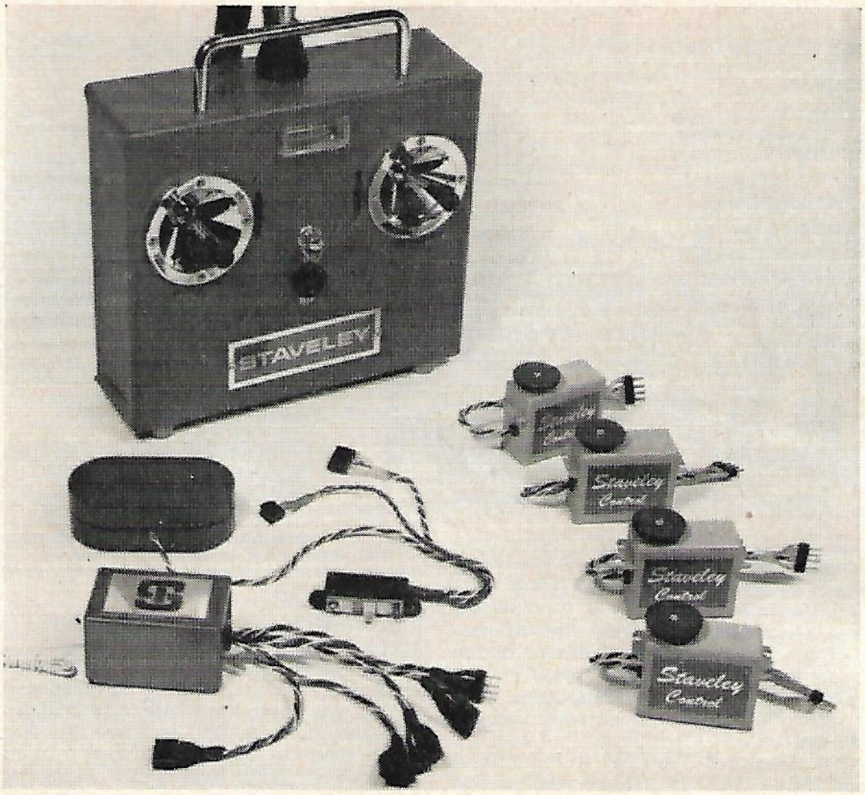


R.C.M.&E. Test Report

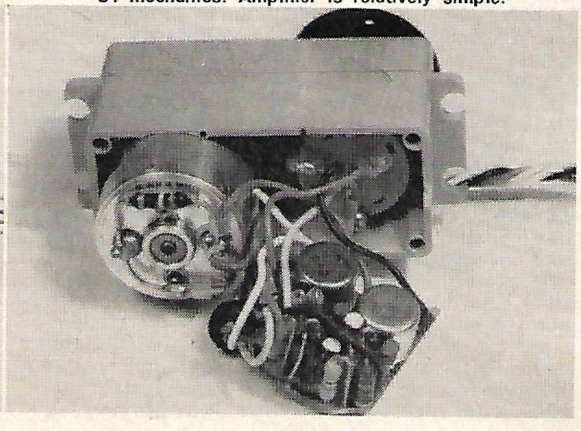
STAVELEY 4

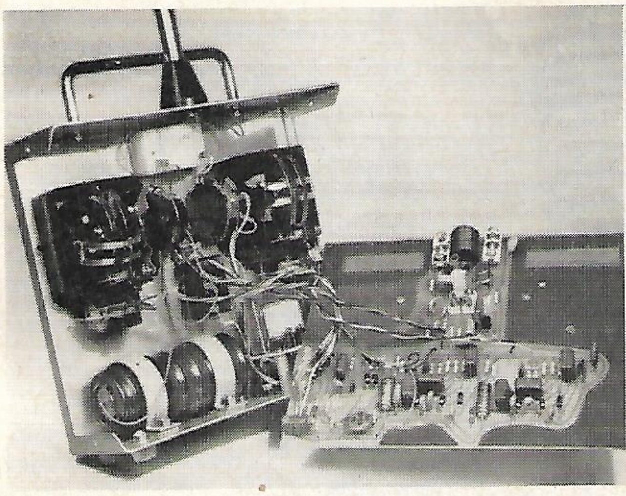
Four function 'wide deviation' analogue proportional system

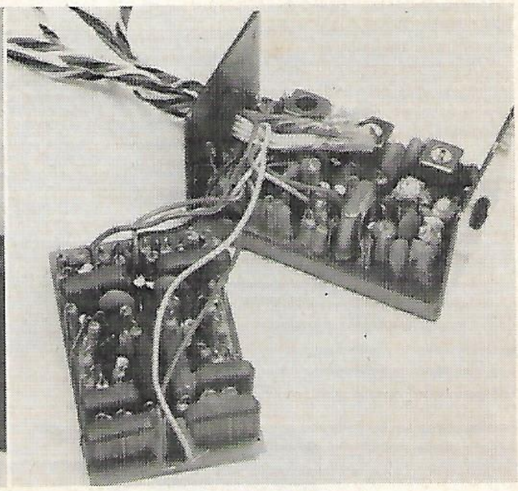
ONE of the most intriguing introductions to the R/C scene in recent years has been the Staveley range of R/C systems, the first of which was the Staveley 4 proportional unit. There have been two reasons for the abnormally high level of interest in this system. Firstly, Staveley Industries is a large industrial group with obvious financial resources unusual to the R/C field, and secondly, the system they introduced operates on the analogue principle.

The first really successful commercially produced proportional systems used the analogue principle and gained a reputation for reliability while lacking servo resolution. Early digitals, on the other hand, offered

Above: complete Staveley system is supplied complete with neck strap mounting fittings and frequency caps. Below: two types of servo are available using either Kraft or Controlaire S4 mechanics. Amplifier is relatively simple.







Above left: transmitter dismantled to reveal component side of P.C. board, and mechanical layout. Above: receiver and decoder boards, showing component layout on separate P.C.'s.

better servo resolution but tended to suffer more from interference problems and involved more electronic components, which was another source of failure.

However, simplification of the digital type system led to a general concentration on this type of proportional unit at the expense of development of the analogue type, so that several years elapsed before Staveley's 'modern' analogue system appeared, promising better performance coupled with proven analogue reliability.

We have had a 'Series II' Staveley 4 for several months now and the system has already accumulated quite an amount of flying time in more than one model – even used to teach one M.A.P. staff member to fly R/C, so the unit has been thoroughly air tested before technical analysis.

Staveley's 'upgrading' of the analogue system begins with its 'modern' packaging. The transmitter is small, size 7 x 6 x $2\frac{1}{4}$ in. in its olive green, vinyl clad case which follows the usual double 'U' folded metal arrangement with removable rear cover. Front face of the case carries two dual axis Kraft-Hayes stick assemblies with electro mechanical trims. One of the features of this system is that the lower half of the throttle control throw on the stick assembly commands only about one quarter of the throttle servo travel. Both the normal control column arrangements are available, but due to the previous mentioned throttle control arrangement, although the change over on throttle command from one stick assembly to the other involves only a two-minute spring removal and reattachment job, the non-linearity of the throttle response will necessitate a factory realignment of the system.

The Tx. front face also features an output meter, toggle type on/off switch (down for on) and an attachment for a neck strap (supplied with the system). On the case top is a handy chrome finish carrying handle.

Removal of the case cover reveals a full depth glass epoxy P.C. board, copper side out to display some neat soldering work. DEAC rechargeable power pack is strapped into the bottom of the case, together with the dual output charger. Mains input and output connections to the airborne power pack are in the case bottom. Unique feature of this charger (among R/C systems) is that its output is automatically regulated according to battery state, providing a full charging rate when batteries are fully discharged, tapering off to zero as the batteries come up to the fully charged condition.

The superhet receiver, which features three R.F. coils and three I.F. cans, is protected by a quite robust green anodised case, size 2 3/16 x $1\frac{3}{8}$ x $1\frac{1}{4}$ in. The receiver case also encloses the decoder circuitry on a separate P.C. board and a number of components on both boards are supported by contact adhesive. Outputs to the four servos are made via four pin O.S. connectors, solder connections to which are very adequately supported.

Power pack for both receiver and servos is a 4.8v. DEAC enclosed in a flat moulded case. The battery harness includes an on/off slide switch and a charging socket which by-passes this switch.

Staveley offer a choice of servos, either Kraft KPS-10 or Controlaire S4a types, both with rotary output drives. The two types of servo use a common amplifier, which is much simpler than the equivalent digital type employing only six transistors.

Flying

As previously mentioned, test flying on the system *after* a considerable amount of air time had been put on the system so that performance figures achieved on test are likely to reflect those of a system during the greater period of its service after initial 'burn in'. One idiosyncrasy of the Staveley analogue system is that if the aileron stick is released from full deflection and allowed to flip back to neutral, the rudder servo sometimes gives a momentary twitch. This does not always happen, and under normal stick handling conditions, it does not happen at all, so it is only an academic point really.

Models used for test flying of our system were a Goldberg *Skylark* 62 and a *Tauri* (for pilot training purposes). In either case we used the Controlaire servos, installation of which is made that much easier by the mounting clips provided. For the Kraft type servos, installation trays are available from Staveley separately.

Our system logged about 35-40 flights before test analysis, and at no time was there even the slightest hint of bother. First-class servo resolution making flying a pleasure.

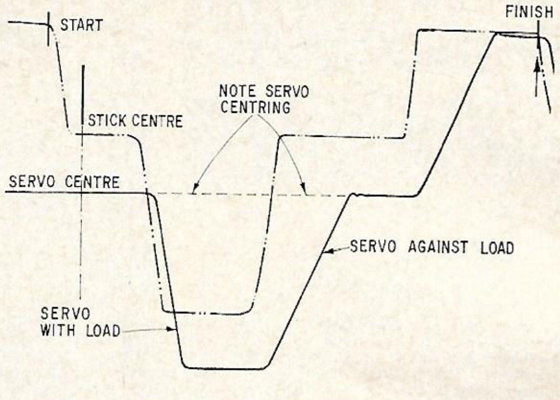
technically speaking . . .

Rex Boyer analyses the Staveley 4

First of all, let us look at the method of operation of the system. The two primary functions or channels (aileron and elevator) are operated by the widely used system of variation of frequency of a tone and variation of the mark/space ratio of that tone. Nominal frequency is 500 Hz. at centre stick position, varying between 350 Hz. full left to 650 Hz. full right This is used for aileron. The mark/space ratio uses 1:1 for centre varying 1:2.4 for full up elevator to 2.4:1 for full down elevator. So far this is nothing unusual.

Now we come to the clever bit, or bits, the 3rd and 4th functions or channels (throttle and rudder), both of which are varying frequency channels. First of all, let's consider channel No. 1, the varying high frequency channel, in its centre stick position. Now move it about a bit so as to vary the 500 Hz. mean frequency to, say, 520 Hz. and down to 480 Hz. If you listen to this on a monitor you would hear the note varying as the stick is moved. Now, imagine this 'waggling' of the stick to be 60 times a second. On your monitor, you will hear the 500 Hz. mean frequency plus the 60 times a second (i.e.) 60 Hz. waggling, just like the tremolo effect on an electronic organ. So far, so good. Now let us make this 'waggling' speed variable between 40 and 80 'waggles' per second or 40 to 80 Hz. We then have channel (function) No. 3 because no matter where channel 1 is positioned, we still waggle its mean frequency by about 7 per cent. Conversely, the frequency of waggle is only affected by variation of No. 3 channel. Oh! Easy, you say, just F.M. of a sub-carrier. So that's settled that – now about function No. 4? Well, now that you understand how channel 3 works, which, incidentally, is used for rudder, No. 4 is easy – we just 'waggle' the mark/space ratio of the 500 Hz. (channel 2) the same as you waggled the frequency in channel 3 and there is channel 4. The 'waggling' frequency is similar at 60 Hz. nominal, varying from 40 to 80 Hz. (see diagram below).

There then, we have the transmitted information for the 4 channels, a very complex signal. This is fed into fairly conventional modulation stages and P.A. stage. Modulation is effected by switching the P.A., the local oscillator running constantly. On receipt of the signal, the receiver has to decode this complex information into four usable commands. The first two are done again in the accepted manner with a monostable rate-to-D.C. converter. Both these then give a D.C. level corresponding to the frequency or mark/space ratio of the high frequency level. But at the input to these filters 40 to 80 Hz. ripple is present. So now we have channel 1 with channel 3 superimposed, and channel 2 with channel 4 superimposed. Let us now feed the signals into R/C filter networks, one of which sees nothing above about 90 Hz. This will rid the No. 3 channel of the 500 Hz. frequency, as a similar one will for No. 4 function. These two 'waggle' frequencies are then individually converted by the



Servo response trace showing electronic trace recording of stick and servo movements. Straight line of servo trace with tight corners at stop positions prove this to be an accurate responding control system.

same method as the 500 Hz. channel, i.e. monostable to D.C. converters. This, then, gives us No. 3 and 4. As you can see, the exact frequency response of these filters is in no way critical, as the two information frequencies are poles apart.

There, then, we have the method by which the Staveley system works in plain non-technical English. Our more technically qualified readers will see the holes in this description, but basically, this is how it works. There are more technical refinements which we have left out in the interest of clarity.

If you are still not clear, have a look at the block diagram and reread the explanation.

Now that you are fully conversant with the system's operation (!) here are a few test facts and figures.

The system was tested with both Staveley/Kraft servos and Staveley/S4A servos. All figures in mA.

Rx./Kraft

	Idle.	Idle 4 servos	Average Running	1 Servo stalled
– ve lead	1 9	110 *	200	480
+ ve lead	1 9	45	200	490

S4A.

– ve lead	1 9	120	230	460
+ ve lead	1 9	100	220	500

Battery voltage at Rx. on both tests 5.21 volts on 200 mA load.

* This high figure in one direction proved to be a 'sticky' motor in one servo.

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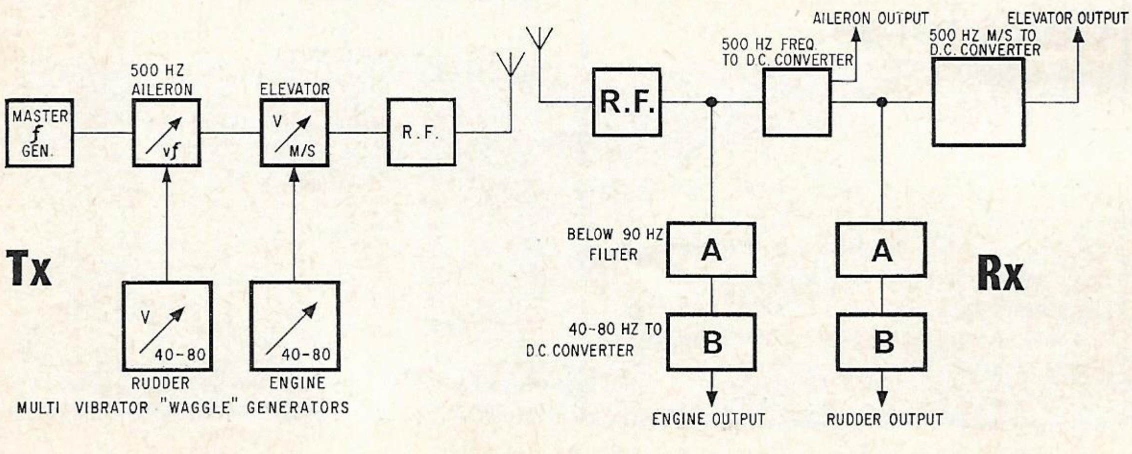

Servo Response times for step function input.

Load In outer hole	Time stop to stop Kraft	S4A	Delay before servo moves after stick Aileron and Elevator	Rudder and Throttle
No Load	·675 sec.	·5 sec.	75 m.s.	130 m.s.
4 in. 0 ozs. (1 lb. 1 oz.)	·85 sec.	·675 sec.	75 m.s.	130 m.s.
8 in. 0 ozs. (2 lb. 2 oz.)	·925 sec.	·85 sec.	75 m.s.	130 m.s.
12 in. 0 ozs. (3 lb. 3 oz.)	1·1 sec.	1·25 sec.	75 m.s.	130 m.s.
16 in. 0 ozs. (4 lb. 4 oz.)	1·3 sec.*	Stalled at 14 oz. ins.	75 m.s.	130 m.s.

* Just about stalled.

What can we conclude from the servo response traces? First of all, at all loads on both servos the delay time between movement of stick and movement of servo remains constant. The rudder channel and engine channel being longer, due to the lower frequency of the information signal.

Secondly, at all loads, the response was absolutely linear with no drop off as the error signal became small.

Thirdly, centring accuracy and dead band in the worst case was no greater than 2-3 per cent, in the best case about 1½ per cent under all load conditions. We must qualify this in the case of the S4A servo, where mechanical twisting of the output arm due to the plastic deflecting under load did cause an apparent zero datum shift, but this datum remained constant. The Kraft servo did the same but to a lesser degree.

Transmitter

One feature worthy of note here is that the R.F. circuity is not, in the conventional way, coupled to the case but by a fixed capacitance. The effect of this is that the R.F. output does not vary to any degree due to the manner in which the transmitter is held.

The normal battery voltage is 9.6 DEAC. Test figures are as follows: –

Tx. aerial retracted 107 mA.
Tx. aerial extended 92 mA.

Measured battery voltage on load 10.5 volts.

To sum up, then, a very exacting system with good servo response and in answer to the obvious question, is it as good as Digital, we can answer quite definitely, YES.

Details of gear as tested

Tx.

Size Overall : 7⅛" x 6" x 2⅜ in.
Weight : 3 lbs.
Aerial removable.
Retracted length : 8"
Extended length : 60"
Power supply 9.6v. nominal.

Rx.

Size Overall : 2⅛" x 1⅜" x 1¼ in.
Power Supply : 4.8v.
Total airborne weight : 14½ ozs.

Manufacturer.

Staveley Control, Staveley Research Centre, Green Lane, Clapham, Bedford.

Price.

£158.0.0.

sport & single

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(rudder and elevator) should be realised by the unique swept-back rudder, which seems very simple and economical for small models.

I was not able to check the trueness of this hypothesis, for my Tx. (O.S. Pixie and electronc pulser) has only a constant pulse rate, but I should be very interested to know if yourself or some of your readers have tested such a way of control. At least I should be glad to know if you are of the opinion that such a system is able to work or not.'

Having considered this one fairly carefully I cannot see anything wrong with the hypothesis but, like Jacques, I have not had a chance to try it. If, before we have a chance to try the theory ourselves, any reader has any comment, either from practice or theory, please write in.

Finally, two quickies, Mr. M. R. Ritchie in New Zealand is most interested in seeing more S/C low or mid-wing designs. He, and many other modellers, prefer the appearance of these designs, particularly swept wing models. Any takers?

Mr. K. Drew of Bristol found that the rudder area shown on the 'Apprentice' powered glider design was insufficient for slope soaring work. This I can understand and would suggest that any prospective builder of this model for slope soaring flying double the rudder area. Also, the degree of sweep back to the rudder can cause binding of the rudder horn and clevis when a push rod system is used. To overcome this, make the rudder hinge line more vertical.

That's it for another month – more news of slope soaring next time.

Don't forget— your licence

Just in case newcomers to Radio Control are not aware of it – you need a licence for operating remote control equipment. No tests, just fill in a form and pay 30s. for five years' cover. Application form and full particulars from G.P.O. Radio & Broadcasting Dept., Waterloo Bridge House, Waterloo Road, London, S.E.1.

Contest Calendar

S.M.A.E. Contest Calendar 1969

Sept. 28th	S.M.A.E. R/C centralised event, R.A.F. Upwood, Hunts. Multi Aerobatics.

Other Events

Sept. 7th	Boscombe Down and Flying Druids Fly-for-fun Rally. Novelty radio Events – multi and single. R.A.F. Middle Wallop.
Sept. 7th	South Coast R/C Rally, Golden Cross, Nr. Lewes, Sussex.
Sept. 13/14th	R/C demonstration team, Sywell Airfield, Northants.
Sept. 14th	Northern Area Goodyear and Open Pylon Racing, R.A.F. Topcliffe, Yorks.
Sept. 21st	South Midland Area Rally, Cranfield, Beds.
Sept. 21st	Cotswold R/C Rally, R.A.F. Hullavington, Wilts. Pylon Racing.
Sept. 21st	Edinburgh Rally. Team Pylon Racing (Goodyear), Spot Landing at Donibristle.
Sept. 28th	South Coast Gala (venue to be announced).
October 12th	London Area Gala, R.A.F. Greenham Common, Nr. Newbury, Berks.
Nov. 16th	St. Albans Thermal Soaring Rally, Nomasland, Wheathampstead, Herts.