Rebecca Mk8

Rebecca was the airborne equipment used during and after WWII to find a small beacon (Eureka), usually dropped earlier to mark a dropping site for parachutists or equipment.
Mk8 was the last one of the Rebecca series of airborne receiver/transmitters. The main unit is the TR 8193, made in 1956 by Murphy Radio. This airborne set transmits 140 pulses per second on one of 8 channels between 214-235 MHz, with a peak power of 1kW, and a pulse width of 4 us.
The Eureka beacon responds to each pulse on a different frequency, usually 4MHz above the Rebecca frequency, with a 12W pulse of 7us width.
These pulses are received by the Rebecca unit on two aerials, one on each side of the cockpit. Their relative strength gives the direction, the delay from transmit to receive gives the range.

The T.R. 8193 Rebecca-8 airborne unit has range and heading measuring capability to Eureka or BABS beacons. Versions are
ARI 5506 (Rebecca - 2)
ARI 5610 (Rebecca - 4)
ARI 5849 (Rebecca - 7)
ARI 23013 (Rebecca - 8)

20 july 2017, Koos Bouwknegt

CONCISE DETAILS OF ARI.230I3 REBECCA Mk. 8

Function	Rebecca Mk.8 is a lightweight. miniature, airborne interrogator - responsor, operating over the frequency band 200 -235 Mc It is used in high performance single seat aircraft under pan-climatic conditions up to 50.000 feet and provides the following facilities— (1) Interrogates both Eureka Mk.7 and Babs Mk. 4 (2) Responds with meter indications of slant range and the condition of being locked to the transponder. (3) Provides heading information when locked TO Eureka, and course line information when locked to Babs. (4) Receives code identification signals in headset and lock release for unwanted signals
Frequency coverage	Eight spot frequencies for both receiver and transmitter between 200 and 235 MHz
Range	Eureka : 200 miles at 30,000 ft and 60 to 90 miles at 5,000 ft Babs: 20 miles at 1,000 ft within ± 25 deg from Q.D.M.
Polarization	Vertical
Transmitter	
Power Output	1.0 kW maximum
Pulse width	3 µs ± 1 µs
Pulse recurrence rate	140 p.p.s
Receiver	
Sensitivity	80 dB down on 0.1V (10µV) for 2:1 s/n ratio
Bandwidth	Not less than ± 1.5 MHz at 6 dB down; Not greater than ± 5 MHz at 50 dB down;
Intermediate frequency	45 MHz
Left-right sensitivity (adjustable)	Eureka homing. Half scale deflection for 10 degrees off true course Babs approach. Half scale deflection for one degree off Q.D.M.
Range accuracy	± 2 per cent of maximum range excluding meter
Meter accuracy	± 2 per cent of F.S.D..
System capacity	Eureka Mk.7; 75 aircraft Babs Mk.4; 30 aircraft
Maximum operational height	50,000 feet
Power consumption	28V at approximately 7A

Main items of installation

item	*Stores Ref.*	*Size*
Transmitter-receiver Type 8193	10D/19594	15 in. x 8 in. x 8 in.
Control unit Type 8197	10L/16264	7 in. x 5 in. x 4½ in.
Range and heading meter	10AF/530	3¼ in. dia x 2¼ in.
Boxes junction Type 8196	10D/19595	8 in. x 3½ in. x 6 in.
Boxes junction Type 8355	10D/20063	8½ in. x 4 in. x 4 in.

(A.L.10, Nov. 56)

Rebecca Mk8

On 5 april 2010, BEagle wrote on the PPRuNe forum :

"The Vampire 11 had a Rebecca 8 set, as did the Jet Provost and Hunter. In 'range only' mode, if you were lucky it had a range of about 40 nm; in 'homing' mode about 20....

The control box was a large, clunky thing with large bakelite rotary knobs. One control selected the letter and the other the number of the associated Eureka 7 channel; for example, Cranwell was C4 and Cottesmore D5 (I think). The morse coding rate for the Eur7 was very student friendly - about 1 word per week! You had to check it as it was quite common for the Rebecca to lock onto a different station to the one you'd selected.

Somehow we flew radio navigation exercises using nothing more than Eur7 and UDF, then flew a DME let down at base using this contraption. At least we had the left/right indicator, rather than the CRT screen the guys who flew Pigs had! You went outbound in the 'DME safety lane', then faffed with L/R and the DI to establish the correct inbound approach course....:uhoh: Fortunately we'd all had several sessions in the Link trainer before trying it for real.

The 'swingometer' range needle used to hunt around the dial unless the Rebecca could sniff out a station; once I was just pulling off the target at Pembrey when the needle went clockwise at precisely the same rate as the g-meter's needle normally moved - except that it kept going...:ooh: For a moment I eased off the gas a reflex in case I was overstressing....fortunately I was already climbing. We used to pull out of the dive and immediately check the mirror for the 25 lb bomb smoke - having the distraction of the Rebecca needle moving round the dial out of the corner of your eye was most unwelcome!

The bandwidth of Eureka/Rebecca was colossal - about 4 MHz if I recall correctly. When the JP5A came in with VOR/DME, it seemed like the space age. This was about 1974! But the wonderful Gnat with its offset TACAN was truly magical! We had non-offset TACAN in the GT6 Hunters at Valley, but all bar 2 of the jets at Brawdy had the old Rebecca. The Mk9s had ADF, but no-one taught us how to use it - we just used to listen to music on it. A chum, Dick 'Whizzbang' was a bit of a culture vulture and had a memorable time rocketing with SNEBs at Pembrey whilst listening to 'Ride of the Valkyries' on BBC Radio 3! "

Systems Rebecca Mk7 and Mk8

More version info and submodules

Rebecca Mk7 and Mk8 are identical, except for the BABS function, which is only present in Mk8.

Rebecca version	**Mk7**	**Mk8**
Beacons supported	Eureka	Eureka, Babs
Transmitter/Receiver	TR1809	TR8193 (made by Murphy Radio)
Control panel	Type 909	8197 (10L/ 16264)
Junction Box	X.2004	8196 (10D/19595) or 8355 (10D/20063)
Range and Heading Indicator	10AF/530	10AF/530 (made by Sangamo-Weston) or 10AF/1561 (made by Murphy Radio M:165)
Antenna switch port/starboard	Type 273	Type 273
O/R - H coax switch	Type 78A	Type 78A or 514

Modules Mk8

Type	*function*	*Ref No*	*Serial no*
8202	Chassis	10D/19596	M4028
8195	Transmitter	10R/13054	M4170
8204	Tuning unit in transmitter	in transmitter	
8349	Receiver RF head	10P/16310	M4146
8545	IF Amplifier	10U/17210	M5187
8194	Strobe unit	10Q/16313	M3183
8320	Dynamotor	10K/18731	M3700
8193	Dust cover	10D/19594	M3592

Aerials

Left and ringht aerials
Transmit aerial
Omni receive aerial (babs)

Eureka ground beacon

RT-44 / PPN1 (In UK known as Eureka, 1943)
RT-37 / PPN2 (In UK known as Eureka II, 1946)

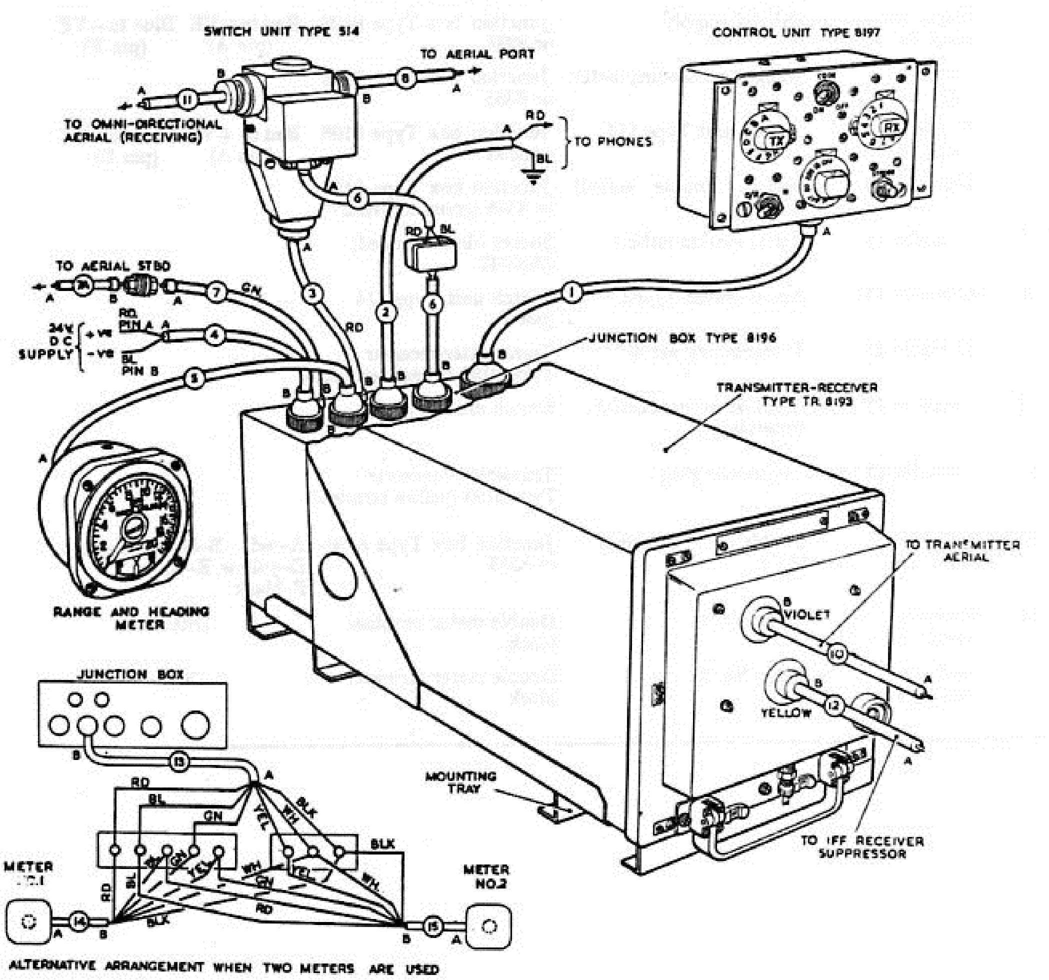
The junction box is fixed directly to the rear side of the TR8193 . It expands the main 28-way plug of the TR8193 into 7 separate plugs, and contains the aerial vibrator, and the A and B power relays.

Revisions

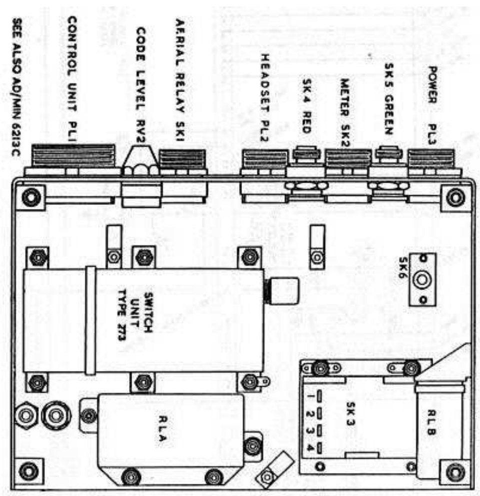
One of the thyratrons in the modulator is replaced by a module with two triodes, forming an oscillator at 140Hz. This signal is used to trigger the remaining thyratron on a more reliable way.

The indicator flag in the earlier versions showed "ON" only when locked i.e. when the AGC level was sufficient. The junction box had a sensitive relay RLC for this purpose. Later versions abandoned RELC and showed "ON" simply when 28V was present on the TR8193.

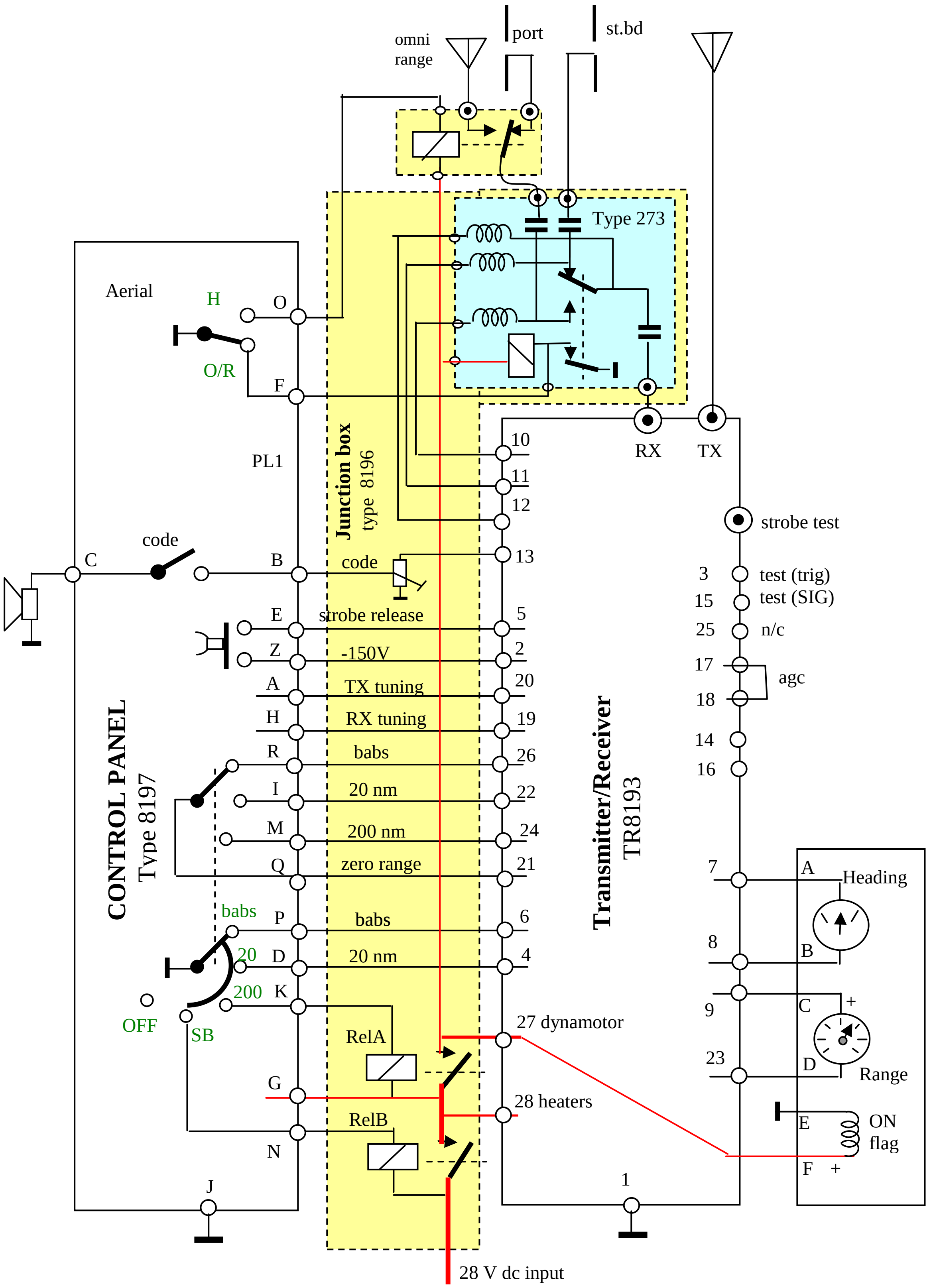
The first technician courses on Rebecca 8 were in June 1956



Components of the airborne Rebecca Mk8 system
The **junction box** plugs directly to the rear of the transmitter-receiver unit.



Interconnections



Rebecca Mk7 / Mk8 Interconnections
18-7-2017 kb

Circuit details

Main chassis

Front: The front has 2 coax connectors. A pink one for the transmitting aerial on the bottom side of the fuselage of the aircraft. Impedance is 50 ohm I assume.
The yellow one is intended to suppress an IFF unit (pos. slope of signal) but can also be used to monitor the range-locking strobe pulse (negative slope of signal)

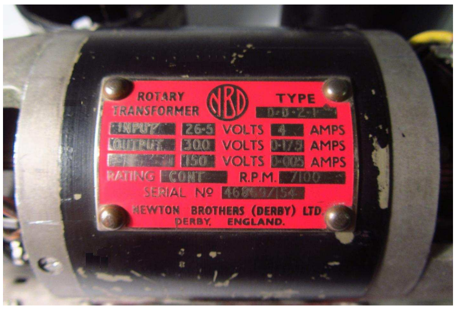
Rear : the rear side of the TR8193 connects directly to the junction box via a coax input from the Rx antenna switch, and a rectangular 28-pin connector which connections expands to the 27Vdc power supply input, the meter, and control box.

Power supply

The complete unit is powered **by 27.5Vdc - 6.2A**
The filaments of the 29 valves are series-parallel connected, together 2.65A at 27.5 Vdc.
When the mode switch is set from OFF to SB, 27V is applied to the relays and the filaments (7A inrush current). The pilot should wait at least 30 seconds before the mode is set to 200nm, 20nm or babs which starts the dynamotor, mine required at least 10A initial to start running. The transmitter starts then immediately. The 30 sec. delay prevents damage to the CV1759 transmitter tubes.

Once running, the dynamotor takes 1.8A for mechanical losses, fan and field , plus 1.6A for the typical load on the 300V bus. That is:
- 40mA for the strobe unit;
- 25 mA for the RF receiver head
- 5... 40mA for the IF strip, depending on signal strenght; (fused at 100mA)
- 15 mA (average) for the transmitter.

Together approx. 85mA



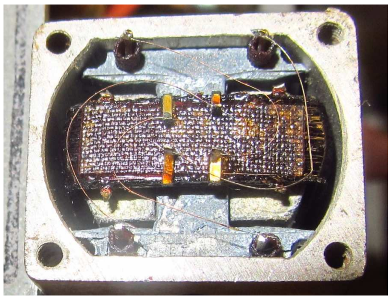
Dynamotor
No load
Input 26.7V / 1.8A
Output + 380V, - 168V both no load.

Typical load (without transmitter)
Input 24V / 3.4A
Output + 280V, - 140V typ. load.

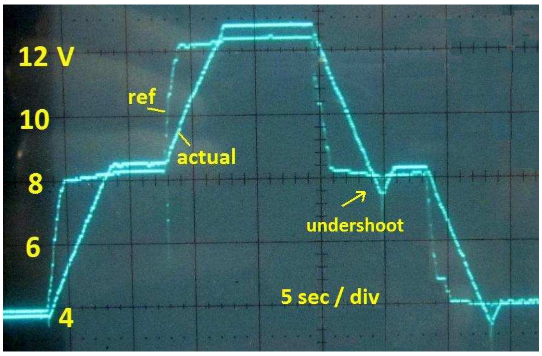
The extra load by the transmitter is only 15mA @ 300V dc
The IF strip oscillates (?) at 300Vdc, 280Vdc is a better choice. The DC voltage on the cathode follower output of the IF strip is 10 to 15V dc.

Tuning

Both the receiver and the transmitter have remote controlled tuning motors. Remote tuning is done from the control box by 8 presetted variable resistors.



Each motor is controlled by two relays (forward and reverse) that are controlled by a very sensitive *moving coil* relay. A current of only + or - 0.4mA is sufficient to activate the forward or reverse drive relay, yet the coil can withstand 8mA in either direction. Such relays were made in 1954 by Elliott (model R350B) or Sangamo Weston ltd (type S.115).



The position of the tuning elements is measured with a potmeter, producing a voltage between 1.7V (approx. 240 MHz) and 22V (approx. 193 MHz). The channel selection in the control panel provides a voltage in the same range. When the difference between these two voltages is more than 0.1V, the motor runs either forward or backwards.

A special circuit eliminates the dead band.
With an ***increase*** of the reference voltage, the actual tuning position follows as expected.
With a ***decrease*** there is an undershoot caused by the 33k resistor on the second coil of the moving coil relay. This undershoot is followed by an increase once the 33k offset is witched-off. This way, the final position is always reached in the same direction. and the dead band does not show up.

The transmit frequency at the lower endstop is 193 MHz in my set,
The transmit frequency at the upper endstop is 256 MHz
Tx tuning over this (maximum) range takes 18 sec.

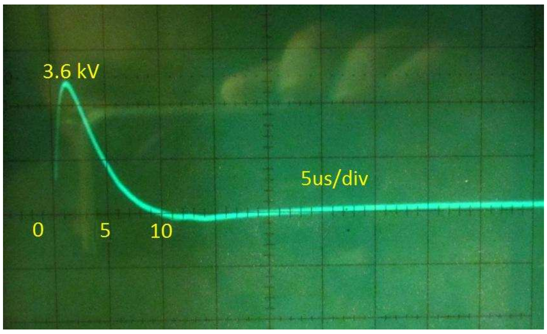
The receive frequency with var.co fully closed is 192 MHz
The receive frequency with var.co fully open is 240 MHz
Rx tuning over this (maximum) range takes 13 sec.

Spec is 200-235 MHz

Transmitter

The transmitter is the only module with a reinforced box, pressurized to 5 psi via a standard tyre valve. This box has a desiccator cartridge with pressure indicator.

Two cold-cathode neon thyratrons (one redundant) CV2349 fire each time the voltage on the 0.5uF storage capacitor has reached 230Vdc. This discharges the capacitor into the HV transformer, providing a 3kV/1A peak pulse to a balanced oscillator (2x CV1759). The RF output is 1kWp, 140 times per second. Waveform see picture.



The average input to the modulator is
300Vdc x 15mA = 4.5W
The average RF output is 1kW x 5us/7ms = 0.7W

The peak voltage on the 47 Ω common cathode resistor is 80V, so the peak current to the transmitter final is 1.6A
There is no intentional jitter of the pulse repetition frequency like in the TACAN system.

Receiver

The receiver is a single superhet with 45 MHz IF, the standard IF frequency since the H2S radar.
The min. Rx frequency range is 200 - 235 MHz.
The RF part has a grounded-grid RF amplifier, followed by a triode mixer and oscillator. The oscillator is remotely tuned in the range 154 -190 MHz
The IF amplifier has 100dB gain. Bandwidth is > 2 MHz at -3dB, yet < 5MHz at -50dB
Sensitivity is -86 dBm (5µV) for equal noise and signal.
Typical output pulses are 10Vpk, the max (saturated) output is 20Vpk.

Remote tuning is done from the control box with 8 preset variable resistors. TX and RX are never the same, usually the beacon transmitted 4MHz below its receive frequency like C4

TX	RX	Frequency band	Centre
A	1	208 - 212 Mc/s	210
B	2	212 - 216	214
C	3	216 - 220	218
D	4	220 - 224	222
E	5	224 - 228	226
F	6	228 - 232	230
G	7	232 - 236	234
H	8	spare ?	

The older Rebecca sets could home in on Walter personal rescue beacons at 177 MHz. Clearly, this was no longer possible with Rebecca-8.

What is received
Because there may be up to 75 aircraft interrogating the same beacon, a great many pulses may be received at this same frequency. Only one of them is synchronous with the transmitted pulses of this Rebecca unit and should be found in order to measure the distance. The solution is based on a stroboscopic effect: only the response to its own transmitted pulse arrives each cycle at the same delay from the transmitted pulse.

Strobe unit

The Rebecca Mk4 from 1955 still had a CRT to show blobs left and right of a vertical timebase line. The Mk7 / Mk8 presents the range and heading to the beacon on a **meter**.
The span of the indicator is 20 or 200 nautical miles, which corresponds to 25 + 20 x 12.36 = 272 µs or 25 + 200 x 12.36 = 2497 µs (time of flight plus beacon delay). This is about one-third of the time between the transmitted pulses.

To find the reply to its transmitted pulse, a short pulse (walking strobe) is generated in the strobe unit at a variable delay between 10 and 300us resp. 0.1 and 2.5ms after each transmitted pulse. Only received pulses during this gate time are considered. The delay itself is controlled by a slow ramp, gradually increasing the delay until at least 3 successive pulses pass the gate. From then on, the delay no longer ramps but is maintained at the expected time of arrival of the received response pulses.
The slow ramp advances with 20nm/s, and the flyback time is 1 sec in both 20nm and 200nm range.

Strobe gates

All received pulses are applied to the control grid of 4 pentodes; their suppressor grid is normally held at a negative voltage and the valves are cut-off. Positive "strobe" pulses are applied to this g3 to give a negative anode pulse if the strobe pulse *coincides* with a received pulse.
The walking strobe generator is followed by two one-shot circuits, to provide four strobe pulses (A,B,C and D) at or just after the expected time of arrival of the response. They are:

A Range gate (V4)

B AGC (V14)

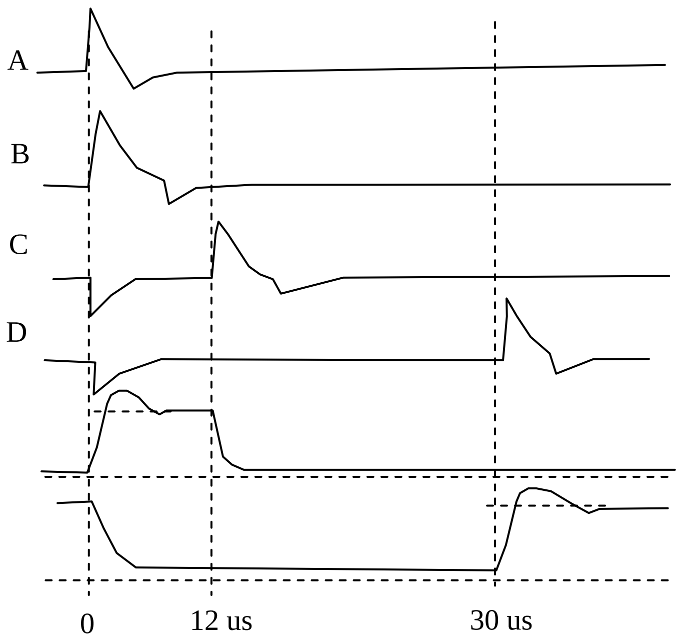
C BABS dash (V17)

D TONE-ID (V7)

All pulses are 30Vpp, and 5us wide except for pulse B which is 8us wide.

Pulse A is the "expected time of arrival" . The wider **pulse B** is used for automatic gain control, and for the heading deviation indicator.

P**ulse C** is used to detect the longer "dash" pulse in BABS mode,.



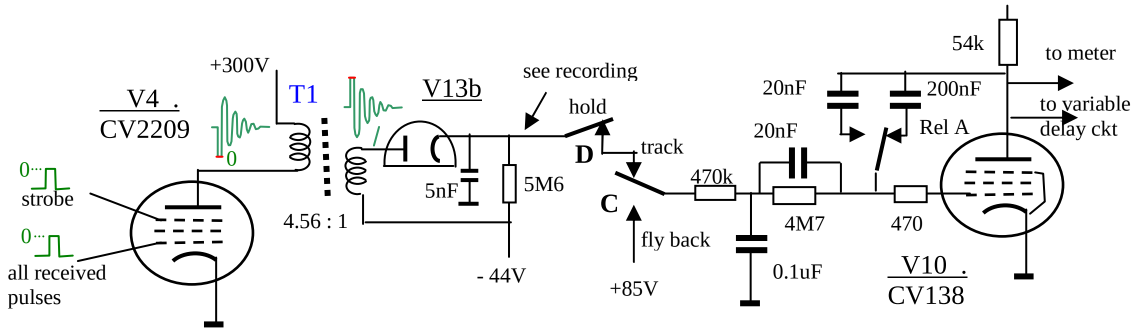
Pulse D checks if the received pulse is longer than 30us, to produce a 1 kHz tone during a dot or dash of the beacon identifier (ID). Eureka beacons normaly respond with short (5us) pulses. However, every few minutes a beacon ID is transmitted as a two-letter morse code by widening the response pulse to 33us during the dots and dashes.
The lower two traces are the 10us and 30us one shots. During the positive slope the current in the anode inductor is cut off, resulting in an overshoot above the +300V HT line. This *overshoot* is a strobe pulse, coupled to the suppressor grid of a "gate" penthode CV2209

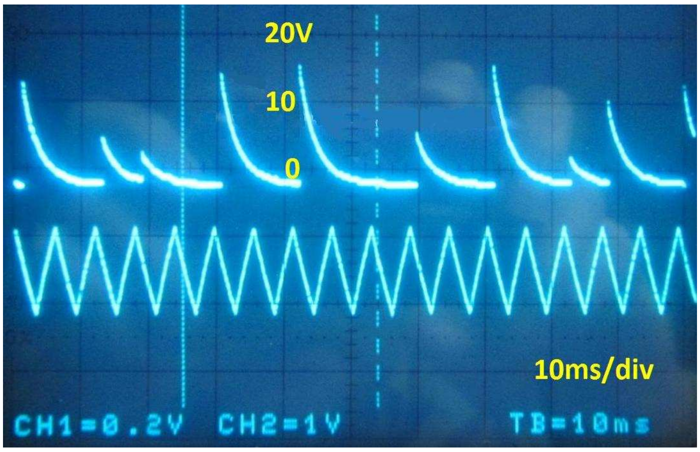
Range circuit

The control voltage for the walking strobe generator varies between 30 and 200V. This voltage drives the 1mA, 270 deg rangemeter via a 150 kOhm resistor. There are separate zero range adjustments for 20nm, 200nm and BABS mode of operation. BABS beacons have 1 naut.mile = 12.4us internal delay plus the standard eureka delay (25 us ?)

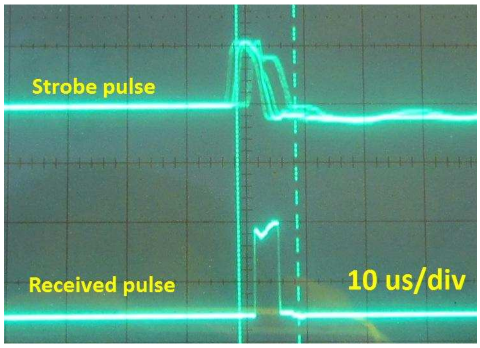
The range circuit operates either in **Hold, Search, or Track mode.**

Hold mode: Relay D is a memory-type relay which is "set" when the sum of the two heading triode currents is higher than the plate current of the AGC triode.
Without signal, relay contact D is open, and the range meter stays where it was. This occurs when the beacon signal is temporarily interrupted. Hold mode ends after 6 seconds, when the expected signal returns, or when the "strobe" button is pushed to start a new search.
Search mode: The contact of relay D is closed, and a negative voltage enters the grid of V10. The anode voltage ramps **up** slowly to 200V, where polar relay C changes state, so a positive voltage is applied to the grid of V10. The anode voltage of V10 runs down quickly to 20V where relay C changes state again, and the cycle repeats.
Track mode: When a response is received at the expected time of arrival (ETA), then a positive impulse enters V10, and the anode voltage drops a little, reducing the ETA to less than the arrival of the next received pulse, so the anode voltage starts to rise slowly, advancing the strobe pulse until pulses are received again in the ETA strobe pulse, and the process repeats.





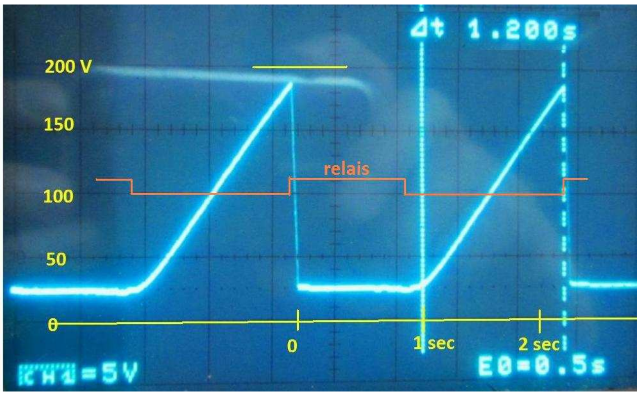
When the 5us wide strobe pulse exactly coincides with a received pulse, then the anode voltage of V13b peaks at +50V, and its cathode voltage to 15V (see recording). This advances the strobe pulse so the next received pulse arrives outside the strobe pulse.
The triangle trace is the clock from the beacon simulator. The upper trace is recorded at the cathode of V13b



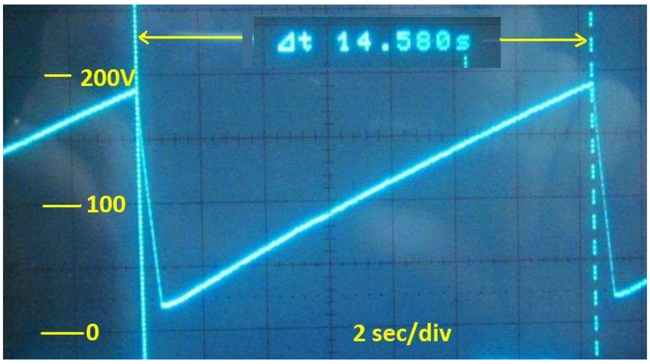
The jitter of the strobe pulse is about 3us, corresponding to 0.3nm. This is not visible on the meter.

Range recordings

The following recordings were made with the available supply voltages minus 123V en + 243V dc. This increased the search cycle to 1.2 resp. 12 sec in stead of 1 s resp 10 s. Further, with a 1mA meter the tracking stops at full scale, but with a 0.5mA meter and 180k extra in series, cycling was OK.



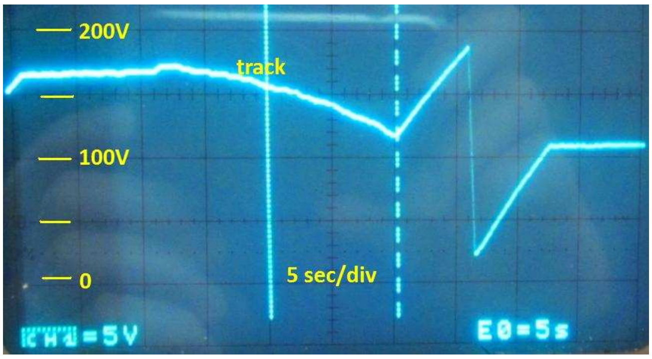
Search cycle 20nm.
Timebase is 0.5s/div
Without a beacon, the search voltage rises from 25 tot 170V , then relay C changes state and the search voltage drops rapidly until relay C changes state back again. The 0.1uF capacitor was at +85V during flyback and discharges in about 1 sec before the next cycle starts.
With nominal supply voltages, 200V span corresponds to 20nm, and the search speed would be about 20 nm/s



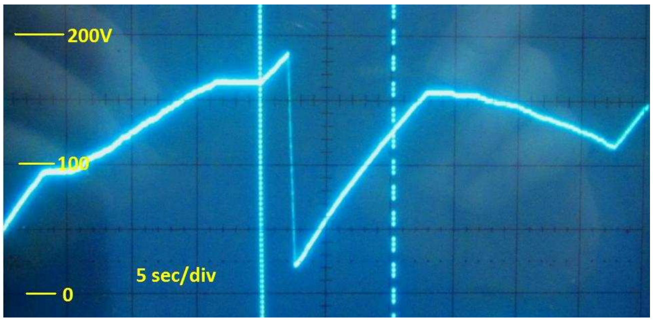
The 200nm search cycle takes 14 sec with a 0.5mA range meter connected (and 150k extra series resistor). Without meter the cycle takes only 12 sec (?!)

200V corresponds to 200 nm
De search speed is again 17 nm/s

Time base 2s/div



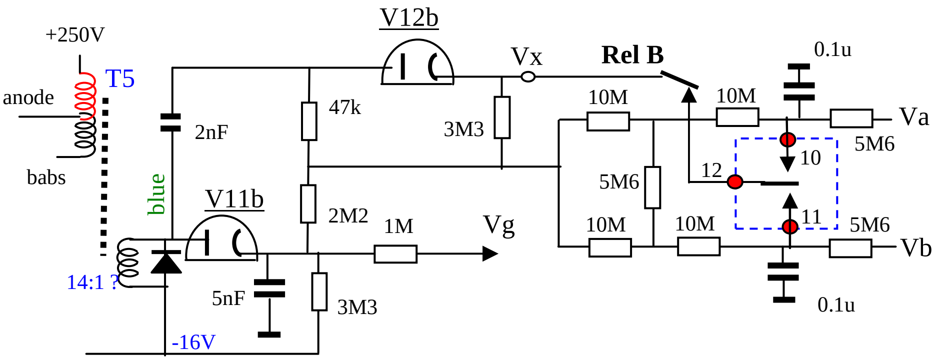
Tracking in 200nm range.
Using a beacon simulator, I tried to change the range as fast as I can without loosing lock. It was possible to fly *to* the beacon at a rather high speed of 6 nm/s . With a higher speed (at the dashed line) tracking was lost and a search cycle takes over until the correct range was found again 12 sec. later.
But flying *from* the beacon was only possible at 1 nm/s without loosing lock.
When the range is constant for a while, a higher speed of 2 nm/s was possible.

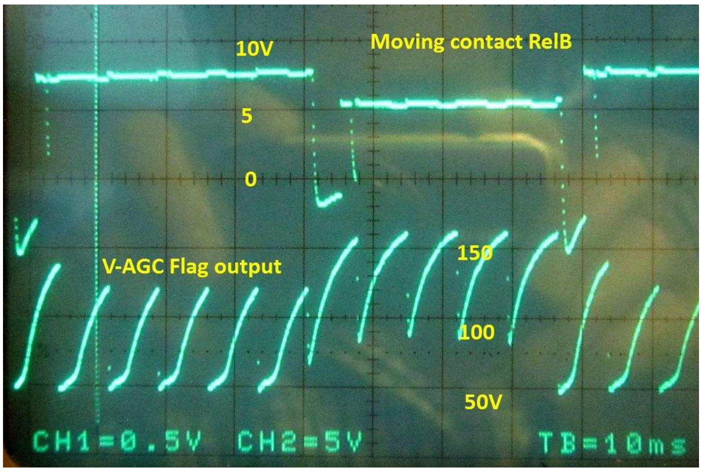


Tracking 2
Some more tests. Tracking was lost at the first vertical line, so a search cycle takes over until the correct range was found again 12 sec later.

Heading circuit

The secondary of T5 produces pulses, proportional with the strenght of the station where the range circuit was locked to. A typical amplitude is 15V peak. The semiconductor diode prevents ringing.
Diode V11b is the (fast) peak-hold function that drives the AGC circuit.
Diode V12b is the (slower) peak-hold function that drives the heading circuit. Its hold function is either the upper or the lower 0.1uF capacitor, depending on the actual aerial lobe. The actual lobe is a relay contact, either in the antenna lobe switch, or by Relay E which toggles in synchronism with the babs lobe switching.
The voltage difference Va-Vb drives the heading meter via two cathode followers.





The upper trace in this recording is the voltage Vx in the diagram shown above. You see alternating the voltages Va and Vb here, and during the change-over time of the lobe-switching relay the voltage Vg which -amplified by V11a - controls the gain of the IF amplifier.

The anode voltage of V11a is on the lower trace.

Automatic Gain Control

The AGC is based on the average value of the *selected* received pulse, not on all other received pulses resulting from interrogation by other aircraft. To prevent the range tracking jitter from entering the AGC circuit, both the reply pulse and the strobe pulse for the AGC gate are made wider.
The automatic AGC can be switched-off on the older control panels, in which case a manual gain setting could be set..

ID tone

Every few minutes, an Eureka or BABS type beacon transmits its ID as a two-letter morse code by widening the response pulse from 5 to 35us *during* the dots or dashes. This is detected in the Rebecca strobe unit using the D strobe at 30us after the main strobe pulse. If a pulse is still recieved there for 5 successive cycles, then a collpitts oscilator produces a 1kHz, 2Vrms signal at the ID-tone output during the dots and dashes. Typical load on the tone output is 100Ω

Random pulses can activate the ID oscillator as well, so the ID-tone could be switched-off on the control panel when not stricktly needed.

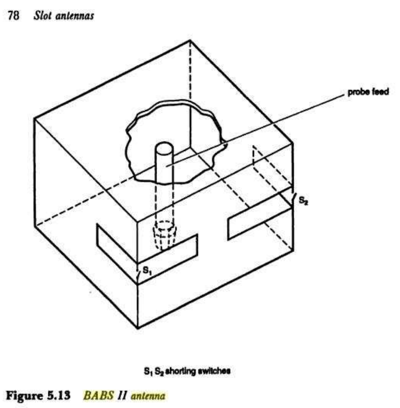
Aerials

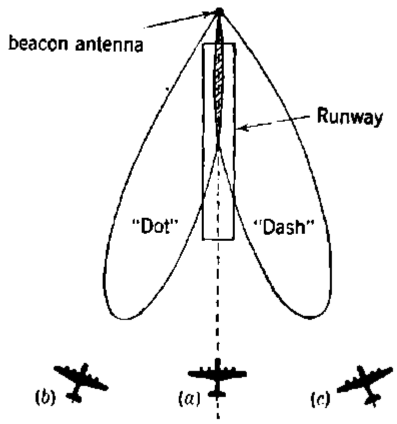
There is only one transmitting aerial, a half-wave stub in the middle of the bottom of the fuselage.
Two homing aerials are at each side of the nose. A fourth, omni-directional receiving aerial is of the same type as the transmitting aerial, placed under the tail section of the fuselage.

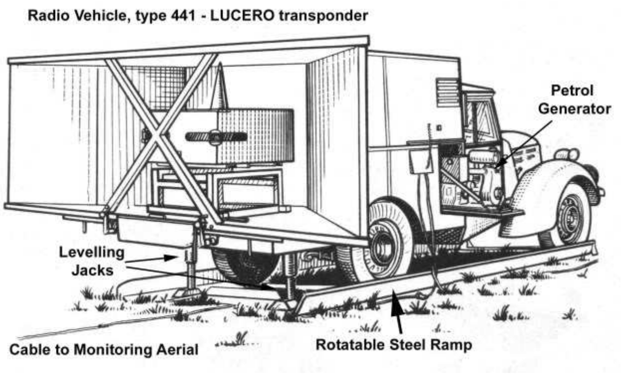
The beacon signal is received by two aerials, one on each side of the cockpit. A vibrator type relay (Type 273) switches between these aerials 15 times per second. The relay has RF contacts, that are also used to connect the AGC signal alternating to the left or right terminal of the Heading indicator. If the signal from the left antenna was stronger, then the heading indicator turns to left, and the pilot should make a left turn to fly to the beacon.

BABS (Blind Approach Beacon System)

These beacons are placed at the far end of the runway, and retransmit a received pulse on a different frequency just like a Eureka beacon does. However, this beacon has a special antenna that switches the main lobe 15 times per second between just left or just right of the runway. When left, the response pulses are 5us, when right they are 12.5 us wide. The rebecca set uses an omni directional receiving aerial instead of the alternating homing aerials.



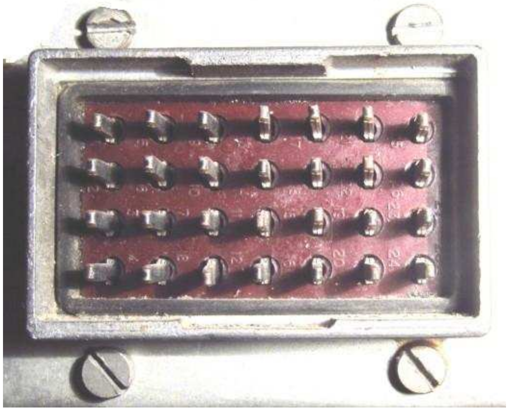




The Babs ground antenna is a metal box around a central antenna with two switched slots to alternate the main lobe between left and right of the runway. This box is placed in a corner reflector.
The mobile beacon was placed in a van at the end of the runway.

BABS circuit in Rebecca Mk 8

In BABS mode, a third receiving antenna is used, and the feedback contact from the normal antenna switch is replaced by relay E contact which position depends on whether short or long pulses are received. The short/long pulse detection is done in V15-V16-V17. The flipflop V16-V17 is set at each pulse received in the strobe gate. If the pulse is still there 10us later, then the flipflop is reset.
Rebecca Mk7 has no babs circuits (V15,V16,V17, RelB,RelE and associated components)



Connector

Both the strobe unit and the main chassis of the T.R.8193 have the same rectangular, 28-pole PYE connector, also made by Magnetic Devices Ltd.

pin	on main unit	on strobe unit
1	gnd	gnd
2	-150 V	-150 V
3	Tx pulse	Tx pulse `TRIG`
4	20 nm range	Rx signal `SIG `
5	Strobe release	Strobe release button to -150V
6	BABS mode	BABS mode (Relay B)
7	Heading meter +	Heading meter
8	Heading meter -	Heading meter
9	Range meter +	Range meter
10	Aerial switch L	Aerial switch left position
11	Aerial switch R	Aerial switch right position
12	Aerial switch return	Aerial switch return
13	ID tone output	ID tone output (2V, 1kHz into >100Ω)
14	OFF flag	AGC voltage to OFF flag
15	Rx signal	20 nm range (Relay A)
16	+ 300V to OFF flag	+300 V
17	AGC link to 18	heaters internal (12.6V)
18	AGC link to 17	AGC (-1 ... -4V)
19	Rx tuning	+25V for heaters
20	Tx tuning	+27 V heaters & relays
21	Range zero input	Range zero input
22	Range zero (20nm)	Range zero (20nm)
23	Range meter return	Range meter return
24	Range zero (200nm)	Range zero (200nm)
25	n/c	+85V
26	Range zero (BAT/BAH)	Range zero (BABS)
27	+28V dynamotor	heaters internal (19V)
28	+28V heaters and relays	Front panel -yellow coax plug

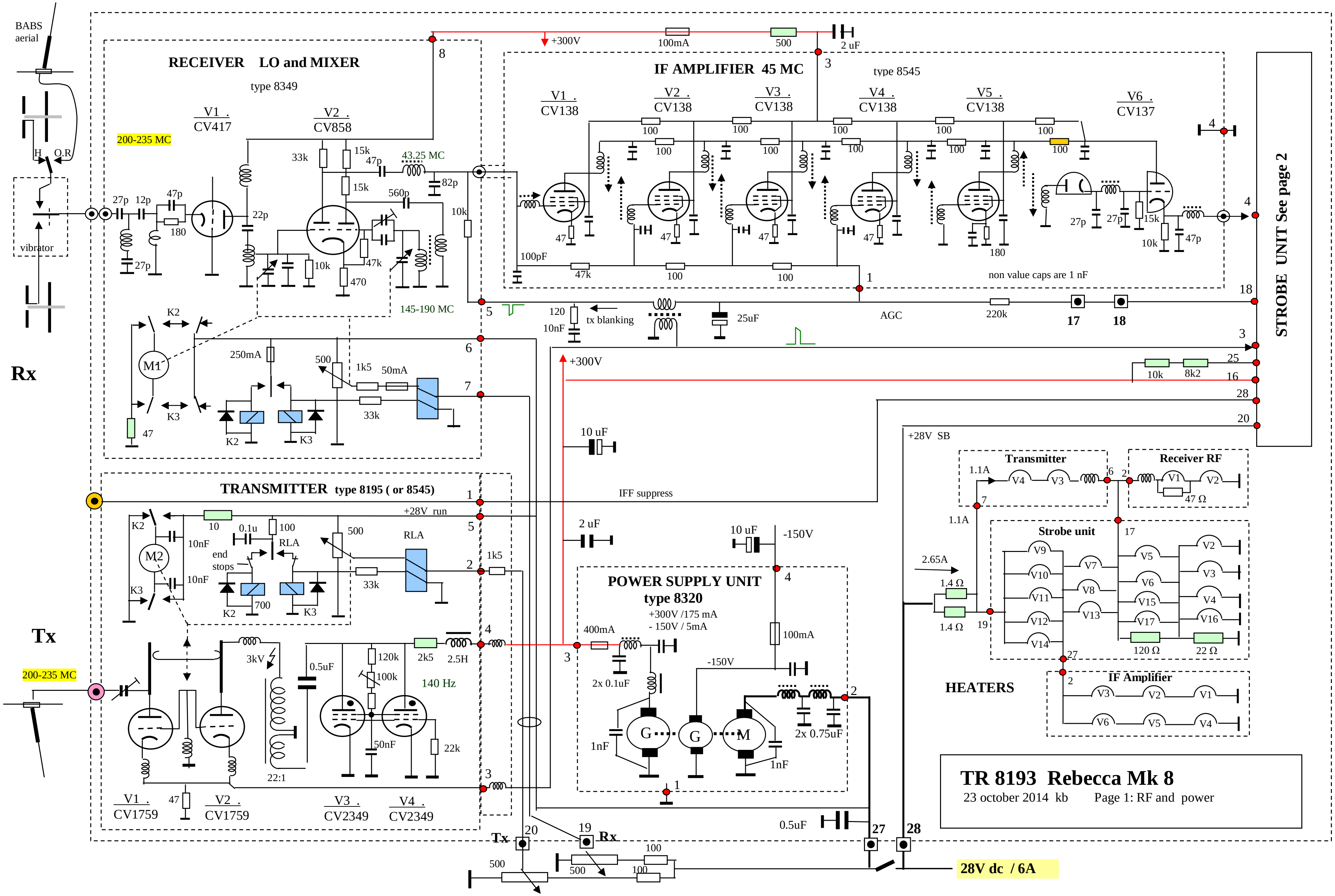
The remote control cable can be connected to the stand alone strobe unit with modifications to 9 pins :

- Swap 15 and 4,
- apply -150V to 2 , +300V to 16 and +25V to 19 and 20 (common to 1) from external supplies;
- and add two resistors: 18k /3W from 25 to 16 for the +85V supply, and 10Ω/ 4W from 17 to 27 for stand alone operation of the heaters in the strobe unit.

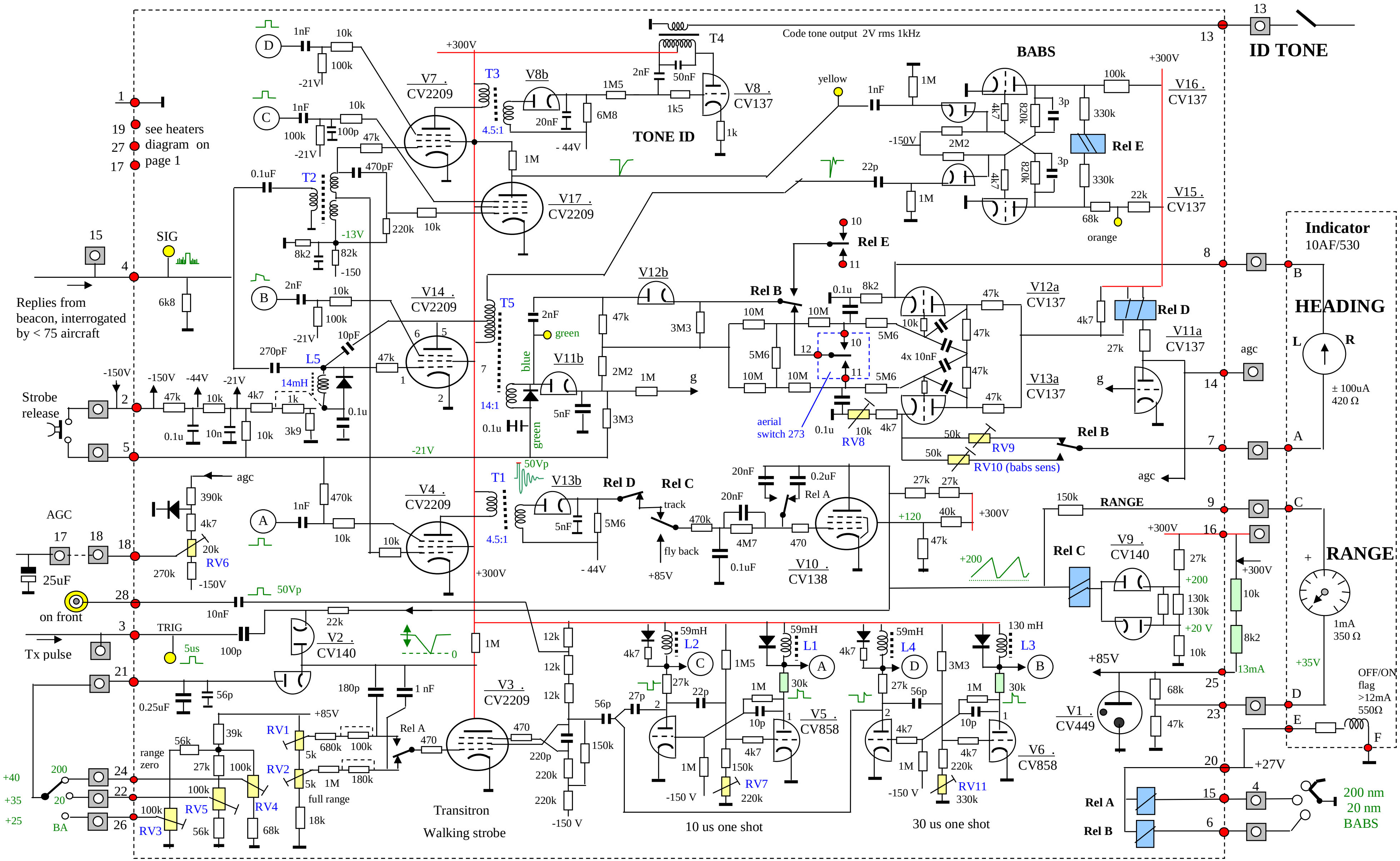
Valve list

		function, equivalents	filament current	
Receiver, RF				
V1	CV417	grounded grid triode,EC91	0.3A	
V2	CV858	6J6 mixer/ local osc.	0.45A	total 0.45A @ 12.6 V
Receiver, IF				
V1	CV138	IF stage, CV4014	0.3A	
V2	CV138	IF stage, CV4014	0.3A	
V3	CV138	IF stage, CV4014	0.3A	
V4	CV138	IF stage, CV4014	0.3A	
V5	CV138	IF stage, CV4014	0.3A	
V6	CV137	detector EAC91	0.3A	total 0.6 A @ 18.9 V
Transmitter				
V1	CV1759	RF triode	1.1A	
V2	CV1759	RF triode	1.1A	
V3	CV2349	thyratron	0	
V4	CV2349	thyratron	0	total 1.1 A @ 12.6 V
Strobe module				
V1	CV449	85A2	0	
V2	CV140	dual diode	0.3A	
V3	CV2209		0.35	
V4	CV2209		0.35	
V5	CV858	6J6 10us one shot	0.45	
V6	CV858	6J6 30us one shot	0.45	
V7	CV2209		0.35	
V8	CV137	EAC91	0.3	
V9	CV140	EAA91	0.3	
V10	CV138	EF91, CV4014	0.3	
V11	CV137	EAC91, CV4059	0.3	
V12	CV137	EAC91	0.3	
V13	CV137	EAC91	0.3	
V14	CV2209		0.35	
V15	CV137	EAC91	0.3	
V16	CV137	EAC91	0.3	
V17	CV2209		0.35	total see ckt diagram
	In total 29 tubes (valves)			

Later versions have:
CV137 replaced by CV4059 (EAC91)
CV138 replaced by CV4014 (EF91)
CV140 replaced by CV4025 (EAA91)
CV2209 can be replaced by 6F33 or CV4064



BABS aerial
vibrator
Rx
Tx
200-235 MC
RECEIVER LO and MIXER
type 8349
V1 CV417
V2 CV858
43.25 MC
145-190 MC
IF AMPLIFIER 45 MC
type 8545
V1 CV138
V2 CV138
V3 CV138
V4 CV138
V5 CV138
V6 CV137
non value caps are 1 nF
+300V
100mA
500
2 uF
tx blanking
25uF
AGC
220k
STROBE UNIT See page 2
+28V SB
TRANSMITTER type 8195 (or 8545)
+28V run
RLA
end stops
IFF suppress
3kV
22:1
140 Hz
V1 CV1759
V2 CV1759
V3 CV2349
V4 CV2349
POWER SUPPLY UNIT
type 8320
+300V /175 mA
- 150V / 5mA
-150V
400mA
2x 0.1uF
2x 0.75uF
HEATERS
Transmitter
Receiver RF
Strobe unit
IF Amplifier
28V dc / 6A
TR 8193 Rebecca Mk 8
23 october 2014 kb
Page 1: RF and power



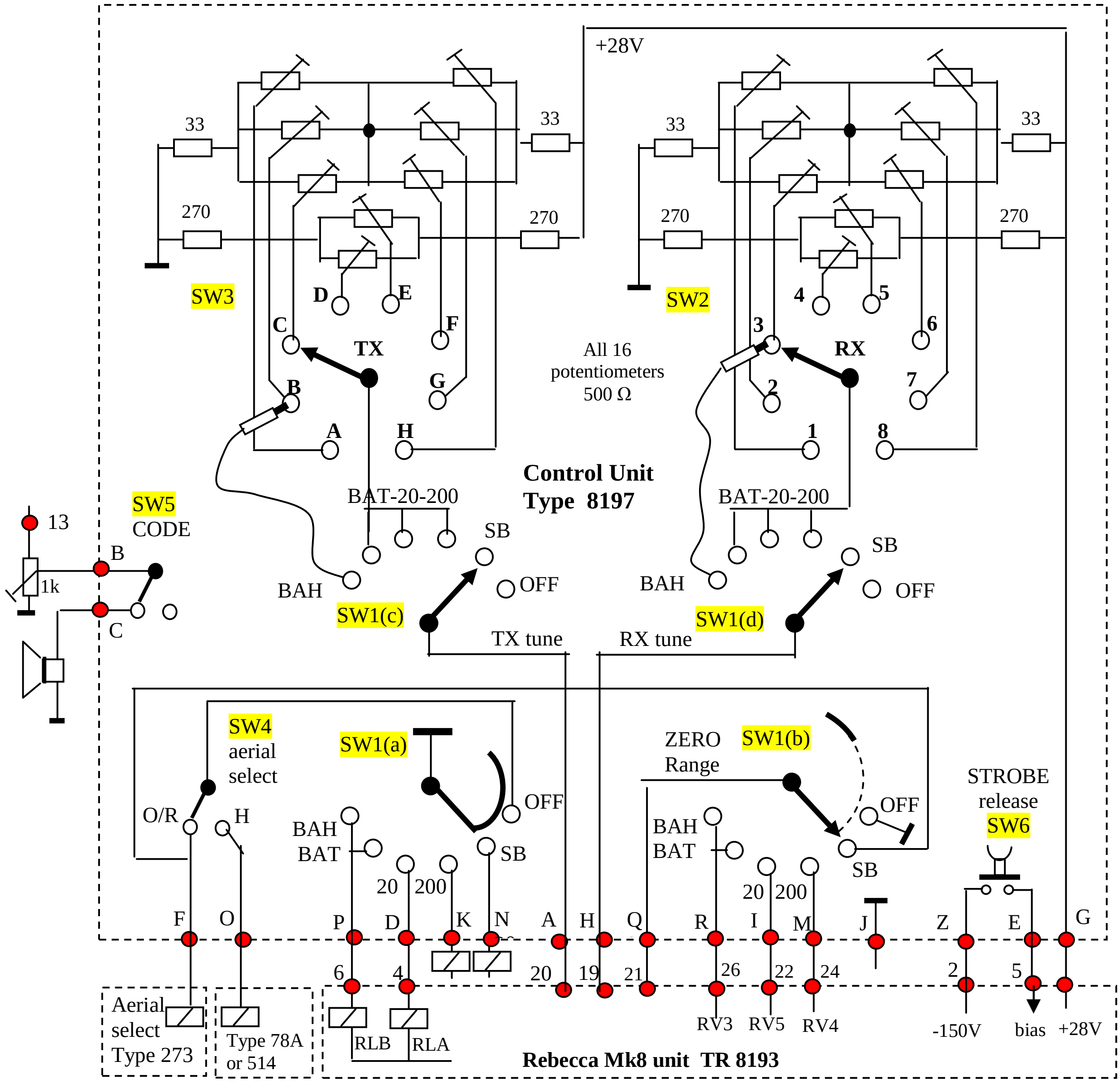
Relays C, D and E are bi-stable relays with
2 coils, each 1500 ohm, that can be used in series.
Relays A and B have 700 ohm coil.
All diodes CV 448

Numbers on the main TR8193 connector ( ) are the same as on this strobe unit ( ) unless otherwise stated.

testpoint

Rebecca Mk 8 Strobe Unit (SU)
23 jan 2017 kb

Control unit Type 8197 for the Rebecca Mk8



The control panel has 6 switches:

SW1 selects the operate mode :

OFF-Standby- 200nm - 20 nm - Beam Approach Tune-Beam Approach Home.

SW2 selects one of eight receive frequencies

SW3 selects one of eight transmit frequencies

SW4 selects the omnirange (O/H) or home (H) aerials

SW5 switches the morse code from the beacon to the pilot's headset

SW6 Pushbutton to release a strobe cycle

Range and Heading Indicator 10AF/530 or 10AF/ 1561

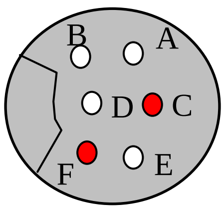
A red pin marks the positive side.

The Rebecca Mk7 and Mk8 systems have a combined Range and Heading meter. Inside are classical moving coil instruments, a few resistors, and a magnetic actuator for the ON flag.
Both movements are fully balanced, and have high damping.

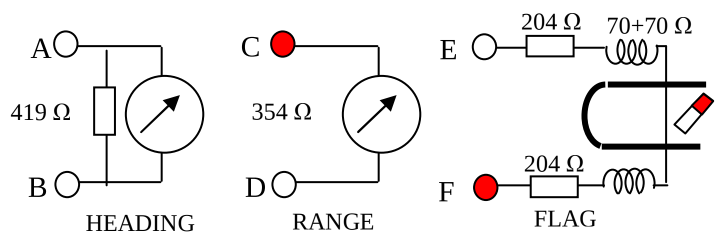
The original 10AF/530 has an 1mA range meter, a +/- 100uA heading meter, and an "ON" flag which can cover the static "OFF" text below it.

The improved type 10AF/1561 is identical, except that the flag has a third position, indicating "X10"

Both indicator types have a single, 6-way connector.



A-B	heading indicator	419 Ω	+150 / -100 uA fsd
C-D	range meter	354 Ω	1mA fsd
E-F	"ON" flag	548 Ω	12mA "ON"

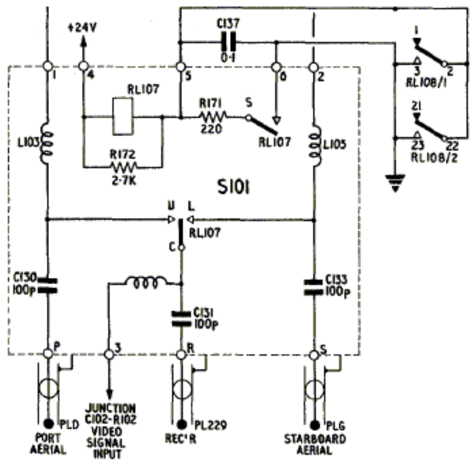


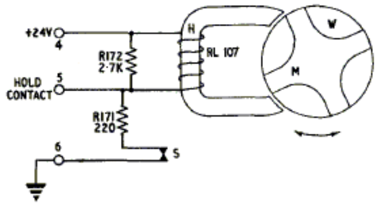
The Heading moving coil is shunted with resistor to get 100uA in either direction.
The Range meter has a magnetic calibration to indicate exactly 20 at 1mA.
The ON flag needs at least 12mA (7V) to show "ON". This flag only indicates that the Rebecca set is turned on, not that the system is locked to a beacon.
Maybe there was an external, very sensitive relay on the AGC output to drive the ON flag - only when a beacon is responding.

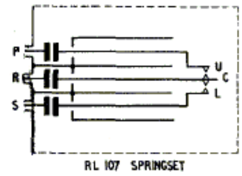
This indicator was made by
Sangamo Weston Ltd, Enfield Middx, England
Murphy Radio Ltd Type M:165 APP. No W.R.517
Weight 1.25 Lb MTG. - ANTI VIB.

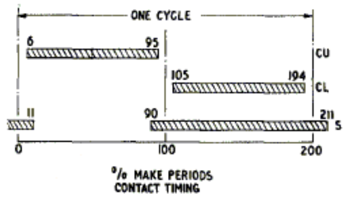
Aerial switching

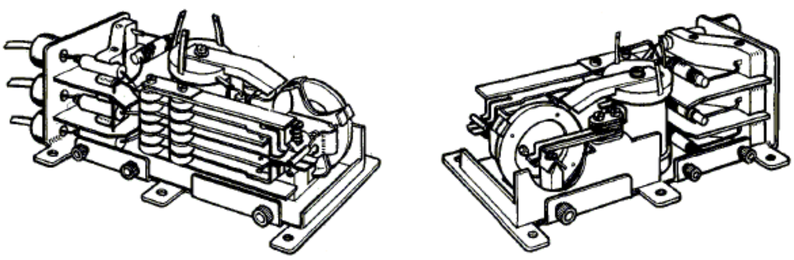
The vibrator Type 273 was used in all Rebecca systems from Mk4 to Mk8 to switch the port or strarboard aerial to the receiver input. . It functions like a vibrator, with speed stabilized by an oscillating disc at. 22 - 23 c/s. With a typical pulse repetition frequency (prf) of 170 c/s, each cycle has 4 pulses from the port aerial, and 4 from the starboard aerial











ARL5610 –TR.3624–switch unit 273

There is only a *single* switch-over contact to switch *both* the aerials *and* the feed back to the heading circuit in the strobe unit to get a perfect synchronization.
In BAT or BAH modes, the vibrator is locked in the "port" position by earthing pin 5.

Technical data: The coil resistance is 450 Ω, so the continuous current is 60mA at 27V. (1.6W)
When oscillating, the average coil current is 25mA, (40mA pk).
Impedance of the shielded RF contacts is 50 ohms, impedance mismatch varies from 1.2:1 to 1.4 to 1 in the frequency range 174 - 236 Mc.   Cross-talk is less than 5%

The omnirange - home switch is the Type 78A , shown here. It is a coax relay.

Later versions had the type 514 coax relay.

Adjustments

All adjustments are on the strobe unit

RV1 thru RV5 calibrate the range meter.
RV8 thru RV10 calibrate the heading meter

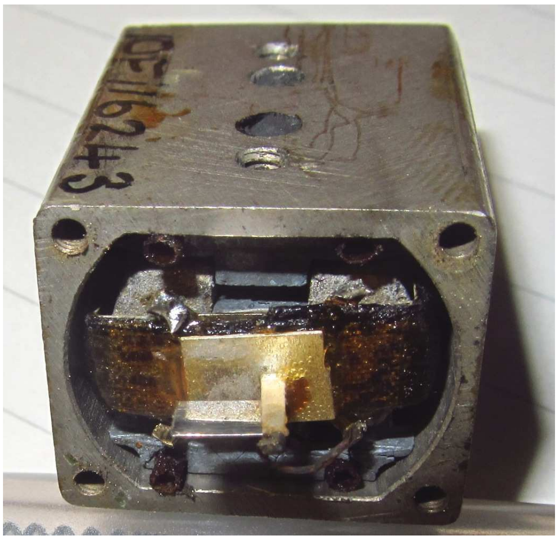
adj	Function	Setting	Potmeter
RV1	full range 20nm and ba		5k
RV2	full range 200nm		5k
RV3	zero range ba		100k
RV4	zero range 200nm		100k
RV5	zero range 20nm		100k
RV6	AGC level		20k
RV7	10us delay (BA dash)		220k
RV8	Zero heading		10k
RV9	full scale heading (non BA)	30k	50k
RV10	full scale heading (BA)	30k	50k
RV11	30us delay (Tone code)		330k

Special components in the TR 8193 set.
A : Relays

The Rebecca Mk7/8, from 1956 had some extremely sensitive relays, with a sub-mW coil sensitivity . These relays are sensitive for vibration and shock and it is impressive that they were used in aircraft at that time.

A1. Moving coil relay (2-off)

Each tuning motor is controlled via a forward and a reverse relay, which are controlled by a *moving coil* relay. The moving coil is like a mA meter, placed around a permanent magnet. A small vane is attached which is the moving contact. To handle the low contact pressure, both the vane and the contacts are made of 80% platinum, 20% iridium.



The coil has two separate windings of 350 Ω each.
If the current in both coils in series in either direction is:

- < 0.12mA Both contacts are guaranteed open
- > 0.4mA One contact is closed;
- < 8mA does not damage the coil

Sensitivity is 0.4mA x 0.28V = 0.1 mW !

UK Manufacturers in 1954 :

Elliott	(model R350B)
Sangamo Weston Ltd	(type S.115)
Electro Methods Ltd, Stevenage	(type 416)

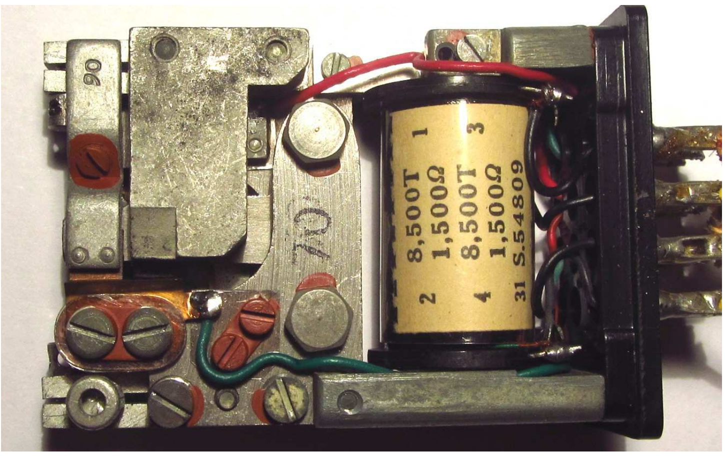
A defect moving coil relay can be replaced with a 4-transistor circuit although the dead band is larger.

A2. Telephone relay (3-off)

This polarized relay was patented by R.E.H.Carpenter in 1947 (US2559399). Telephone mfg co, UK
The relay has two coils, each **1500 Ω**. When the current in both coils in series in either direction is:

- < 0.12 mA then the previous contact position is maintained
- > 0.12 mA then one contact is closed, depending on polarity.

Three of these polar relays are used in the RT 8193 (Rel C, D and E in the strobe unit).



The sensitivity of this relay is remarkable: 0.12mA x 0.4V with both coils in series is 0.05 mW !!

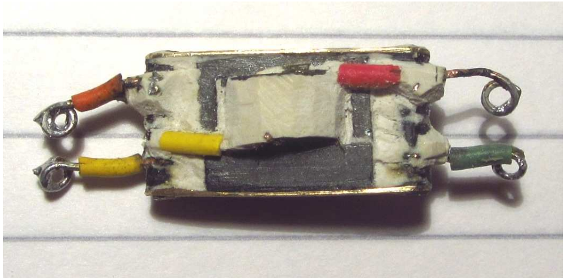
This is a record I think.

Problem: the magnets attract iron particles which shorted the moving contact to the case in one of the relays.

B : Murphy transformers

The TR 8193 has 5 small reactors, and 6 transformers. All are wound on a tiny E-I ferrite core, and potted in a round mould.   The transformers **T1, T3 and T5** have a long primary on 300V, and a short secondary, biased on -44V. All are wound with very thin wire without additional insulation.

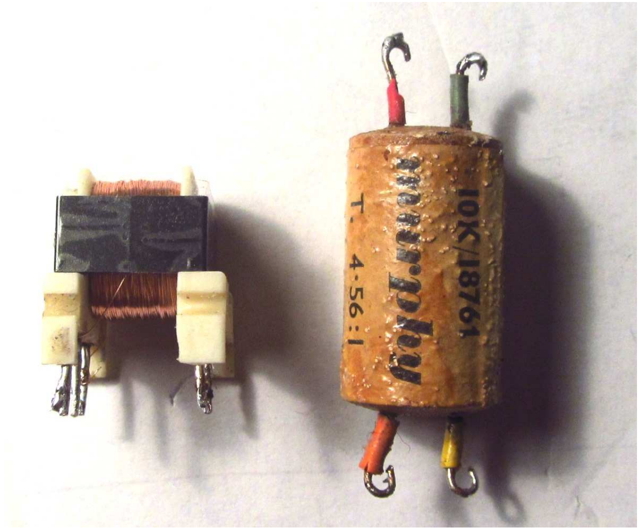
After 50 years, either the primary or the secondary was interrupted, but not fully- the resistance went from a few hundred ohms to several kOhm.



So I decided to remake the transformer on a EE core with 900 primary turns and 200 secondary turns.
This worked perfectly. The new transformer fitted quite well in the available space.

The ringing of the 100mH primary with the internal and external capacitances was 80kHz, not far from the original 100 kHz.

It is nearly impossible to re-wind the original transformer because the ferrite core is brittle, and glued inside the bobbin.



C : TCC Visconol-X capacitors

These metallized paper capacitors, impregnated in PCB oil, are used in the strobe unit as timing capacitors.   After 50 years, they are very leaky, with shunt resistances of a few MOhm. Nearly all had to be replaced by modern foil capacitors.