R.C.M. & E.

DESIGN BOOKLET TWO

GALLATROL

COMPLETE GALLOPING GHOST PROPORTIONAL CONTROL SYSTEM

Assembly instructions for Tx, Rx, and Servo . . . . . .
All Transistor, Relayless and with P.C. construction

Designed by T. B. Tippett

GALLATROL

A COMPLETE GALLOPING GHOST SYSTEM

Designed by

T. B. TIPPETT

Free WITH SEPTEMBER 1965 RADIO CONTROL MODELS & ELECTRONICS

THE basic system used is "Simpl Simul" or "Galloping Ghost", offering simultaneous proportional control of rudder and elevator with trim on each—suitable for 25 in. to 56 in. wing span models. With the larger size use of balanced surfaces is advised.

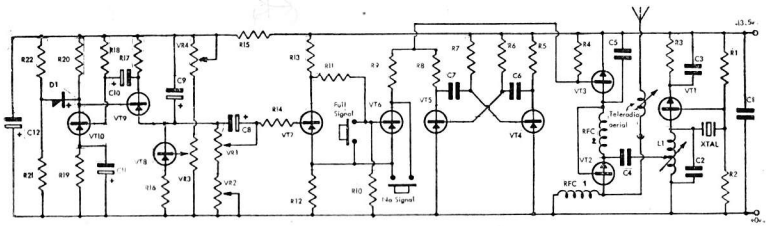
Transmitter

The transmitter is controlled by a specially developed pulser. Output is variable mark space of 80/20, 20/80 and variable pulse rate of 2 c.p.s. to 12 c.p.s. The space is filled with carrier and mark is for interrupted carrier wave tone. The complete circuit is built on a 6 in. x 3 in. p.c. board and uses 10 transistors. No relays are used. Batteries, circuit and control stick assembly are housed in a 6 in. sq. by 2⅝ in. deep aluminium case with a collapsible centre loaded aerial. 13.5 volt supply is used; 3 x 4.5v. and current drain is 70 mA.

Description of Tx Circuit

A conventional crystal controlled oscillator generator R.F. (VT1) and this is amplified by (VT2) in grounded base configuration, the centre loaded aerial forming the turned circuit. Current consumption of the amplifier is approximately 45 mA.

An NPN switching transistor is connected in the supply to the R.F. amp, and is complementary coupled to two outputs. (1) The output from the multivibrator tone generator and (2) The output from the pulser. Both



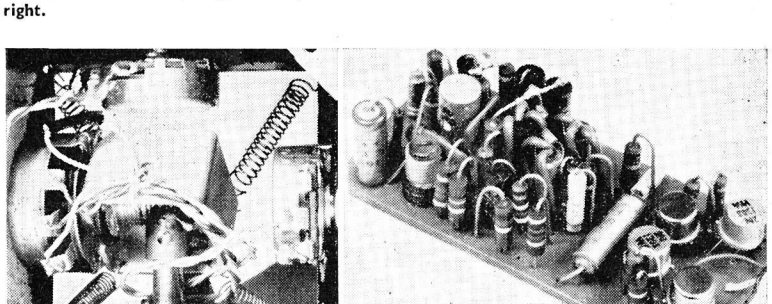
THEORETICAL CIRCUIT OF TX AND PULSER

FIG. 1

TRANSMITTER VALUES

R1	:	3.3K
R2	:	6.8K
R3	:	100Ω
R4	:	2.2K
R5	:	4.7K
R6	:	47K
R7	:	47K
R8	:	4.7K
R9	:	3.9K
R10	:	22K
R11	:	10K
R12	:	1K
R13	:	4.7K
R14	:	47K
R15	:	100Ω
R16	:	330Ω
R17	:	22Ω
R18	:	33K
R19	:	1K
R20	:	1.5K
R21	:	3.3K
R22	:	1.2K
VR1	:	25K linear WW pot.
VR2	:	10K linear pot.
VR3	:	10K linear WW pot.
VR4	:	10K linear
C1	:	.01μF
C2	:	33pF
C3	:	.01μF
C4	:	.01μF
C5	:	.01μF
C6	:	.05μF
C7	:	.05μF
C8	:	2μF electrolytic
C9	:	150μF electrolytic (100μF + 50μF)
C10	:	8μF electrolytic
C11	:	100μF electrolytic
C12	:	100μF electrolytic
VT1	:	2N708
VT2	:	2N697 (with heat sink)
VT3	:	OC139
VT4	:	OC83
VT5	:	OC83
VT6	:	OC72
VT7	:	OC72
VT8	:	OC72
VT9	:	OC83
VT10	:	OC72
D1	:	OA81
Xtal	:	27 Mc/s (third overtone)
L1	:	15 turns, 22 s.w.g., e.c.w. on ¼ in. dia. former, tap at 4½ turns
R.F.C.'s	:	Mac Pack type (1 Amp. T.V. choke rewound one layer 40 s.w.g., e.c.w.)
Aerial	:	Teleradio tunable, centre loaded type
Full Signal	:	Continuous tone
No Signal	:	Continuous carrier

Heading photo shows the neat appearance of the Tx, compact Rx and simple Servo. Below : Pot linkage in Tx, Rx right.



Tx Assembly

Component No.	Over and in hole No.	To hole No.	RESISTORS		REMARKS	
1	2	3	3.3K	Orange	Orange	Red
2	13	14	6.8K	Blue	Grey	Red
3	17	16	100	Brown	Black	Brown
4	37	36	2.2K	Red	Red	Red
5	71	70	47	Yellow	Violet	Red
6	53	52	47	Yellow	Violet	Orange
7	68	69	4.7K	Orange	Orange	Orange
8	50	51	4.7K	Yellow	Violet	Red
9	40	39	3.9K	Orange	White	Red
10	79	80	22	Red	Red	Orange
11	83	84	10K	Brown	Black	Orange
12	105	104	1K	Brown	Black	Red
13	101	100	47	Yellow	Violet	Red
14	111	112	47	Yellow	Violet	Orange
15	119	118	100Ω	Brown	Black	Brown
16	98	97	330Ω	Orange	Orange	Brown
17	91	92	22Ω	Red	Red	Black
18	76	77	33K	Orange	Orange	Orange
19	65	64	1K	Brown	Black	Red
20	62	61	1.5K	Brown	Green	Red
21	42	35	3.3K	Orange	Orange	Red
22	59	60	1.2K	Brown	Red	Red

CAPACITORS

1	5— 6	.01
2	21—22	33pF
3	9—10	.01
4	18—19	.01
5	27—28	.01
6	72—54	.05μF
7	67—49	.05μF
8	115—114	2μF + VE to 114
9	93—94	150μF + (100μF + 50μF) + VE = 94
10	75—78	8μF + VE to 75
11	41—47	100μF + VE to 41
12	45—44	100μF + VE to 44

RFC1	24—23	Macpac type
RFC2	25—26	Macpac type
Diode	46—43	OA81 + VE to 46
Xtal	11— 3	27 M/c 3rd overtone

	E	B	C	TYPE
VT1	8	4	7	2N708
VT2	32	31	30	2N697
VT3	34	38	33	OC139
VT4	74	66	73	OC83
VT5	56	55	48	OC83
VT6	83	86	82	OC72
VT7	103	110	102	OC72
VT8	106	107	108	OC72
VT9	95	88	90	OC83
VT10	57	63	58	OC72

Wiring

18 in. length in each hole light flexible.

NOTE: Bind to pot lugs to prevent fracture.

Hole No.	Colour	To
121	Red	+ VE 12v. or 13.5v. Bat. via switch
117	Black	Rate trim pot wiper (RV4)
88	Red	Rate pot one side (RV3)
109	Yellow	Wiper rate pot (RV3)
96	Red	M/S trim pot wiper (RV2)
113	Green	M/S pot wiper (RV1)
116	White	M/S pot wiper one end (RV1)
99	Blue	One tag on each of FS and NS buttons
87	Orange	Other tag on FS button
81	Brown	Other tag on NS button
120	Black	—VE 12—13.5v. Battery

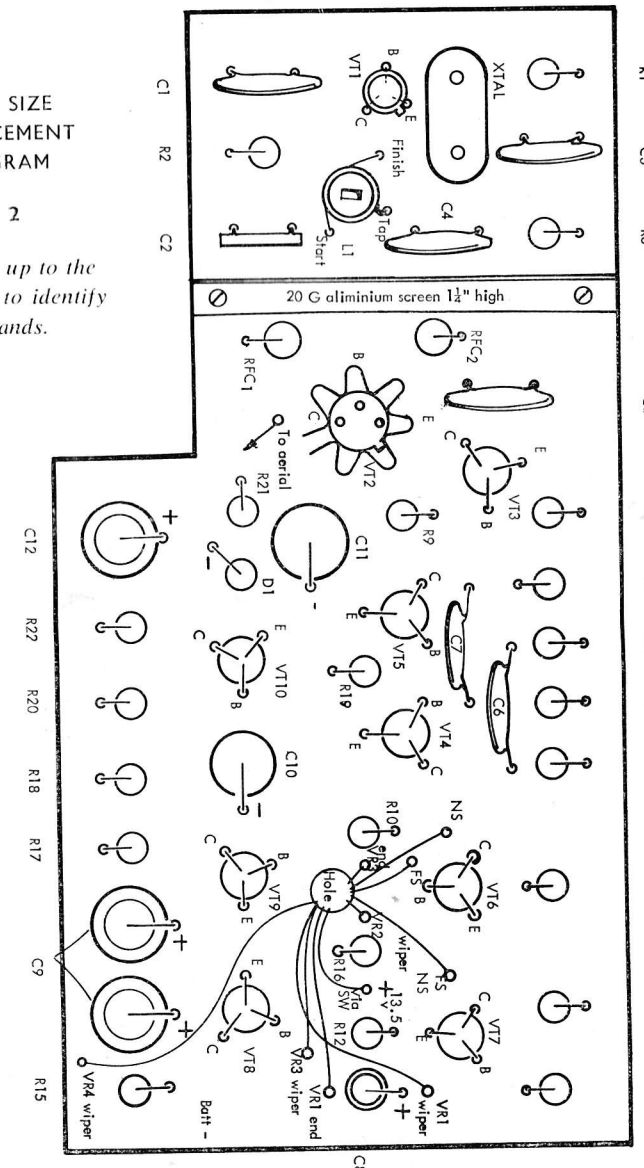
Further Connect
Free end RV1 to one end RV2
Free end RV3 to one end RV4

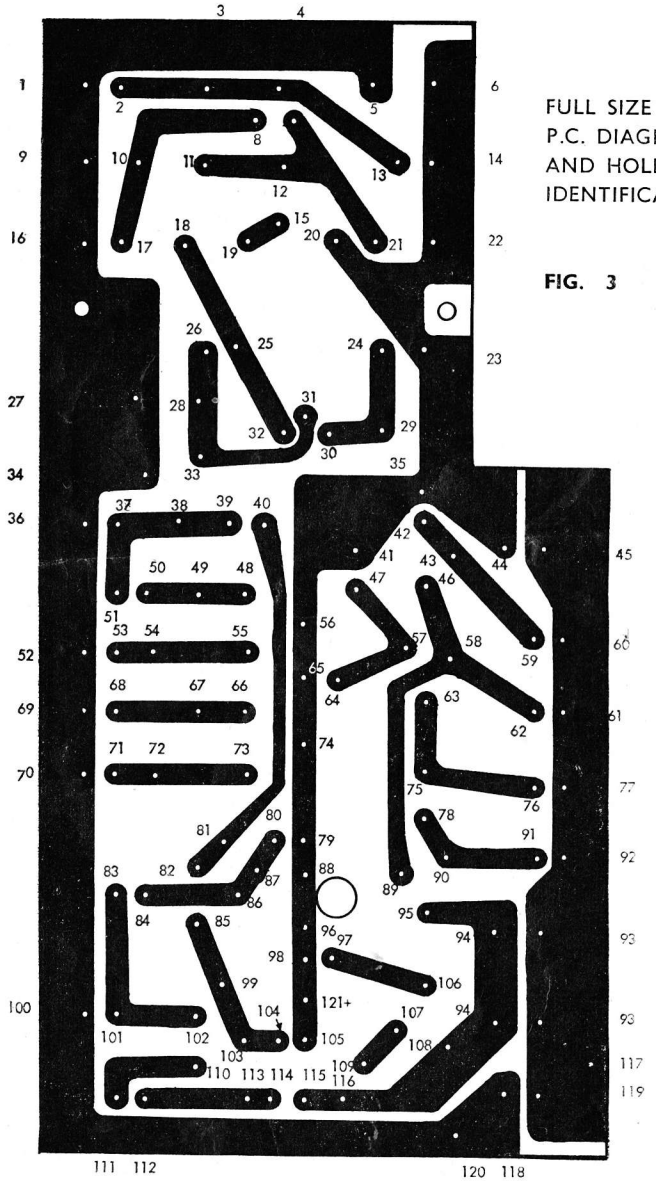
TX

FULL SIZE PLACEMENT DIAGRAM

FIG. 2

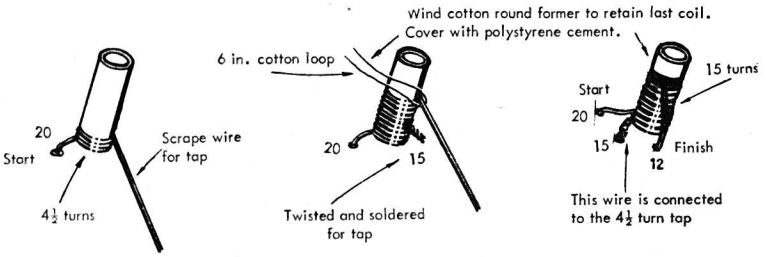
Hold up to the light to identify p.c. lands.





FULL SIZE
P.C. DIAGRAM
AND HOLE
IDENTIFICATION

FIG. 3

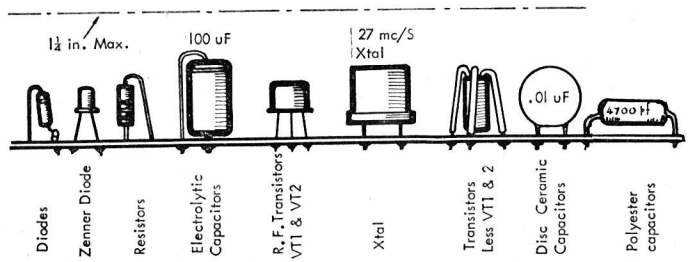


TX COIL WINDING SHOWN IN THREE STAGES ▲

FIG. 4

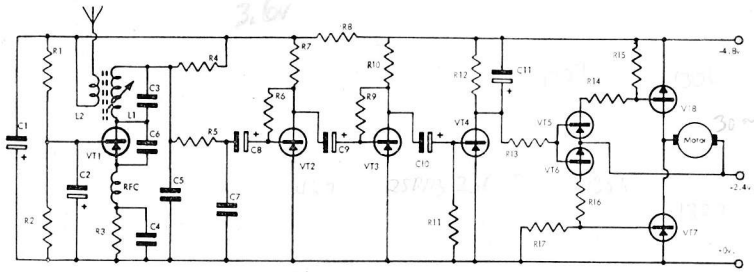
TX COMPONENT PLACEMENT ▼

FIG. 5



pulser and tone generator run continuously. Consider for a moment the output from the pulser to be in the 'off' condition (i.e., VT6 off. The base of VT3 will then see the tone generator wave form across R4, the transistor will respond to this and switch the R.F. at tone frequency. Now consider the pulser output to be 'on' (VT6 on). VT3 will now see a min. voltage level across R4 caused by the divider R9-R4; this is sufficient to keep it fully on during the 'off' periods of the tone generator. It follows then that when the pulser output is on, carrier is transmitted and when the pulser is off tone is transmitted.

A Schmitt Trigger forms the output of the pulser ensuring clean switching. The Schmitt is connected to a sawtooth wave form generator who's frequency is variable forming elevator control. The point at which the Schmitt triggers on the sawtooth is variable forming variable M/S or rudder control. These two variables are connected to a single joystick giving two independent proportional channels with 'in series' pots wired in to give in flight trim. With component values shown the Tx output is suitable for Galloping Ghost.



THEORETICAL CIRCUIT OF RX & SERVO AMPLIFIER

FIG. 6

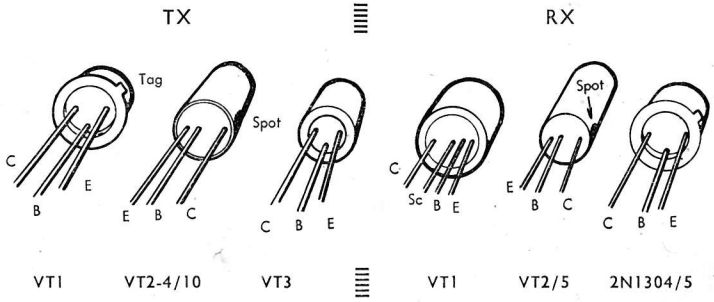
RECEIVER VALUES							
R1	:	4.7K	R14	:	150Ω	VT1	: OC170
R2	:	2.2K	R15	:	1K	VT2	: OC44
R3	:	4.7K	R16	:	150Ω	VT3	: OC44
R4	:	4.7K	R17	:	1K	VT4	: OC42 or OC72
R5	:	6.8K	C1	:	50/80μF electrolytic	VT5	: 2N1305
R6	:	220K	C2	:	2μF electrolytic	VT6	: 2N1304
R7	:	4.7K	C3	:	22pF	VT7	: 2N1305
R8	:	1K	C4	:	.001μF	VT8	: 2N1304
R9	:	470K	C5	:	.005μF	L1	: 8½ turns 24 s.w.g. on ¼ in. dia. former
R10	:	4.7K	C6	:	25pF	L2	: 3¼ turns thin p.v.c. wire wound over L1
R11	:	4.7K	C7	:	.05μF	R.F.C.	: Mac Pack type
R12	:	2.2K	C8	:	.32μF electrolytic	Aerial	: 30 in.
R13	:	1K	C9	:	.32μF electrolytic		
			C10	:	1μF electrolytic		
			C11	:	3.2μF electrolytic		

Receiver

Doug Bolton's "Flexitone" (modified) built on 3 in. x 1⅞ in. p.c. board with "push pull" output. A total of 8 transistors are used.

FIG. 7

TRANSISTOR IDENTIFICATION



TO REMOVE LIFT TOP STAPLE

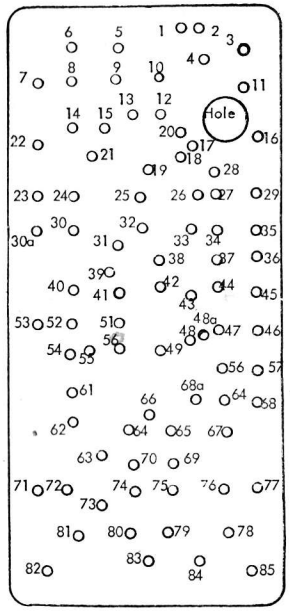


FIG. 8

RX P.C. BOARD
FULL SIZE

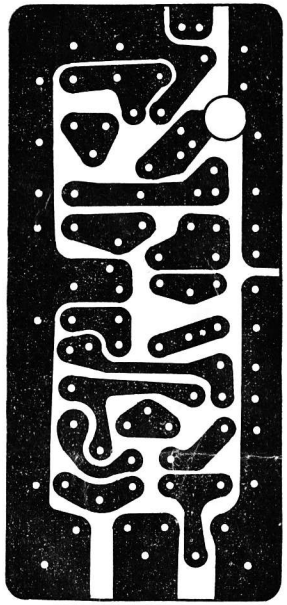
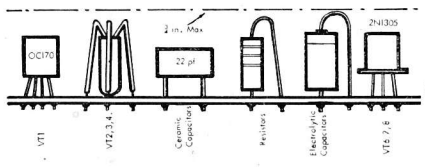


FIG. 9

HOLE IDENTIFICATION

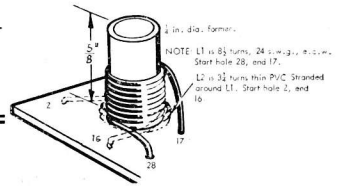
FIG. 10

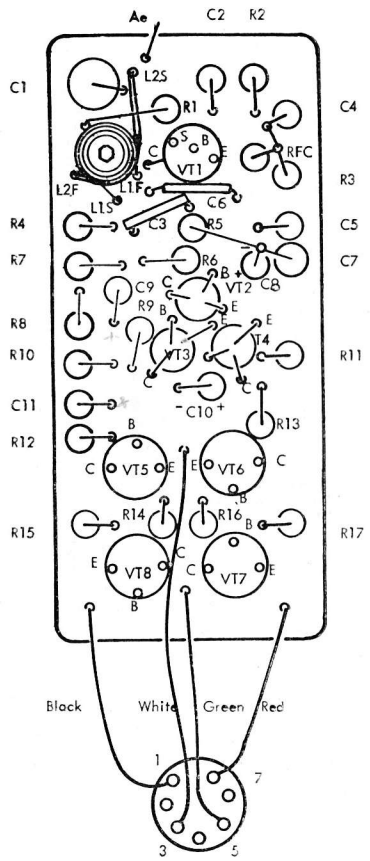
COMPONENT PLACEMENT
ON RX



L1 & L2

COIL WINDNG
DETAIL





FULL SIZE
PLACEMENT
DIAGRAM

Hold up to the light to identify hole numbers

FIG. 11

Have a care . . .

Check at every stage . . .

Rx Assembly

RESISTORS **REMARKS**

Component No.	Over and in Hole No.	To hole No.				
1	10	11	4.7K	Yellow	Violet	Red
2	6	8	2.2K	Red	Red	Red
3	22	C4/RFC	4.7K	Yellow	Violet	Red
4	29	27	4.7K	Yellow	Violet	Red
5	25	C8/C7	6.8K	Blue	Grey	Red
6	32	33	220K	Red	Red	Yellow
7	35	34	4.7K	Yellow	Violet	Red
8	45	36	1K	Brown	Black	Red
9	43	48a	470K	Yellow	Violet	Yellow
10	46	47	4.7K	Yellow	Violet	Red
11	53	52	4.7K	Yellow	Violet	Red
12	68	64	2.2K	Red	Red	Red
13	61	54	1K	Brown	Black	Red
14	75	69	150Ω	Brown	Green	Black
15	77	76	1K	Brown	Black	Red
16	74	70	150Ω	Brown	Green	Black
17	71	72	1K	Brown	Black	Red

CAPACITORS

1	3— 4	40/80μF + VE to 4
2	5— 9	2μF + VE to 5
3	19—26	22pF
4	7—RFC/R3	.001
5	23—24	.005
6	18—21	25pF
7	30A—R5,C8	.05
8	30—R5,C7	.32μF + VE to 30
9	37—44	.32μF
10	50—49	1μF + VE to 50
11	57—56	3.2μF
RFC	14 R3,C5	

TRANSISTORS

	E	C	B	SC	
VT1	15	20	13	12	OC170
VT2	39	38	31		OC44
VT3	41	49	42		OC44
VT4	40	55	51		OC72
VT5	66	67	60		2N1305
VT6	64	62	63		2N1304
VT7	81	80	73		2N1305
VT8	79	78	84		2N1304

Wiring

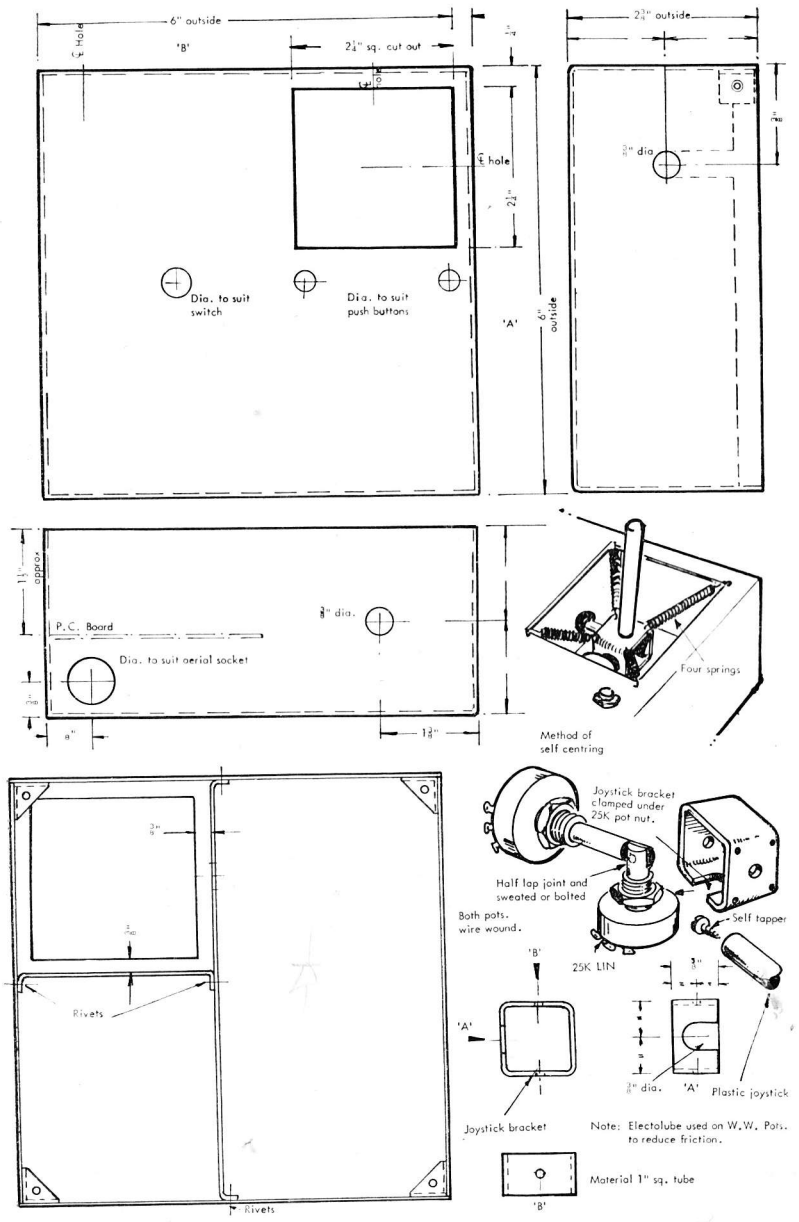
8 in. length in each hole

Hole No.	Colour	To		
82	Red	Pin No. 7	B7G	plug
85	Black	Pin No. 1	B7G	plug
83	Green	Pin No. 5	B7G	plug
66	White	Pin No. 3	B7G	plug

Aerial 30 in. length wire to hole No. 1

Checked it? Good!

Now check again



Servos

As long as "Mighty Midget" motors remain available, these are easily modified with a torsion centring spring. Battery supply for Rx and servo is 4.8v. centre tapped 500 DEAC or 225 DEAC for light weight.

Servo Coupling

Fig. 3 shows a typical servo to control surfaces link-up. The success of the system depends upon correct linkage to give the required throws of elevator and rudder.

(1) It is easier to get the required throws of surfaces if rudder and elevator hinges and *end* of brass crank bearing are kept in the same vertical line (see sketch).

(2) A good idea is to finish model completely, servo installed, torque rod, etc., but the tail block with the brass bearing in is deliberately cut small and left unstuck, i.e., free to move up, down, left, right.

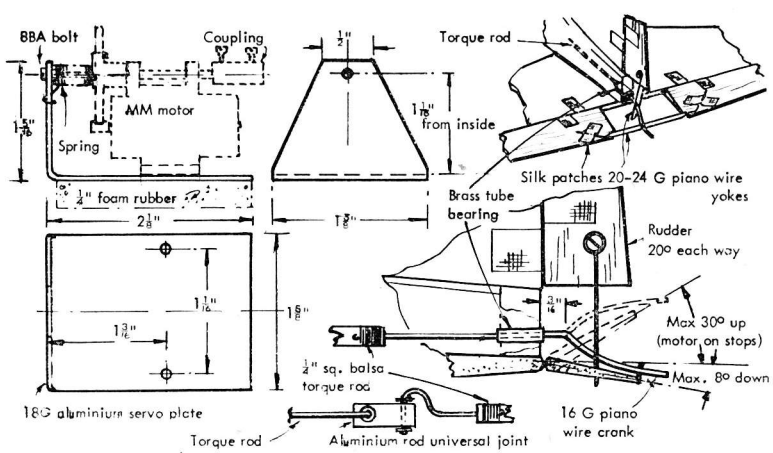
Now careful bending of crank and cutting of block to move the pivot point will easily lead to the correct alignment and surface throw when satisfied wedge and stick well with cement. This saves bending the wire loops and crank to the most odd shapes to attain correct operation. Before leaving the subject of servo linkage it must be mentioned that the movement of the servo and linkage must be as friction free as possible.

Due to the limited power available from the servo the size of model is limited to about 56 in. span and on the larger size of model balanced surfaces can be used with advantage.

FIG. 12

◀ DETAILS OF TX CASE AND POT LINKAGE

FIG. 13 SERVO DETAIL LINKAGE



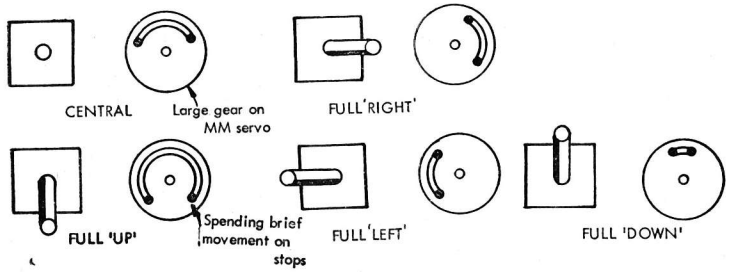


FIG. 14

COMPLETE SYSTEM CHECK

Testing Tx

1. Make sure all components are in correct position.
2. Set trim pots to half way position.
   Set L1 core into coil.
   Set extended aerial.
   Set up meter in –VE line on 100 mA scale.
3. Connect supply leads to a 9-13.5v. supply.
4. Switch on for a brief moment just long enough to ensure that the current drain is approximately –70 mA if there is much more current drain disconnect and check over again. If current is correct or less carry on with test.
5. Check with R.F. meter that there is some R.F. present at the aerial—slowly turn out core of L1 noting the corresponding rise in R.F. to a maximum where further unscrewing will produce a rapid fall in R.F. —turn back until R.F. suddenly appears then turn in one complete turn.
6. To tune the amplifier adjust aerial coil slug in or out to obtain maximum R.F. strength.
   The tuning of the aerial coil produces a fairly rapid but smooth fall off in R.F. either side of the correct tuning point.
   Final tuning should be carried out with p.c. board installed and one hand on Tx case.
7. The note from the Tx (if any) should now be studied, a crystal earpiece with one end of the jack plug held on the aerial or better still connected to the R.F. meter is required.

Adjust the main pots (M/S and Rate) to provide pulsing—the M/S pot first to "find" the pulses. (Too much to one side will be full tone and too much to the other side, just carrier.) Once the pulses are "found" adjust the rate pot to give about 2½-3 c.p.s. with the stick in fully down position. Set the M/S pot so that pulsing still occurs at both extreme right and left movement of the stick.

The Tx is now roughly set up. Final R.F. tuning and pulser setting should be done in conjunction with the Rx. Servo response to stick movement is shown in Fig. 14. Don't worry about "in-between" movements they will sort themselves out providing the right, left, up, down, are O.K.

Rx Testing

1. Check component positioning.
2. Connect batteries and servo.
3. Switch on for a brief moment—servo should drive to one side stop after 'flipping' to the other one first.
4. Check with R.F. meter that R.F. is being transmitted from the Rx aerial (only weak signal), this shows that front end is working.
5. Switch on Tx and tune L1 (Rx) in or out to receive the pulsed signal.
6. Proceed to line up equipment as previously explained.

System Specification

All transistor Tx. Weight: 2¼ lb. plus batteries
Size: 6 in. x 6 in. x 2⅜ in.
Room for 12v. (2 x 6v.) DEACs approximately 5½ hours capacity.

All transistorised Rx. Weight: 2¼ oz. including plastic case push/pull output, no relays.

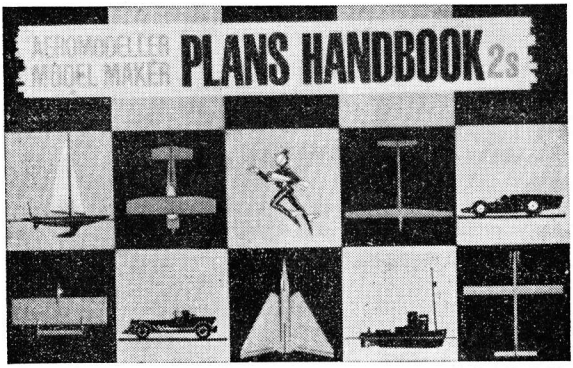
Supply: 4.8v. servo battery.
Servo: Modified M.M. motor. Weight: 2½ oz.
All up flying weight: 225 DEACs = 7 oz. 1½ hours capacity.
All up flying weight: 500 DEACs = 9 oz. 4 hours capacity.
Combined range = 500 yards.

Notes

Do not let Tx supply go below 9v. or pulsing will stop (Zenner diode stops switching at 8.2v.).

Do not leave Tx switched on for lengthy periods with no aerial load. Output transistor gets hot. (The 15 ohm emitter resistor should prevent any damage in any case.)

Complete set of components and mechanical parts or completely assembled outfit is available from the designer.



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