1. Summary

Gambrell Bros. & Co. Ltd. London 4x decade resistance box 1Ω to 9,999Ω.
S/N 722

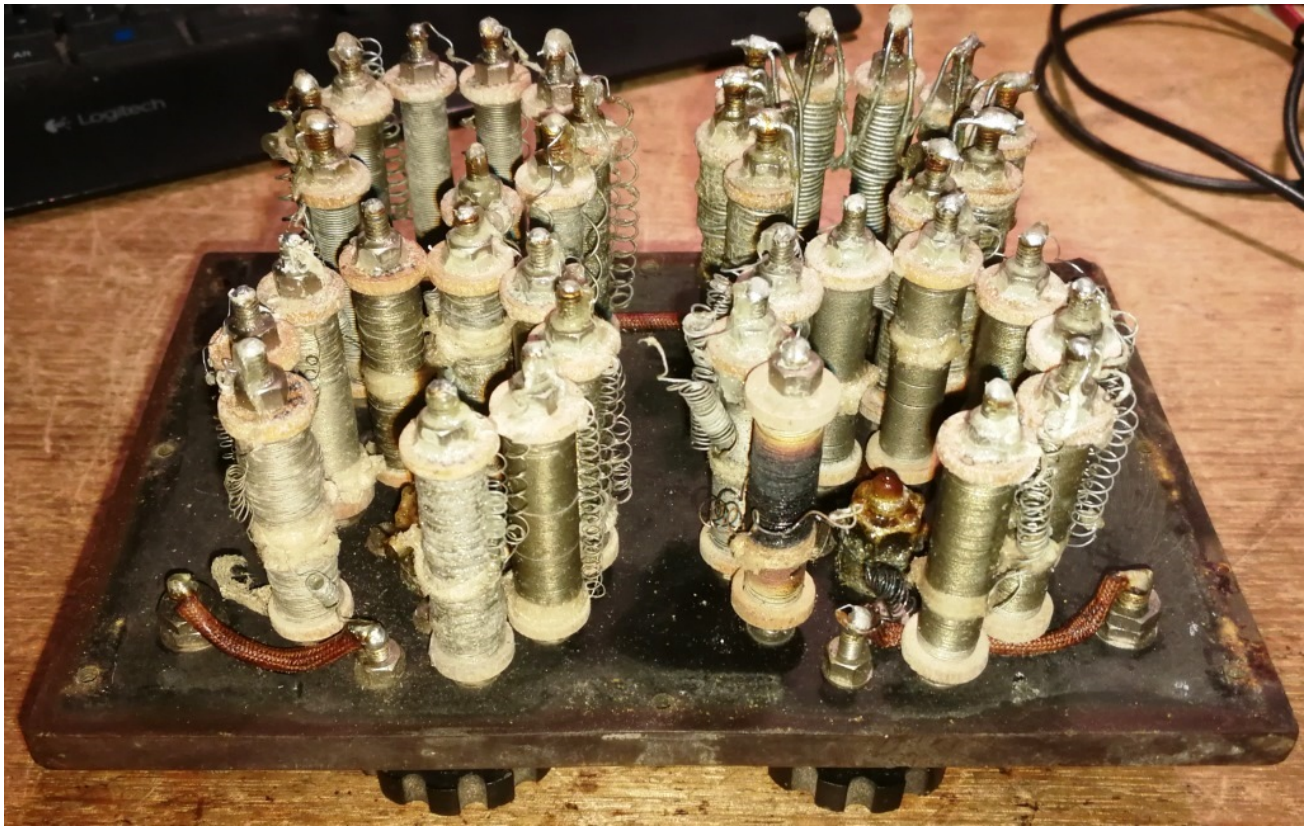
Bakelite front panel, with metal enclosure and 2 side mounting tabs. 4 rotary switches with three contacts between each rotary shaft and a commoning ring and each resistor element pad.

(Likely) Manganin coil resistor elements. Wooden coil bobbins on (likely) brass mounting bolts that act as rotary switch contact pads on one end, and termination solder joint for the element wires on the other threaded end. Coils wound as a bifilar winding.

Poor external and internal condition. Missing cracked corner of top bakelite. Burnt 100Ω element. Poor resistance contacts on rotary switches. 3 resistor elements with slightly high levels (70Ω; 5kΩ; 9kΩ;, and 1 with slightly low level (5Ω). I element with broken connection wire (1kΩ).

Gambrell Bros exhibited in the late 1920's and early 1930's in England.
Wireless Engineer magazine 1931 extract:

GAMBRELL BROS. had a good display of laboratory and testing equipment. A useful type of condenser bridge was shown, for the rapid comparison of ganged variable condensers, giving the difference of capacity throughout the scale and also the deviation from normal at minimum and maximum settings. Standard fixed condensers, a new standard variable condenser and the McLachlan modulated C.W. wavemeter were also on view. Bridge components and accessories included a valve source of 300–2,000 c/s., balanced and screened bridge transformers and screened boxes of non-reactive resistances. Other laboratory items included a range of very sensitive galvanometers, standard Wheatstone bridges, potentiometers, etc.



2. Restoration

The mounting bolt lower nuts were checked for tightness. One was quite loose.

The high tolerance resistor elements were stress relieved by loosening their top mounting nut. Subsequent tightening/loosening brought the tolerance back to nominal a bit, so thermal cycling

may be a benefit. A parallel high resistance was solder across the tops of the bolts to bring the resistance element back into tolerance.

The burnt 100Ω element bobbin was removed and the retaining wire wrapping removed to allow the outer layer of burnt wire to be free, but with the next layer of wire held so as not to uncoil. The burnt layer wire had its carbonised insulation dusted off and the un-tensioned layer was then fixed in place with an archive pva glue. Insulation tape was wrapped around part of the length and the final turns were separated and moved down to be over the insulation tape until no turns were touching (slightly lowering the net resistance) or shorting (due to the bifilar wound configuration). The loose coil turns were fixed in place and the element re-mounted and reconnected.

The broken connection wire on the one of the elements was repaired as an in-line soldered joint.

The resistor element mounting bolt contact pads had the top oxide layer sanded down using 1000 grit paper until rotary contact operation was generally ok (some caution is needed as contact resistance variation can occur). Each pad clearly shows three parallel wear tracks. Contact cleaner lubricant was then used.

7 resistor elements were trimmed using parallel resistors, and one element trimmed with a series resistor. 28 resistor elements were within 0.1% tolerance.

Pass through resistance was somewhat reduced by soldering in parallel cables.

3. Measurements

HP3497A with Kelvin connection resistance measurements at 1mA below (consistent with initial Keithley 197 measurements). Still to do a +10C rise test for TCR. All settings above 4Ω were withing 0.1% tolerance, and most were within 0.05%.

Phase shift at 60kHz is about 10deg inductive for 1Ω elements.
Phase shift at 60kHz is about 2-3deg inductive for 10 Ω elements.
Phase shift at 60kHz is about -0.5deg capacitive for 100 Ω elements.
Phase shift at 60kHz is about -16deg capacitive for 1k Ω elements, and needs about 560uH series to reduce to near 0 deg.
Impedance phase shift for 1Ω and 10Ω elements was reduced to less than 1deg at 90kHz using shunt capacitors soldered across tops.

Setting	Ohm	Note	Tolerance	Comment
	0.000			Shorted kelvin leads
0	0.007			minimised - variance due to knobs
1	1.001		0.10%	//100Ω//300nF
2	2.003		0.15%	//200nF
3	3.004		0.13%	//250nF
4	4.007		0.17%	//200nF
5	5.003		0.06%	//200nF
6	5.999		-0.02%	//200nF
7	6.994		-0.09%	//200nF
8	7.994		-0.08%	//100nF
9	8.999		-0.01%	//100nF

10	9.992		-0.08%	//(2k7+330)//10nF
20	20.000		0.00%	//4k7Ω//10nF
30	30.001		0.00%	//10nF
40	39.961		-0.10%	//10nF
50	49.968		-0.06%	//10nF
60	59.981		-0.03%	//10nF
70	69.993		-0.01%	//2k2Ω//10nF
80	79.998		0.00%	//10nF
90	90.018		0.02%	//6.8nF
100	99.997	overload repair	0.00%	+0.3Ω
200	200.04		0.02%	
300	300.11		0.04%	
400	400.18		0.05%	
500	500.21		0.04%	
600	600.22		0.04%	
700	700.25		0.04%	
800	800.29		0.04%	
900	900.32		0.04%	
1000	999.84	fixed broken wire	-0.02%	
2000	1999.9		0.00%	
3000	3000.9		0.03%	//2M2//330k
4000	4000.7		0.02%	
5000	4998.0	stress issue	-0.04%	//27k//2M7
6000	5998.2		-0.03%	
7000	6998.6		-0.02%	
8000	7998.7		-0.02%	
9000	8995.0	stress issue	-0.06%	fluctuates //20kΩ
10	9.995		-0.05%	HOLCO H8 Y 0.05% reference

4. Operation

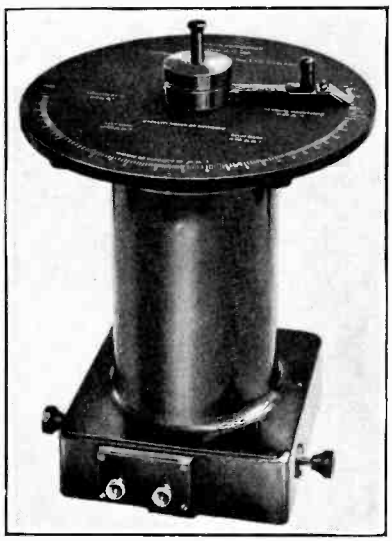
Take care to confirm that rotary contact resistance is nominal for a particular setting. Forcing the knob down, or rocking it, can slightly modify the reading.

Take care in removing front panel from enclosure as metal cut-outs can easily catch a coil end.

shown by the WESTINGHOUSE Co., including instruments of this type made by several firms, *e.g.*, Everett Edgcumbe, Ernest Turner and the Cambridge Instrument Co., using Westinghouse Rectifiers.

Laboratory Equipment.

Amongst new items in this category the CAMBRIDGE INST. Co. showed a six-element Duddell Oscillograph, generally similar in principle to their well-known three-element instrument, but with the optical and illuminating arrangements modified to



Cambridge Moullin condenser.

work the six vibrators. The Moullin variable condenser, described in our last issue, was another new product. The Campbell Frequency Meter was shown this year in a new long-range form up to 12 kc/s., and was demonstrated in operation with a beat-frequency generator designed by Dr. W. W. Dye.

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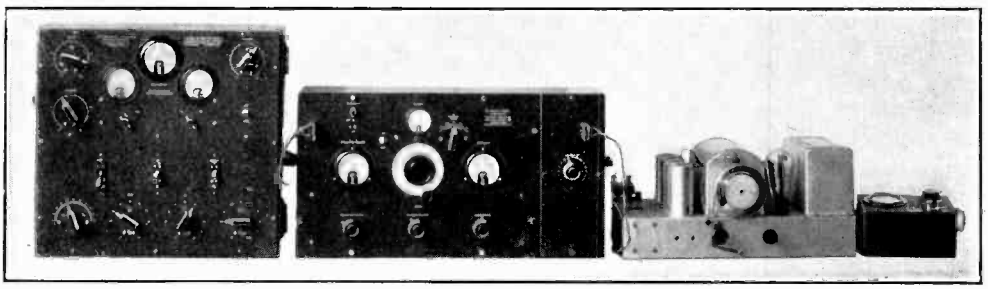
At the stand of EVERSHED, VIGNOLES, LTD., a new item of interest was an insulation and capacity meter for testing condensers of wireless and telephone type, reading up to 4,000 meghoms and 11.5 microfarads.

In addition to the measuring instruments already mentioned, ELLIOTT BROS. showed new forms of vibrating telegraph relay and a new relay test-set, while CROMPTON PARKINSON, LTD., showed their standard potentiometer equipment, Wheatstone bridges, etc.

Amongst apparatus of laboratory interest, the DUBILIER CONDENSER Co., LTD., included adjustable standard condensers and wavemeters of several patterns.

H. W. SULLIVAN, LTD., showed new Short Wave Precision Sub-standard Wavemeters of 10 to 100 M., and a new type of heterodyne wavemeter using a novel method of discrimination between fundamental and harmonic heterodyning. Other new products were a general purposes Variable Air-Condenser, a Low Tension Schering Bridge for power-factor and permittivity tests and a portable capacity test set of wide range (0.00005 to 1 μF. on a single scale). Other items of laboratory gear included the Sullivan Griffiths' variable air condenser on the series-gap principle, the Sullivan Griffiths' Generating Wavemeter, the Standard Miltivibrator Wavemeter and accessories, and the Lucas-Sullivan Quartz Crystal Standard, and the complete Frequency-standardising apparatus using this scheme.

Newcomers to the Exhibition were CLAUDE LYONS, LTD., who are well-known as British agents for several American makers of high repute. Chief amongst their exhibits were products of the General Radio Co., of Cambridge, Mass., who supply a very extensive range of apparatus for wireless test and measurement. One of the most important items



Receiver testing equipment (Claude Lyons, Ltd.).