to be talking about the blustery and very wintery Toledo Symposium!

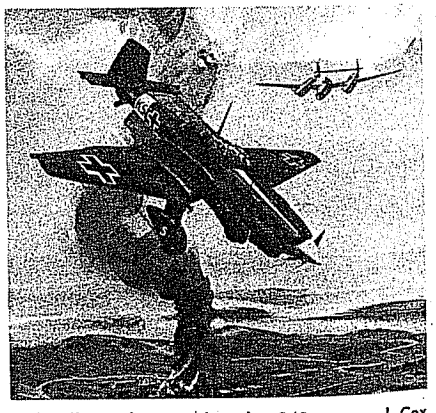
While watching the flying session, we were fortunate to have a photo taken with Eric Swenson, III.

m.a.n. at work

▶ Like all modelers who by trade are experimenters, I just had to challenge that immutable law that man by himself is not designed to fly and cannot do so unless aided or abetted by some mechanical or other device.

Having accepted the challenge, I now know how Charley Grant, as a boy, felt when he too took the same challenge and with the additional aid of what he felt to be competent wings attached to his arms. Charlie's challenge took the form of jumping from the ridge pole of his Dad's barn roof and glide to the ground with the assistance of the supplemental wings. Charlie's young bones (9 years old) were not equal to the challenge and broke in several places. My challenge was not to jump, simply to fall from the roof of my home while attempting some simple do-it-yourself repairs and my aged and well padded bones did not break but bent slightly. The major bend was a displaced clavicle and assorted bruises including a black eye. This last injury was due to the fact that I landed first on the least vulnerable section of

Here's another photo of Eric with his Meyers Old Timer using Kraft KP-3B powered by S/T 23.



And still another good scale .049 powered Cox plane, the Stuka Ju87D is added to their line.

SUBSCRIPTION PRICES

U.S. & POSSESSIONS: 1 year $6.00, 2 years $10.00, 3 years $12.50

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PLANE ON THE COVER

John Maloney, World Engines prexy at right, and Don Baisden, designer and creator of the M.A.N. 2-3-4 Digital system, tested the system in plane and boat as shown in cover photo. Prototype units received considerable flight testing in both machines. Photo inset shows the M.A.N. 2-3-4 system in all its colorful good looks. Only two S3 servos are shown. The S4 servo is as small and powerful as any servo offered to date.