Leeds & Northrup High Resistance Ayrton Shunt Model 2664 Does Double Duty as a 0.03% Resistive Reference Standard

By ©George Dowell K0FF

Back in the days of the Galvanometer (think of it as a single range sensitive microAmp meter) there was a need to measure currents higher than the Galvanometer's design allowed. Enter the external switched "Shunt Boxes".

Operation of the switch of switched shunt box of basic design could expose the sensitive Galvanometer to excessive currents, damaging it. William E. Ayrton invented a novel arrangement that provided safety to the meter by always having a shunt connected even during switching, as well as providing the meter a constant load to stabilize its dampening.

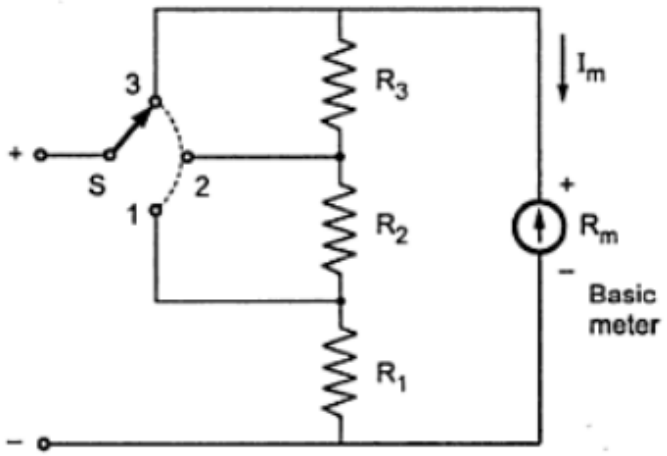


Fig. 1 Ammeter with Ayrton shunt

William Edward Ayrton (1847–1908) was a clever fellow who studied with the best pioneers in electrical measurements (e.g. Lord Kelvin) in the early years of what we now call "electronics". In collaboration with Professor John Perry (1850-1920) he invented the Ayrton-Perry winding, which is the basis for the non-inductive wire-wound resistor.

Ref: https://www.gracesguide.co.uk/William_Edward_Ayrton

This easy project makes use of the precision resistors inside the Cat. 2664 and relabeling he controls is all it takes.

To what end you may ask. Well at a minimum it's a fun way to obtain a near lab grade reference to use when testing your shop Ohm Meters. Not to mention use as a precision Voltage Divider. A set of precision resistors is but one leg of the Electrical Metrology or Electronic Measurements Home Lab. A very precise Voltage Reference is the next leg.

Fig.2- As found

Fig.3- Rear of front panel-switch, Leeds & Northrup 0.03% Wire Wound resistors, wiring and terminals

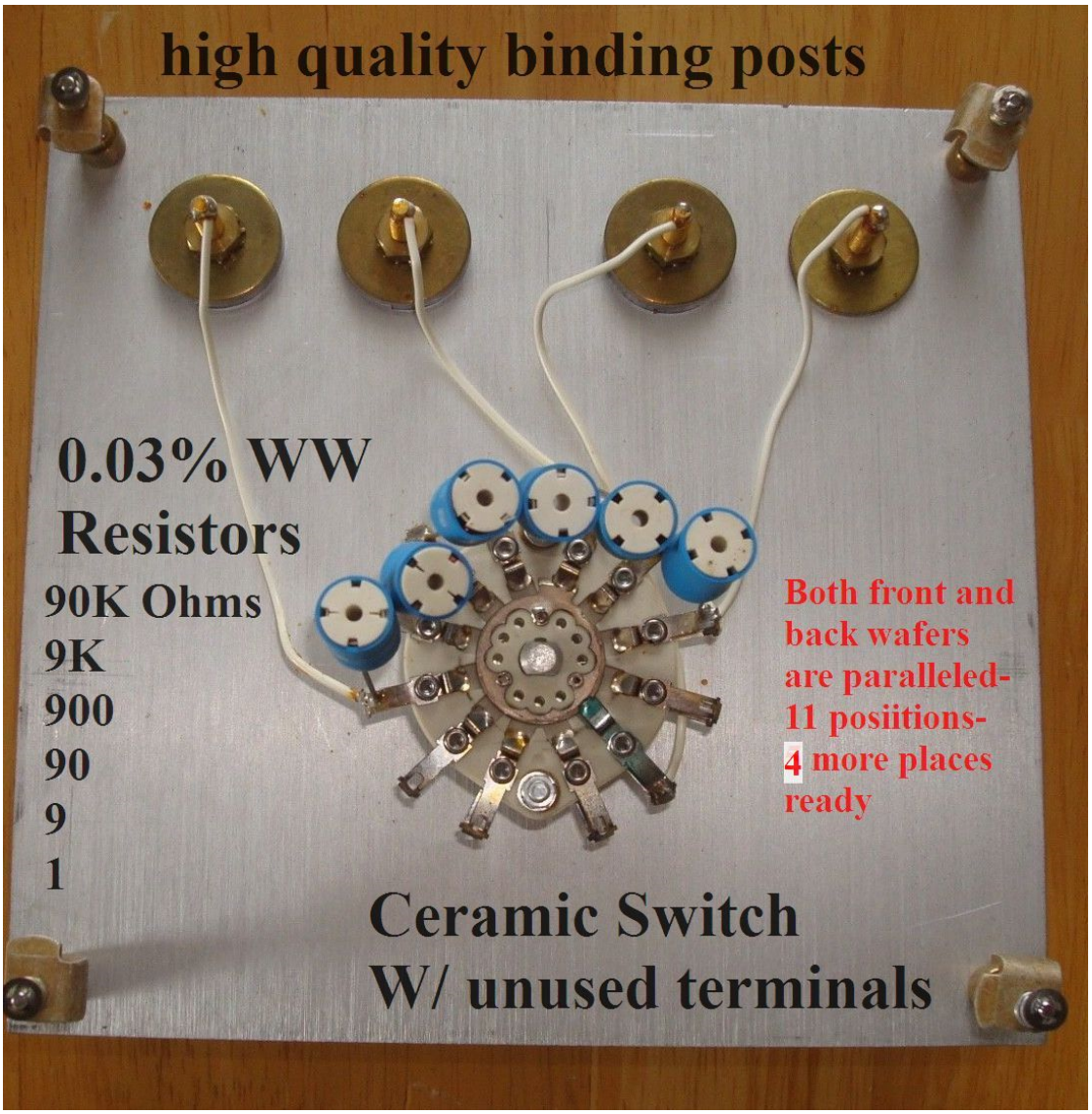


Fig.4- No changes need be done to the internal wiring at all.

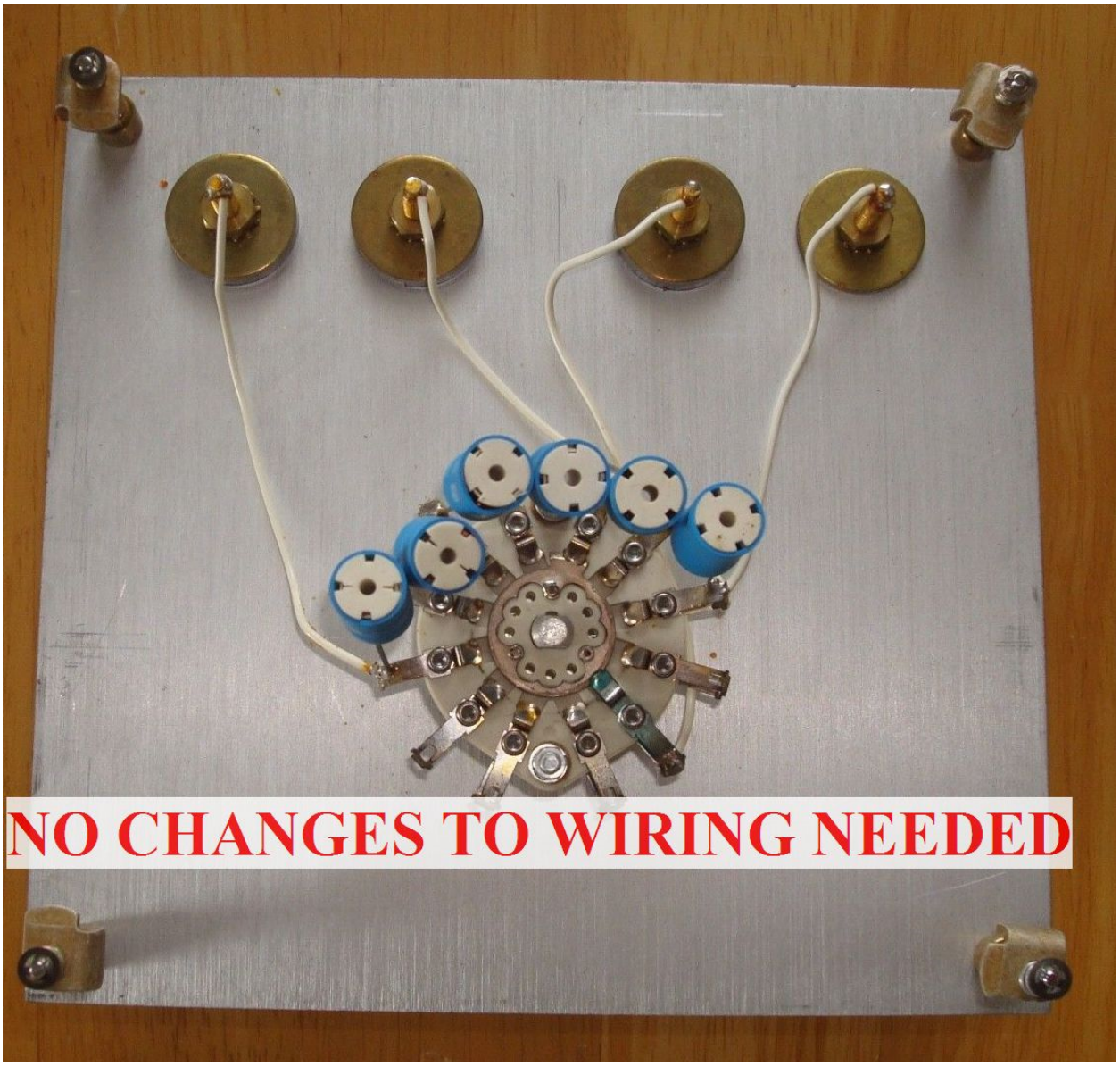


Fig.5-The only tools needed to relabel the repurposed functions and terminals.

Fig.6- Relabel knob positions to indicate the actual resistance present at the new R OUT terminals.

Fig.7- Relabel the original INPUT terminals as R HIGH and R LOW. These is the new Resistance Output terminals.

Fig.8-Representative schematic of the Leeds & Northrup Cat 2664 Ayrton Shunt Box

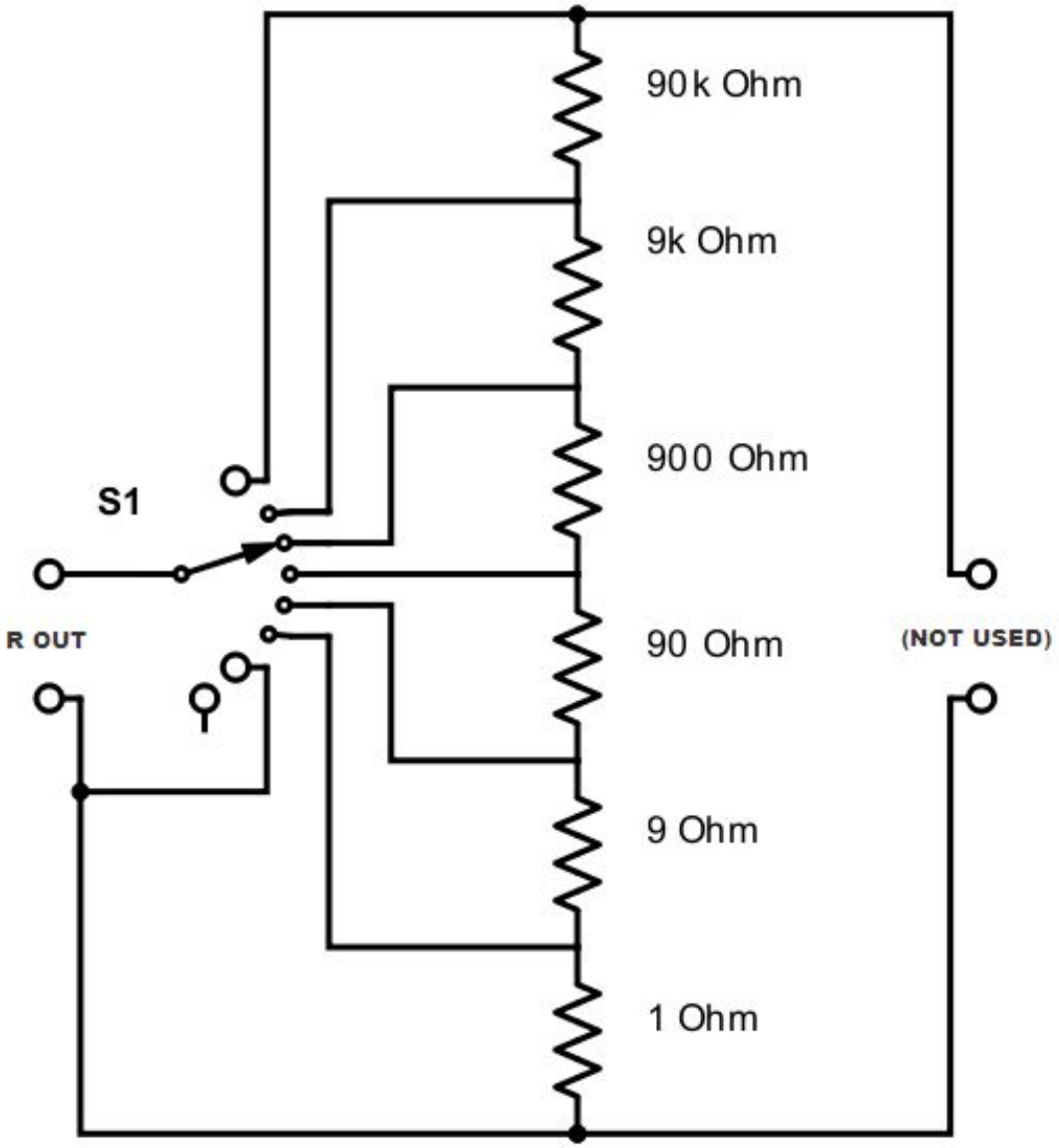


Fig.9- Direct measurement of the 1 Ohm resistor shows it a little low.

FIG.10- But add in the extra resistance of wiring and switch contacts, at the terminals it is perfect!

Fig.11- Direct measurement of the 9 Ohm resistor is also slightly low.

Fig.12- Again at the terminals, 9+1 = 10.

After the lowest resistances have corrected for wire and switch contact stray resistance, the rest are spot on.

Fig.13- 10+90 = 100 Ohms.

Fig.14- Add the 900 Ohms for 1000 Ohms

Fig.16- 10k Ohms total

Fig.18- And finally 100k Ohms. Not bad for a $20 eBay investment.

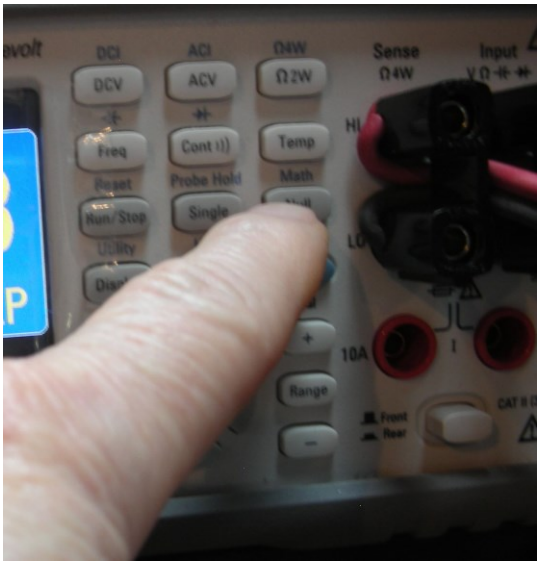
These instruments have retained this level of precision after maybe 50 or 55 years. Pretty amazing.

Appendix

Sequence of measuring then nulling (removing mathematically) the lead resistance from the meter to the resistor box. For accuracy in measurements, a 4 wire Kelvin hookup is used; each individual jaw of the test clips has its own insulated wire. Current (I) from the meter is sent down one pair of wires and the resistance is calculated by e meter as the product of the know current and the measured Voltage across the resistance is sent back on the other set of wires.

Short all the leads together

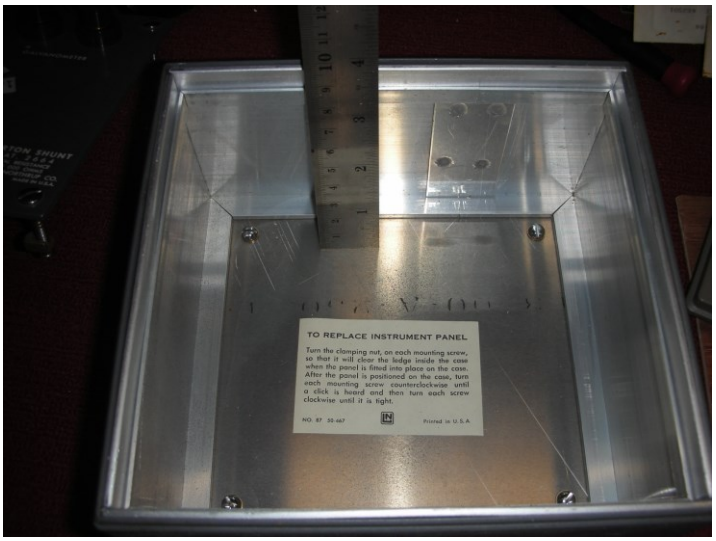
The meter measures the test lead resistance (each wire is 18 awg)



Push the NULL Button

and the lead resistance is nulled.

The massive housing that all the Leeds and Northrup “Boxes” come in.



Next time, hacking the Leeds & Northrup Cat. 4385 Low Resistance Shunt Box.

From this similar looking box we “borrow” 0.01 Ohm, 0.02, 0.05, 0.1, 0.2, 0.5. 1.0 and 2.0 Ohms

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