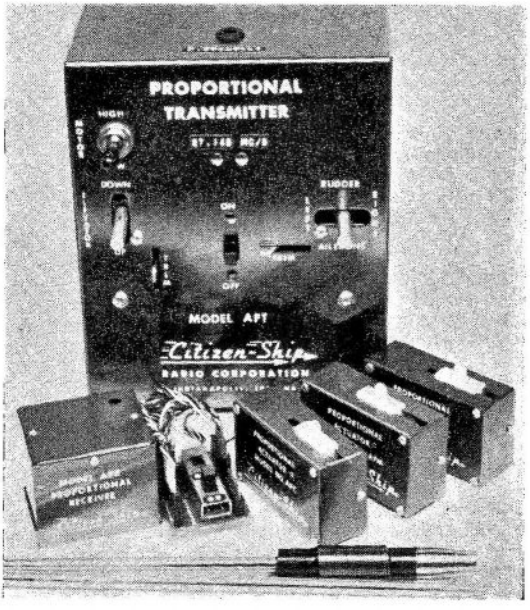
R.C.M. & E. Test Report

EDITORIAL REVIEW & TEST

CITIZENSHIP APC PROPORTIONAL SYSTEM



THE Citizenship APC system is a dual, independent, simultaneous proportional control system with a non-simultaneous trimmable throttle control. This means that, for example, elevator and aileron may be operated in true proportional manner but when throttle change is required, the two main controls zero automatically during the time the throttle servo is moving to the required position. Coupled aileron/rudder systems are possible by wiring in a parallel rudder servo to the aileron circuit. Here, a straightforward electrical connection to each of the servo leads is all that is required. The manufacturers claim that the system is suitable for class 1, 2 and Pylon racing. Class 3 operation is possible when using the coupled aileron/rudder system (C.A.R.).

The Citizenship outfit is all transistorised, the transmitter known as the A.P.T. employs a silicon power output transistor. The transmitter radiates a pulsed tone. The tone frequency being 3750 c.p.s., bursts of this tone are used as the control code; the rate being variable between 20 and 60 cycles per second, this information controls the elevator. Pulse width (symmetry) control the rudder or aileron servos. The throttle operates on pulse omission system, i.e., a continuous tone gives high motor, continuous carrier low motor.

The system is failsafe, in that should the pulsing information or signal be lost, the decoding network in the receiver "sees" this condition as a "low motor" command. Both other servos return to neutral under this condition normally and the failsafe mode produces the same result.

The reason for this system using a high frequency audio tone upon which is impressed the pulse information, is to reduce the chances of interference caused by other signals and electrical noise present in a model.

The receiver known as the A.P.R. is a superhet and employs a selective tuned filter which has quite a narrow A.F. range.

The servos used for elevator and rudder are proportional feedback analog devices and have a rack type linear output. The throttle servo is of similar construction but is progressive, control is effective on all servos by varying the reference voltage to, in the case of the feedback servos + and – ·65 volts and the throttle servo + and – ·75 to 3 volts.

Tx Physical Data

Size

7 in. high × 5⅝ in. wide × 2¾ in. deep + 1 in. lever projection.

Aerial

17½ in. retracted, 43½ in. extended. Loading coil 16 in. from bottom end. Upper section is telescopic and screws into loading coil unit. When this is removed the total projection of the aerial is reduced to 8 in. for convenience of transport.

Control Levers

Two separate plain dural rod levers are used, the right hand lever moving sideways for aileron or rudder control, the left hand one moving vertically for elevator control. The levers move ¾ in. each side of neutral. Adjacently placed flat dural strip trim levers have a total throw of ¾ in. and are mechanically linked to the main control pots so that the pot in question is rotated independently of the control stick. The effect is to provide a change of neutral position but not to extend the total throw of the servo. Trim affords a variation of approximately 20 per cent of the normal control movement. A normal lever switch is used for the motor control, this is the centre biased off type normally employed with reed outfits. It is placed above the elevator control stick.

Construction

The case is a two piece folded aluminium box 16 gauge material anodized red with white silk screened legend. Rear of the case is retained with four PK screws which, as supplied, had not been driven in to tap their threads in the case material.

The case is fitted with four rubber feet and balances well when held in operating attitude with the control sticks either under the thumbs or between thumbs and forefingers. There is no waterproofing around the stick apertures although, these being narrow slots, are perhaps less likely to be "rain traps".

The components are mounted on the front face of a 1/16 glass epoxy p.c. board located in the upper part of the case. The aerial screws onto the bracket fixed to the front of the Tx. case and there is a further bracket below the board to locate a VT9 or PP9 battery. The manufacturer states that a 450 milliamp hour, 9·6 volt DEAC pack may be used as an alternative source of power.

Test Figures

Currents

Carrier 58 mA
Solid tone 77 mA
Pulse 64 to 73 mA.

Modulation

Square wave 3.75 Kc. Collector modulation employed.

Scope display showed increase of approximately 10 per cent in level when modulated.

Pulse frequency was checked at 20 c.p.s. min.—60 c.p.s. max. The symmetry was approximately 25/75 per cent—75/25 per cent.

Stability

Voltage was reduced to 6v. with no apparent drift in the complete system. At 5v. the elevator control was affected and motor went to high.

Controls

All controls moved smoothly and elevator and aileron sticks were biased to centre with scissors type springs. The effort required to move the stick to full deflection was 7·5 ozs. There was no apparent float at neutral and the trim levers, although friction locked, move freely. We noticed however, that the leads connected to the control pots were *not* anchored. The pots only move a very small amount on trim, but this is a point which might be improved upon.

Receiver

The A.P.R. receiver is small by proportional standards and should fit easily into rudder-only and intermediate class models. It is a superhet employing three I.F. stages and six transistors. Operating voltage is three volts although the last stage of A.F. amplification (transformer coupled) operates on 4·8v. The I.F. employed is 0·455 and the crystal although a plug-in type has a bonding wire soldered to its case. (The Tx. on the other hand has an easily removable plug-in crystal). The decoding network is mounted on a separate P.C. board in the other half of the two piece case, both sets of components face inwards.

The decoding system fed from the tuned filter has rate, symmetry and pulse omission detector sections and operates on a centre tapped supply.

Physical Data

Size

2– in. long × 1 11/16 in. wide × 1¾ in. deep.

Weight

3·27 ozs.

Harness Length

8 in. (6 colour coded wires terminating in an 8 8 in. flat plug visually polarised).

Construction

Two piece folded 18 s.w.g. aluminium red anodised with white silk screened legend. Two circuit boards employed with vertically placed components on 1/16 in. glass epoxy p.c. boards. Aerial led out through separate grommet in case, supplied 12 in. long, recommended length 36 in.

Test Figures

Currents (Rx. and decoder)

32 mA min. 50 mA max. (depending on signal information).

Sensitivity

Better than 3 microvolts.

Stability

The Rx./decoder operated successfully down to an input of 3·7v. (total). The manufacturer states that dry cells of up to 6v. total may be used as an alternative to DEACs. The test was however, conducted with 4·8v. centre tapped 500 DKZ power supplies for Rx. and servos.

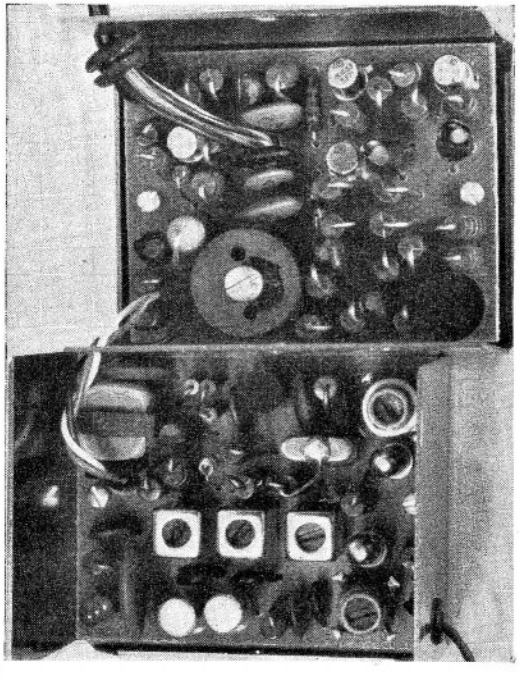
Servos

The A.P.C. (proportional) and A.P.M. servo (motor control) are of similar construction. Unlike some other makes of proportional servos the mounting system is by means of blind nuts, which although supplied fitted to the bottom of the case, can be transferred to the side. Machine screws (supplied) are used to mount the servos onto the fuselage sides or a servo mounting tray. The output arm emerges off-centre to the servo, so if the direction of movement is not as required, the servo has to be re-positioned so that the pushrod attachment is in correct alignment.

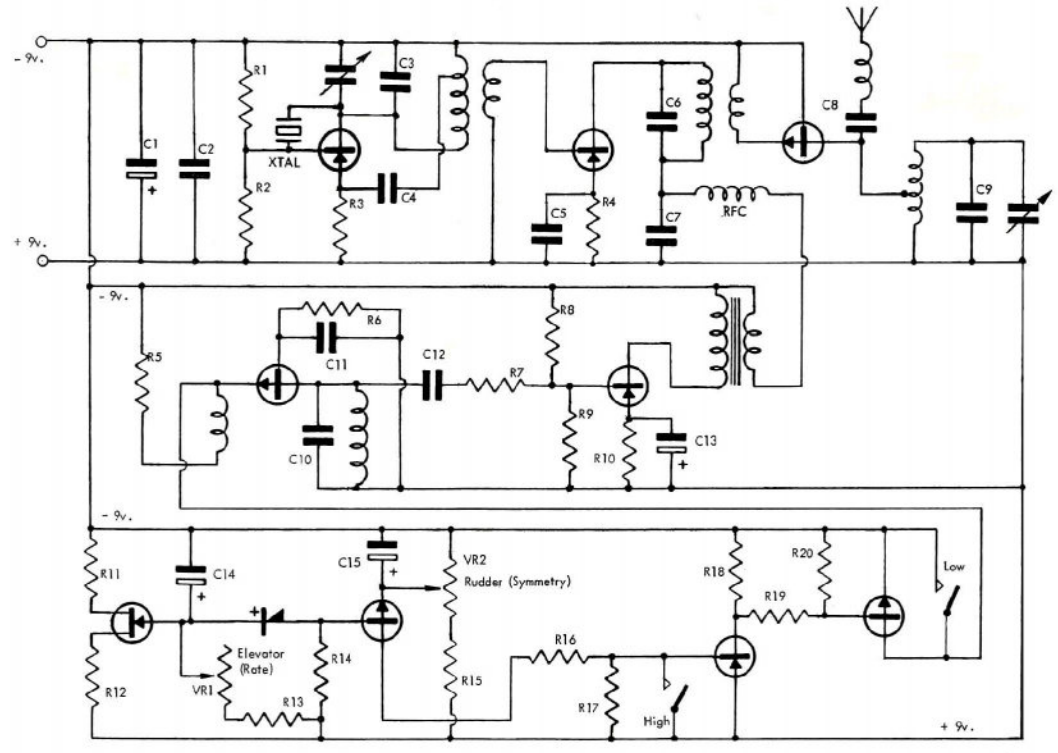
The A.P.C. servo has a 6 transistor feedback circuit using a carbon track linear pot and has limit switches operated by the same wiper connections.

The A.P.M. servo has a simple 4 transistor switching circuit.

Mechanically, the servos have similar gear boxes and construction. Each uses a Mabuchi A.M.170 motor. A brass pinion on the armature shaft drives a nylon spur gear which is mounted on a long shaft carrying a nylon worm. The worm engages in a further spur gear pinion combination, this pinion operates a short nylon rack on a movable block which carries the feedback and limit switch wipers. The output arm bolts onto this block and is guided by a cut-out in the case. Two nylon bearing blocks are used to support the gear system, although the final gear combination runs on a steel post with brass bearing sleeve. The post is rivetted to the bottom of the case.



Heading photo shows a complete system, note the connecting board and switches to right of Rx.
Right: The receiver and decoding boards each in one half of the case shown separated. The large pot core in the upper (decoding) section is the audio filter. This photograph is actual size.

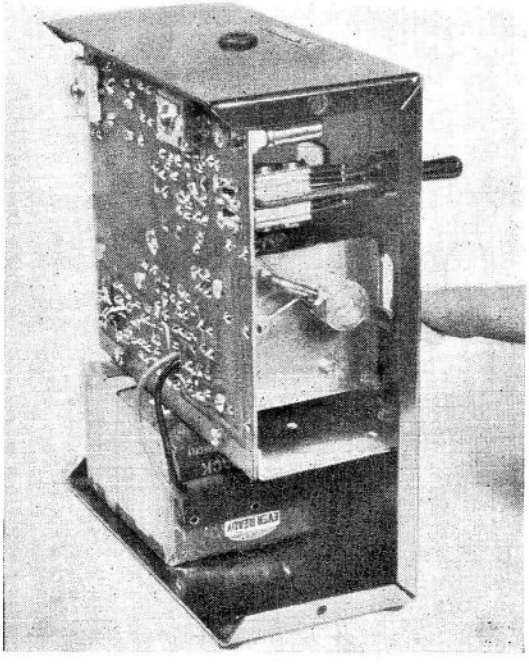


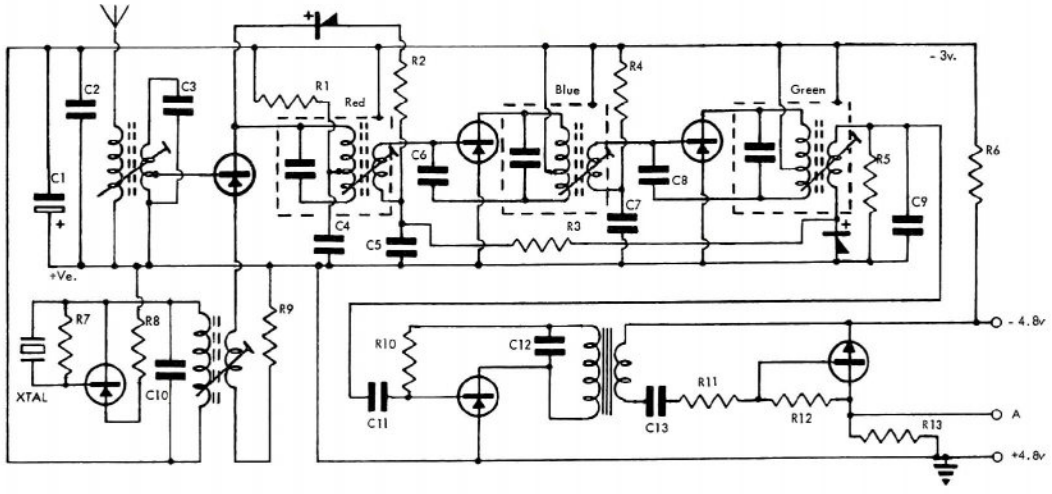
Below: Interesting scissors centring spring on main pot demonstrated.

Tx. Circuit values

R1	10K	R16	22K	C10	.0056 μF
R2	212K	R17	2.2K	C11	.05 μF
R3	470Ω	R18	4.7K	C12	.47 μF
R4	33Ω	R19	1K	C13	90 μF electrolytic
R5	33Ω	R20	470Ω	C14	4.7 μF electrolytic
R6	150Ω	C1	160μF electrolytic	C15	6 μF electrolytic
R7	100K	C2	4700 pf	VR1	25K
R8	68K	C3	15 pf	VR2	25K 1 in.
R9	10K	C4	22 pf		
R10	68Ω	C5	.001μF		
R11	10Ω	C6	22 pf		
R12	100Ω	C7	.01μF		
R13	2.2K	C8	.01μF		
R14	1 Meg	C9	10 pf		
R15	12K				

No provision is made for shock absorbing on the servos and it is concluded that modellers will adopt the servo mounting tray method, fixing this item to the model with rubber grommets as a means of shock absorbing. The servo cases are grounded to the servo battery centre tap. It is most important that the servo cases do not touch the receiver case, as this is also grounded to its own battery supply and could cause a short circuit.





RX. CIRCUIT VALUES

R1 : 1K	R10 : 150K	C5 : .47 µF
R2 : 100K	R11 : 10K	C6 : 10pf
R3 : 10K	R12 : 47K	C7 : .05 µF
R4 : 100K	R13 : 10K	C8 : 5 pf
R5 : 4.7K	C1 : 25 µF electrolytic	C9 : .05 µF
R6 : 820Ω	C2 : .05 µF	C10 : 15 pf
R7 : 100K	C3 : 15 pf	C11 : .01 µF
R8 : 330Ω	C4 : .05 µF	C12 : 2000 pf
R9 : 100Ω		C13 : .47 µF

This particular point, although stressed in the manufacturers instructions might become overlooked, although we feel it would be better to avoid this problem. For example, if the equipment accidentally became displaced in a model, the servo and receiver cases could come into contact. We would therefore advise that the receiver case be thoroughly bound with insulating material. A similar precaution should be taken with the connecting board. This board made from glass epoxy p.c. material carries all the sockets and on/off switches for the complete harness. It is into this unit that the DEACs and all sections of the system plug. It is also important to note that the plugs and sockets are only *visually* polarised whereas they could have been physically polarised by transposing pins and sockets at one end of the plug/socket units.

Physical Data

Size

2¾ in. long × 1 9/16 deep (+ ⅜ in. output lever projection) × 1 in. wide.

Mounting hole centres in bottom 2 9/64 in. × 21/32 in. (width).

Mounting hole in side 2 9/64 in. × 1¼ in. (high).

The output lever when at neutral is ¾ in. from opposite end to motor.

Servo moves in direction of motor end on positive reference voltage and opposite end on negative reference voltage corresponding to down/up right/left high/low, elevator, rudder and motor positions respectively.

Total output arm movement ⅝ in. linear (limit to limit). Harness 8 in. long 6 colour coded wires terminating in 8 pin plug.

Test Figures

Currents

4·8v. centre tap DEAC used, readings taken in 2·4 half of supply.

Unloaded 250 mA.

Stall 550 mA.

All servos stalled 95 mA.

Output power.

A.P.C. maximum recommended loading 14 ozs. (stall 20 ozs.).

A.P.M. maximum recommended loading 19 ozs. (stall 28 ozs.)

Float of output arm 3/64 in.

Each servo was in turn mounted on the servo analyser and the completed system operated by the transmitter. The servo was arranged to produce one trace on the recording tape and the transmitter control stick coupled to a second recording pen on the same strip. Measurement was therefore possible to ascertain resolution.

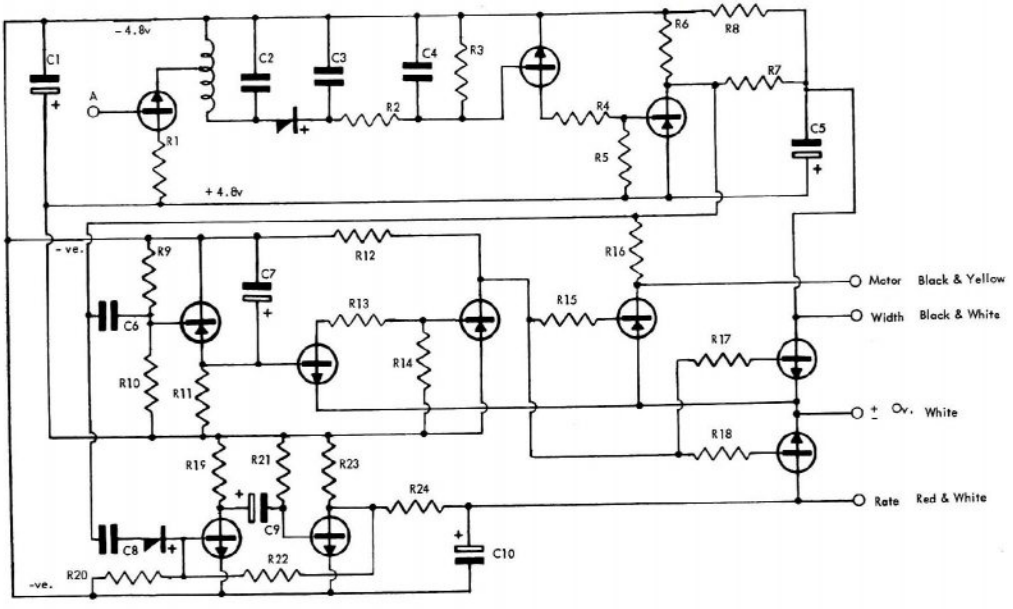
Maximum speed (with control stick released from full throw position to neutral; 0·7 secs.)

Trim

Trim moved the centre position of the servo 21 per cent. No further increase of throw was possible as for maximum stick deflection in either direction the servo reached the end of its limit track. There was little noticeable free movement of control stick after this condition.

The servos moved smoothly under load, although when unloaded a slight jerkyness was apparent. This would not necessarily be the case when flight loads were imposed on the model.

The throttle servo would move a small amount in response to a quick flick to the throttle key on the transmitter, this proceedure also caused elevator and rudder servos to twitch in the direction of neutral if held deflected at the time. The operation of throttle causes the servos to move to their own neutral and not the transmitter trimmed neutral. It is therefore important that the model is trimmed to fly with all trims "neutral" this is easily done in a similar manner to reed models which do not employ elevator trim servos.



Receiver Decoder

R1 : 1.5K
R2 : 2.2K
R3 : 6.2K
R4 : 2.2K
R5 : 470Ω
R6 : 470Ω
R7 : 2.2K
R8 : 33K
R9 : 10K
R10 : 3.3K
R11 : 15K
R12 : 1.2K
R13 : 2.2K
R14 : 1.5K
R15 : 2.2K
R16 : 2.2K
R17 : 2.2K
R18 : 2.2K
R19 : 1.5K
R20 : 15K
R21 : 15K
R22 : 15K
R23 : 270Ω
R24 : 2.2K
C1 : 25 μF electrolytic
C2 : .04 μF
C3 : .22 μF
C4 : .47 μF
C5 : 50 μF electrolytic
C6 : .47 μF
C7 : 4.7 μF
C8 : .002 μF
C9 : 1 μF electrolytic
C10 : 50 μF electrolytic

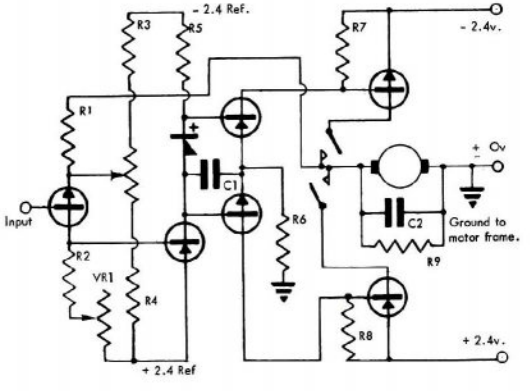
Proportional Servo

R1 : 22K
R2 : 220Ω
R3 : 470Ω
R4 : 1.2K
R5 : 2.2K
R6 : 22 Ω
R7 : 470Ω
R8 : 470Ω
R9 : 33
C1 : 25 μF
C2 : .01 μF

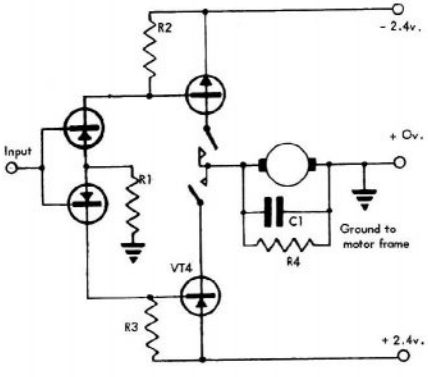
Throttle Servo

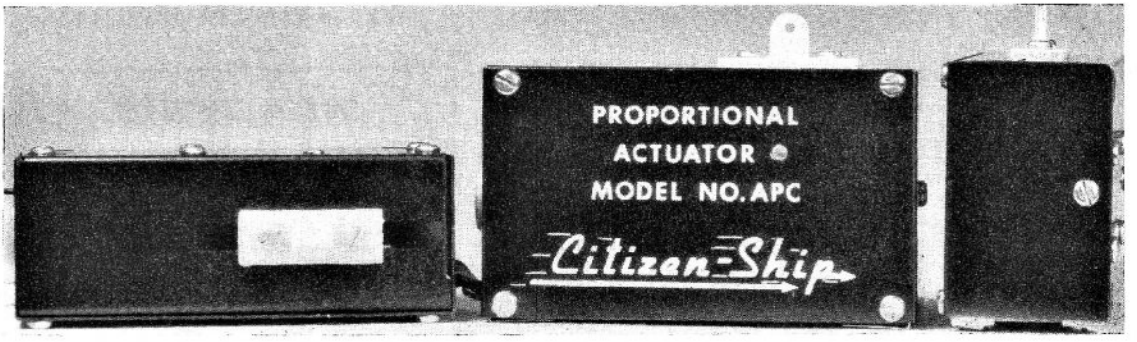
R1 : 22Ω
R2 : 470Ω
R3 : 470Ω
R4 : 33
C1 : .01 μF

PROPORTIONAL SERVO



THROTTLE SERVO





Resolution at neutral was tested by mechanically amplifying the servo throw. The servo was operated and returned to within 3 per cent of neutral. This, considering the mechanical float is acceptable. It should be pointed out that as the feedback pot wipers are mounted on the output arm, most of this float is cancelled out, this does however mean that if the control surface is displaced mechanically, a slightly higher battery consumption is to be expected due to the fact that the servo will be correcting this externally induced error.

Summary

The system operated accurately on the test bed when subjected to flight simulated conditions, interference was deliberately produced and it is interesting to note that the system was not affected by a worn Mighty Midget motor close to the aerial, or to *weak* signals from a reed transmitter on the same spot frequency. The manufacturer indicates that careful aerial positioning is advisable for the best operation of this outfit and recommends that the receiver aerial be taken from the fuselage side on the opposite side of the main harness then to the tip of the tailplane, up over the top of the fin and down to the opposite tip of the tailplane.

The system tested is now to be installed in a model boat, using the elevator feedback servo to give proportional throttle in addition to simultaneous proportional rudder. This is just another application of a dual simul feedback system and we hope to report later on its performance under these conditions. High speed model boats can be successfully operated with proportional systems.

Other tests conducted on the complete system showed that it operated between 32°F. and 120°F. and that although undamped mountings were used on the servos the latter were not affected (during the limited period of the test at any rate) by vibration.

A.P.M. throttle servo operated at approximately the same speed, accomplishing complete transit from high to low motor in 1·15 secs.

General Comments

The system is low priced and although the throttle control is not simultaneous and not proportional, the receiver is a superhet and the whole system can be quite light if the DEAC 225 packs or even a DEAC 225 and 4 U7 pen cells (Rx.) are used. Pylon race enthusiasts will appreciate this point.

The connecting board supplied does not have an additional socket although the lands are ready to receive one for connecting a parallel servo for operation with C.A.R. systems.

The manufacturer supplied details relating to the feedback servos showing that the reference supply can be part of a receiver power pack, but that the motor supply of course requires to be of greater capacity as stated in the test.

Manufacturer

Citizen-Ship Radio Corporation, 810 East 64th Street, P.O. Box 20007, Indianapolis 20, Indiana, U.S.A.

Distributor

Ripmax Ltd., 80 Highgate Road, Kentish Town, N.W.5.

Prices

£125 complete.

Top: Three servos placed to give actual size three-view of the servos. Below: All the works removed from the case to show gearing, feedback pot, amplifier and output rack.
Owner should be discouraged from dissembling their servos, we did it carefully! But one really needs three hands. . .