RCM PRODUCT REPORT:

CITIZEN-SHIP PROPORTIONAL SYSTEM

THE full production availability of Citizen-Ship Radio Corporation Analog Proportional Control System a few months ago prompted the greatest number of letters that RCM has yet received concerning a single radio control system. These letters were primarily from sport, or "Sunday" fliers, wanting to know the "hows", "why's," and any "if's" about this new proportional rig that sells complete for under $250.

RCM wondered, too. We began our inquiry by obtaining a stock production AP system. This was followed by a conversation with Vern McNabb of the Citizen-Ship Corporation. With regard to the latter, we wanted to find out just what the new system was intended to do – what were its limitations and drawbacks, if any. We also wondered how this system could be sold for a list price of $250, and even less through some of the hobby discount houses.

APT Transmitter

To begin with, the Citizen-Ship AP series proportional control system provides the modeler with two continuously variable simultaneous channnels and a third trimmable channel. The two proportional channels are recommended for elevator and rudder, or elevator and coupled ailerons-rudder. The trimmable function, of course, is for motor control. The Model APT transmitter is a high power, all transistor transmitter utilizing a silicon power output transistor. The APT 100% collector modulated with a fixed 3750 CPS tone using variable rate 20-60 CPS and varying width of tone burst to obtain two proportional controls.

A two stick configuration is used on the Citizen-Ship APT with trim levers located directly adjacent to the appropriate sticks. A multi-channel reed type lever switch is used for the trimmable motor control function. The two main control sticks traverse an arch of 30 degrees to either side of their spring-loaded neutral position. The trim levers give 20% of the movement of the main sticks. The motor control lever switch is used by beeping for small changes in engine speed, exactly as is done with reed equipment. Holding the motor control lever switch depressed for 1 second gives full speed change, l.e., low to high, etc. Rudder and elevator servos return to neutral when either high motor or low motor is signalled. The Apt is crystal controlled and intended for use on all of the available 27 mc RC frequencies. Crystals utilized are ground to a tolerance of .0025% to insure proper operation and to allow changing frequencies by simply plugging in a crystal without the necessity of returning the transmitter.

The APT transmitter has low battery drain of 60 ma and requires only a standard Burgess D6 or Eveready Type #276 9 volt dry battery. Two to three months of normal flying time can be expected from this supply, discarding the battery when the voltage reaches 7.5 volts with the transmitter turned on.

Nicads can be used in the transmitter, if desired, simply by connecting seven 450 mah cells in series.

APR Superheterodyne Receiver

The Citizen-Ship Model APR is a selective superheterodyne proportional receiver which responds to rate and width changes of single movement of the transmitter stick. The APR receiver is an all transistorized unit that will fit

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into some of the smallest RC models. A highly selective audio filter tuned to 3750 CPS is utilized, rejecting most of the noise and interference (electrical) most commonly encountered in RC model aircraft. Crystal frequency is 455 Kc below transmitter crystal frequency.

The receiver should ideally be powered by four 450 mah nickel cadmium cells. Center tapped, these four cells are also utilized for servo reference voltage. Pencell batteries are adequate and can be used if desired. For lightweight installations, 225 mah nicads can be used since receiver drain is approximately 40 ma.

Mounting the receiver in the airborne installation is simplicity itself, since its operation is unaffected by vibration. It is suggested that the receiver be surrounded by foam rubber and mounted with the printed circuit boards in the same direction as the fuselage bulkheads.

The airborne antenna is the key to reliable performance with the Citizen-Ship system. Although several antenna configurations are shown in the Citizen-Ship AP manual, their choice, and ours, is a 30" length of .045 music wire mounted vertically approximately 6" behind the trailing edge of the wing. Do not, *under any circumstances*, use the more common hook-up wire antenna running to the vertical stabilizer. We have conducted extensive tests with the Citizen-Ship proportional system and have *never* experienced a fail-safe or "glitch" of any kind using this form of antenna. If you use another antenna system, you *will* experience an occasional fail-safe – causing neutral controls and low motor – usually occurring only when the model is within 100-150 feet of the transmitter. We discussed this vertical wire antenna with several electronic engineers and RC technicians – and the unanimous opinion was that this is the singularly most efficient antenna for RC usage and would definitely improve the operation of *any* proportional system. Apparently, "fail safes" are in part, caused by phase shift interference. Here is a quote from Vernon McNabb of Citizen-Ship:

"Probably the first thing anyone will hear when the subject of proportional systems is being discussed is the term "fail safe," or "glitch." It seems that when you are flying proportional, sometimes for no apparent reason, and when the plane is not very far out, it will go into "fail safe", which is an indication of the fact that the receiver lost the transmitted signal. Even more strange, this seldom occurs at extreme range, but usually always occurs when the plane is considerably within its reliable range.

The answer is that it is not a function of sensitivity, or power, although increased transmitter power could help, as evidenced by some of the more elaborate transmitters going up to one watt. Rather, it is caused by phase shift interference from signals traveling by different paths and cancelling each other out when they arrive at the receiver. How this occurs so close to a model plane is a little hard to understand, but apparently a signal going out from the transmitter and hitting a foreign object and bouncing off, will arrive at the receiver 180 degrees out of phase from the transmitted signal. Obviously, this signal will be weaker than the transmitted signal, and therefore, the condition is most likely to occur when the transmitter antenna is pointed at the plane, and would be particularly bad if the plane also had a straight antenna that was parallel, or almost parallel, to the fuselage. In this case, the reflected signal and the transmitted signal might be very close to the same strength and cancel each other out, thereby giving "fail safe."

In the AP System, we know that from a range angle you can fly this equipment as far as you can see it, and seldom do you get a "fail safe" at extreme range. It always seems to occur closer in, and strangely, sometimes happens only 100 feet away. From the experiments that we have run, the best solution for preventing this is the proper installation of your antenna – in which the lead from the receiver runs back through the fuselage to about 6" behind the trailing edge of the wing and then a 30" stiff vertical wire erected at this point. We have never had a "fail safe" with this particular installation.

And, here at RCM, utilizing the recommended vertical "whip," we have not experienced any fail-safe conditions or range problems.

Under the receiver Warranty, no retuning of the receiver or transmitter is permitted, and is not necessary. All sets have been double checked at the factory for frequency, sensitivity, and output, and no tuning is necessary.

APC and APM Servo

Although designed for use with the Citizen-Ship AP system, the APC and APM servos may be used with any analog proportional system meeting the input voltage requirement of + and – .65V for full travel. The Model APC servo is a feedback proportional actuator featuring small size, rugged construction, very low electrical noise, and linear output. The total output arm movement is ⅝" linear. Battery requirement is two 4.8 to 6 volt supplies, center tapped.

The model APM servo was designed to give trimmable motor control from the AP proportional system. This means that the servo is not supplied with a continuous input signal and moves only when a motor control signal is received. Positive input voltage runs the servo to one end, negative to the other. Travel time, lock to lock, is one second. In the Citizen-Ship system, the positive or negative voltage is obtained from a pulse omission detector. Input voltage requirement for the APM servo is + and – .75 to 3 volts. Total output arm movement is ⅝" linear, and requires a battery supply of one 4.8 to 6 volt center tapped battery. Servos can be mounted flat or upright with the Tinnerman nuts and 4-40 x ¼" machine screws furnished. Standard Kwik-Links or Annco type retainers can be used for the pushrods.

The total battery for the two (or three, if CAR is used) APC and one APM servo is four 450 Mah nicads, separate from the receiver and reference supply. In small installations, 225 Mah cells can be used. We have received reports of completely successful operation of the Citizen-Ship AP system on one 450 Mah nicad pack of four cells using a 70 uh choke between the plus's and another 70 uh choke between the minus's, although we found no problems for reducing the recommended complement from that recommended by the manufacturer.

Airborne weight of the entire system, batteries and four servos included, was 20 ounces.

Findings

The Citizen-Ship AP analog proportional system is not only in somewhat of a unique position, it is also amazing in its performance. Vern McNabb of the Citizen-Ship Corporation commented to us that the system was intended to provide the sport flyer with proportional control for a minimum cost, and that it was *not* intended for competition flying. He also went on to say that there would be certain limitations to the system when compared to the $600 rigs, for with the AP's intended market in mind, you cannot put $600 worth of materials into a system that sells for less than $250.

Let's take a closer look at the AP system. First of all, proportional design dictates that we forget our earlier concepts of "single" and "multi" channel. But if we are to use this familiar terminology, the AP system is a "single channel system" in the more traditional sense. We say this, because it utilizes a single tone, varying the width and rate to obtain the two channels of control, rudder and elevator. A pulse omission detector calls upon this single tone for even one more function – motor control. Upon the absence of the tone, the throttle moves in one direction – a solid tone, conversely, applies the throttle move-

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ment in the opposite direction. Therefore, it stands to reason, that your primary control surfaces will neutralize during that fraction of a second (or full second, if total throttle movement from low to high, or high to low) the throttle servo is in motion. To the serious competition pilot demanding the utmost in timing and precise settings, this would be a disadvantage. To the sport flier, it presents no problem at all.

In other words, Citizen-Ship has taken a single channel of control and carried it to what could be termed, its finite form, as we know it today. As an example, we flew the system first in the small Royal Coachman design presented only recently in RCM. The gear was installed and flown. No problems of any kind were encountered.

The second test ship utilized is a design by Phil Kraft intended for all-out competition flying on the Class III circuit. This in effect, was a test of the Citizen-Ship AP system for which the system, itself, was never intended – a Class III competition design. We are still flying this system in this model with more than satisfactory results. Response is precise and instantaneous. Range is out-of-sight, and no "fail-safes" or "glitches" have been experienced.