

INSTRUCTION MANUAL

DC - RESISTANCE BRIDGE
TYPE MB3

Contents:

page:

1.	Introduction and Specifications	1
2.	Operating Instructions	4
2.1.	Setting Up	4
2.1.1.	Earth Connection	4
2.1.2.	Cable Connection	4
2.1.3.	Zero Check	4
2.2.	Measurements	4
2.2.1.	Low Value Resistors	5
2.2.2.	High Value Resistors	5
2.2.3.	Filter Circuit	5
2.2.4.	Outputs	5
3.	Circuit Description	6
3.1.	Details of Circuit	6
3.2.	Power Supply	7
4.	Maintenance Instructions	8
4.1.	Meter Zero	8
4.2.	Standard Voltage Zero	8
4.3.	Detector and Measuring Voltage Zero	8
4.4.	Meter Deflection	9
4.5.	Ratio Adjustment	9
4.6.	High Value Input Current Adjustment	9
4.7.	Low Value Correction	9
4.8.	Critical Components	10

Introduction

The MB3 Resistance Bridge has been designed mainly for production applications like the control of trimming machines, sorting machines, final tests, etc.

The bridge has a built-in standard using high precision metal-film resistors with very low temperature coefficient. Readout is provided on a panel meter and an analog output is available as well for the control of auxiliary equipment.

Realizing that for the various applications different control signals are required the limit or classifying circuits have been separated from the basic bridge. Space is available for a plug-in unit containing the functions required and further to standard modules readily available special limit, timing, and interface modules can be used.

Danbridge offers to design modules to customers' specifications. Even the more complicated circuits can be built into the main frame so the need of using the well-known 'black boxes' does not exist.

Specifications

Bridge Circuit:

4-terminal Kelvin Contacts.

Resistance Range:

1 Ω to 211 M Ω .

1 Ω to 111 M Ω in 8 decade ranges plus additional switch for adding 100 M Ω .

Decade values are set by 3 decade dials.

Decade Ranges	Test Voltage
1 - 10 Ω	80 mV
10 - 100 Ω	240 mV
100 - 1 k Ω	800 mV
1 k - 10 k Ω	2.4 V
10 k - 100 k Ω	8 V
100 k - 1 M Ω	24 V
1 M Ω - 10 M Ω	80 V
10 M Ω - 100 M Ω	80 V
above 111 M Ω	80 V

The measuring voltage varies linearly with deviation around the above values.

Max. dissipation in unknown 10 mW.

Long-term Accuracy:	$\pm 0.03\%$ from $10\ \Omega$ to $10\ \text{M}\Omega$. $\pm 0.1\%$ below $10\ \Omega$ and from $10\ \text{M}\Omega$ to $211\ \text{M}\Omega$. Temperature range for specified accuracy: 15 to 35 degrees C.
Meter Ranges:	$\pm 1\%$, $\pm 2\%$, $\pm 5\%$, $\pm 10\%$, $\pm 20\%$ deviation with 20% overrange.
Meter Accuracy:	$\pm 3\%$ of full scale.
Terminals:	2 twin coax connectors for 4-terminal measurement, 2 screw terminals for 2-terminal measurement, ground terminal.
Filter:	An internally switched 2-section filter is provided. The filter timeconstant may be varied as required by installing the appropriate capacitor values.
Settling Time:	With filter switched off the maximum settling time for the deviation output is 10 milliseconds on the six highest ranges increasing to 20 milliseconds on the 10 to 100 Ω range and 50 milliseconds on the 1 to 10 Ω range.
Meter Output:	$\pm 10\ \text{V}$ full scale, max. $\pm 10\ \text{mA}$. Accuracy $\pm 2\%$ of output.
Deviation Output:	0.5 V/% deviation, max. $\pm 12\ \text{V}$, $\pm 10\ \text{mA}$. Accuracy $\pm 1\%$ of output. Stability $\pm 0.1\%$ of output $\pm 5\ \text{mV}$.
DC Supply Outputs:	$+15\ \text{V}$, max. 0.1 A. $-15\ \text{V}$, max. 0.1 A. $+12\ \text{V}$, max. 0.2 A.
Limit Module Facilities:	The instrument is pre-wired for mounting limit module in the right-hand free space of the cabinet.
Power:	90 to 130 V and 180 to 260 V, 50 to 60 Hz. Max. consumption 25 W.
Dimensions:	19 inch. rack cabinet, 360 (deep) x 195 (high) mm overall dimensions.
Total Net Weight:	8.3 kg.
Accessories supplied:	3-core power cable, 13 pole output cable connector. 2 twin coax connectors.

Limit Modules

A basic module has been designed which by small alterations can cover the most common requirements, for example

- 1 Channel System with adjustable low and high limits. Yellow, green, and red lamps to indicate LOW, PASS, HIGH conditions. Outputs are available as options.
- 2 Channel System (for example $\pm 5\%$ and $\pm 10\%$) with light indication for PASS 1, PASS 2 and REJECT. Outputs are available as options.

2. OPERATING INSTRUCTIONS

2.1 SETTING-UP

Check that the mains voltage selector on the rear panel is set to the actual supply voltage. To change the setting, pull the switch knob, turn to the correct position and push back. Check that a 0.5 A slow-blow fuse is fitted.

2.1.1. Earth Connection

For measurements on high-value resistors the instrument must be grounded either to the power supply ground via the green/yellow supply lead or to a local ground using the front panel ground terminal.

2.1.2. Cable Connection

For connecting the unknown use the cables supplied for four-terminal measurements with the shielded cable connected to the detector socket.

2.1.3. Zero Check

Before making any measurements, a zero check must be made. Switch to check zero, set range switch to 1 to 10 Ω , decade to 10-0-0 and meter switch to 1%. Short circuit X terminals on front panel. Adjust zero pot. for meter zero. This adjustment is only important on the lowest ranges and has practically no influence above 1 k Ω .

2.2 MEASUREMENTS

Set nominal resistor value on the upper 3-decade resistor. The highest value (left-hand) dial should normally be set between 1 and 10, but measurements are possible at settings of zero on this dial and down to 8 on the next dial. Set range switch to the required range. The range markings on either side of the index indicate the resistance value corresponding to the settings 1 and 10 on the highest value decade dial. Set meter switch to the required range, mode switch to MEASURE and +100 M Ω switch to NORMAL.

Note: For normal operation all toggle switches will be in their upper position.

Connect the unknown resistor using the cables for four-terminal measurement or the screw terminals for two-terminal measurement.

Read deviation on meter using the scale corresponding to the actual range switch setting.

2.2.1. Low Value Resistors

On the two lowest ranges the instrument is calibrated for measuring cables of 1 meter length. If longer cables are used, small errors will appear. An additional lead resistance of 100 milliohms gives a 0.1% low reading on the 1 to 10 Ω range and 0.03% on the 10 to 100 Ω range. This lead resistance corresponds to a 2 meter increase in length of each lead (cross section 0.75 mm²).

If required, this error may be corrected by off-setting the zero adjustment on the lowest range to obtain a positive check zero reading corresponding to the error. This also corrects the error on higher ranges.

2.2.2. High Value Resistors

When accurate measurements of high value resistors are made it may be necessary to shield the measuring circuit to reduce errors due to hum. Excessive hum causes errors on the lower deviation ranges, or, if a limit detector is used, limit errors appear.

2.2.3. Filter Circuit

A 2-section filter is mounted internally on the main amplifier board. A switch on the board activates the filter when switched in the direction indicated by an arrow mark. Access to the board is obtained by removing the top panel.

The filter constants may be altered as required by changing the capacitors mounted above and below the filter switch. Capacitors of 0.5 μ F value give a hum reduction at 50 Hz of about 45 dB and settling time of less than 0.3 seconds.

2.2.4. Outputs

Two deviation outputs are provided at the rear output connector. One is an output directly proportional to deviation giving 0.5 V per % deviation and may be employed to drive a limit selector.

The second output is proportional to meter deflection, giving ± 10 volt for full scale meter reading ($\pm 1.2\%$ to $\pm 24\%$ according to range). This may be employed e.g. for driving a remote meter.

3. CIRCUIT DESCRIPTION

The circuit functions as a 4-terminal bridge and employs operational amplifiers to determine the bridge ratios. The main bridge circuit comprises the unknown resistor in series with the standard which is switched in steps of 1 - 3.3 - 10 ... between 100 Ω and 1 M Ω by the range switch.

The junction point between the standard and the unknown is connected to the detector amplifier input and constitutes a virtual earth at zero potential. The voltage across the unknown resistor is determined by the measuring voltage amplifier obtaining its reference from the negative 15 volt supply and setting the voltage by feedback resistors changed in steps of 1 - 3 - 10 ... by the range switch.

A second feedback loop from the detector output balances the bridge for deviations from the nominal value by varying the measuring voltage accordingly.

The voltage across the standard is controlled by a +8 volt reference voltage obtained through an inverter from the -15 volt supply.

This is applied through the decade resistor standard to the standard voltage amplifier. The amplifier output varies inversely with the decade setting from -8 volt at 1 to -0.8 volt at 10 on the highest decade.

The output from the detector is strictly proportional to the deviation from the indicated value due to the balancing feedback. This output is fed into an inverter to obtain correct output polarity and low source impedance. The inverter output supplies 0.5 V per % deviation for limit detection. It also feeds the meter amplifier via a range switch.

3.1. DETAILS OF CIRCUIT

The measuring voltage amplifier consists of a monolithic operational amplifier A3 driving an emitter follower to supply the current required for low value resistors (up to 80 mA). The output voltage is insufficient for the 3 highest ranges, and these are fed from a 170 volt supply via a constant-current circuit and controlled by a shunt regulator. The current through the shunt transistor is

controlled by the low voltage regulator, thus closing the regulating loop. The constant-current circuit improves regulation and limits the output current to a safe value - about 2 mA.

The standard voltage amplifier is similar to the measuring amplifier except that the output is of opposite polarity and no high voltage supply is required.

The output of the detector amplifier A4 is of the same polarity as the input error signal to obtain correct feedback to the measuring voltage amplifier. Internal feedback in A4 is dimensioned to obtain a cut-off frequency low enough to ensure stable operation for all measuring voltages and for capacitive generator loads up to 400 pF.

A compensating circuit feeds a current set by P6 into the detector amplifier (A4) input to compensate the input current, in order to eliminate errors at high value resistor measurement.

For low value resistor measurement, a compensating voltage proportional to the measuring current is fed to the inverting input of A4. This compensating voltage is adjusted to the correct voltage by selection of R11. This compensates the small error due to the finite transconductance of the X-voltage amplifier.

The amplifiers A3 and A4 are selected for low offset voltage and temperature drift and the offsets are nulled by pre-set pots P3 and P2. "ADJ.ZERO" on the front panel allows correction of temperature drift and long-term drift. An internally switchable filter switches capacitors across the feedback resistors of A4 and A5 to reduce hum and noise if required.

The pre-set pots. P1 and P5 allow nulling the offset of amplifiers A6 and A2. To facilitate zero checks and adjustment the inputs to A3 and A2 may be switched to zero by a 2-pole switch (CHECK-MEASURE). The reference inverter is nulled by P4 which also serves as a ratio adjuster to compensate small overall ratio errors in the complete circuit.

The decade resistor is a 3-dial decade with values 10 x 10 k Ω , 10 x 1 k Ω , and 10 x 100 Ω . A separate switch (+100 M Ω) inserts a 100 k Ω series resistor to extend the range to 211 M Ω .

3.2 POWER SUPPLY

The power supply is mounted on the rear panel. Regulated outputs of +15 V and -15 V are provided. These are adjustable by pre-set pots.

An unregulated +170 V output feeds the high-voltage stabilizer, and an additional 5 volt unstabilized supply

is provided for driving a plug-in limit module which may be mounted beside the bridge module.

4. MAINTENANCE INSTRUCTIONS

Normally no adjustments should be necessary but if e.g. any of the amplifiers have been replaced, the zero off-sets must be checked and readjusted. Using the check zero switch most of the adjustments may be checked and readjusted if required, as described below.

To gain access to the pre-set pots., remove the top panel. The positions of the pots. are marked on the printed circuit board above each pot.

4.1 METER ZERO

Check mechanical zero with instrument switched off and re-adjust if necessary.

Switch on instrument and set meter switch to OFF.

Adjust P1 for zero reading.

4.2 STANDARD VOLTAGE ZERO

Set check switch to CHECK ZERO, meter switch to 1%, decade to 110 and range switch to 100 to 1 k.

Connect a resistor about 1 k to X-terminals.

Note deflection on meter. Switch highest decade repeatedly between 1 and 0 and adjust P5 for zero change.

4.3 DETECTOR ZERO AND MEASURING VOLTAGE ZERO

These two adjustments are interdependent so they must be repeated alternately for correct final setting.

Set check switch to CHECK ZERO, meter switch to 1%, decade to 1000 and range switch to 1 to 10. Connect a decade resistor adjustable to 1 k to X (or connect a 1 k resistor across X-terminals). Set X to 1 k and adjust P2 for meter zero.

Set X to zero (or short X-terminals) and adjust P3 for meter zero. Repeat adjustments until zero is obtained for both settings.

Note: If the pots. are grossly misadjusted, set resistance range switch to a higher setting and switch to the lowest range for final adjustment. This will normally only be necessary if the respective amplifier has been replaced.

4.4. METER DEFLECTION ADJUSTMENT

For checks or approximate adjustment a stable resistance of 1, 10, or 100 k Ω \pm 1% may be used as a standard. Set the bridge for balance with the decade at 100. Set meter switch to 20% and note meter reading (this should be within \pm 1% of zero).

Set decade to 125. Change of reading should be 20% negative. Adjust pot. on -15 volt supply (white leads) on rear panel for best accuracy. For accurate checks use a high accuracy decade resistor for X and check on various meter ranges.

4.5. RATIO ADJUSTMENT

P4 sets the overall bridge ratio by slightly altering the standard reference voltage. It is factory-set to achieve the best possible mean accuracy on all ranges and decade settings. Re-adjustment of this pot. should only be attempted if accurate standards are available e.g. standards of 1 k Ω , 10 k Ω , and 100 k Ω \pm 0.01% or better and a decade resistor or transfer standard with 10 steps equal within less than \pm 0.01%. Using these standards the four middle ranges may be checked and P4 adjusted for a mean accuracy better than 0.02%.

4.6. HIGH VALUE INPUT CURRENT ADJUSTMENT

P6 sets the input current compensation. Connect a high value resistor (about 100 M Ω or higher) to the X-terminals. Set to CHECK ZERO, decade to 100, range to 10 M to 100 M, meter switch to 1%.
Adjust P6 for meter zero.

4.7. LOW VALUE CORRECTION

If the amplifier A3 or emitter follower MPS U02 have been changed it may be necessary to adjust RII which is mounted on the board beside the MPS U02. RII corrects the error at low values due to the finite transconductance of the amplifier circuit causing a too high reading at low resistance values. The correction is normally about 0.05% at 1 Ω and is thus not very critical.

For checking the correction an accurate 1 Ω four-terminal standard is required.

Connect the standard by the four-terminal cables, set the switches for 1 Ω , check zero adjustment and switch to measure. If a positive deviation is noted RII must be reduced, and vice versa.

RII is normally about 20 M Ω for a correction of 0.05% so that a change to 10 M Ω gives a correction of 0.1%.

Note that the zero adjustment must be corrected for any

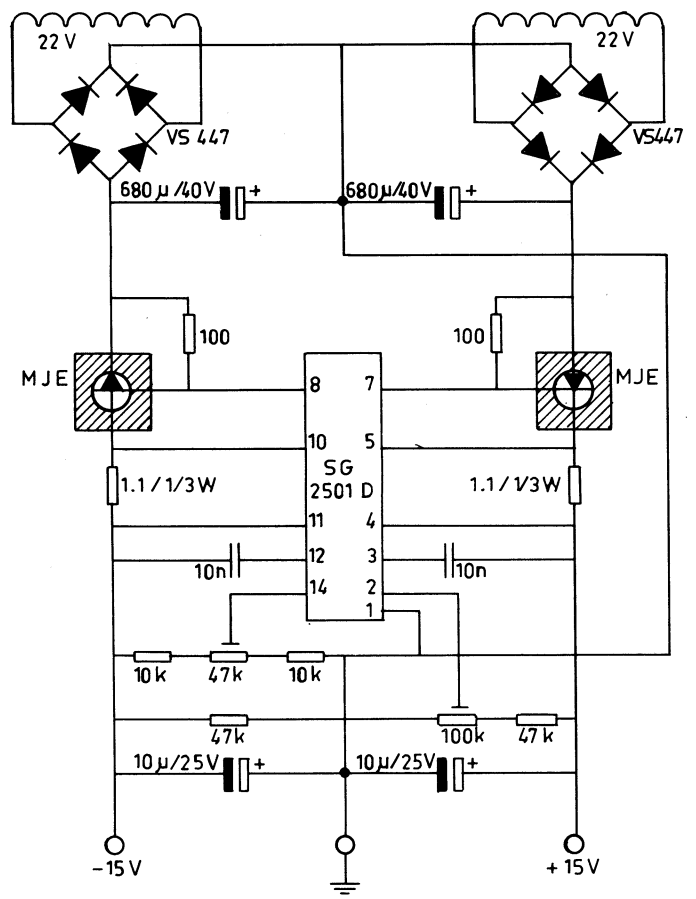
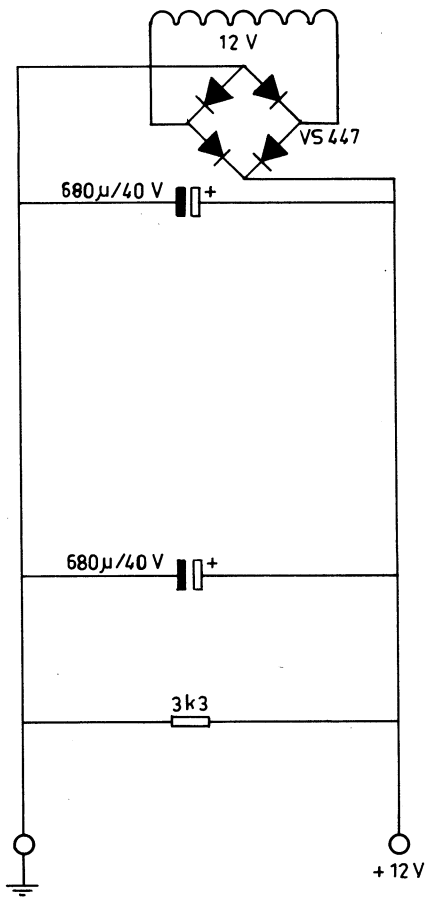
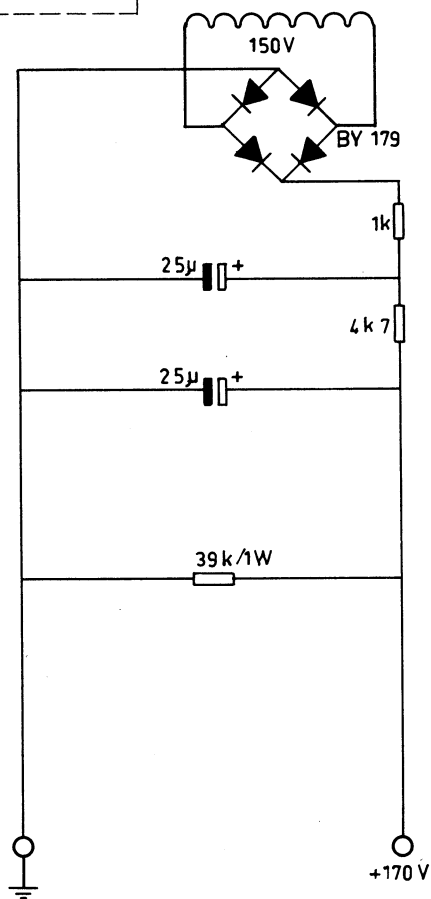
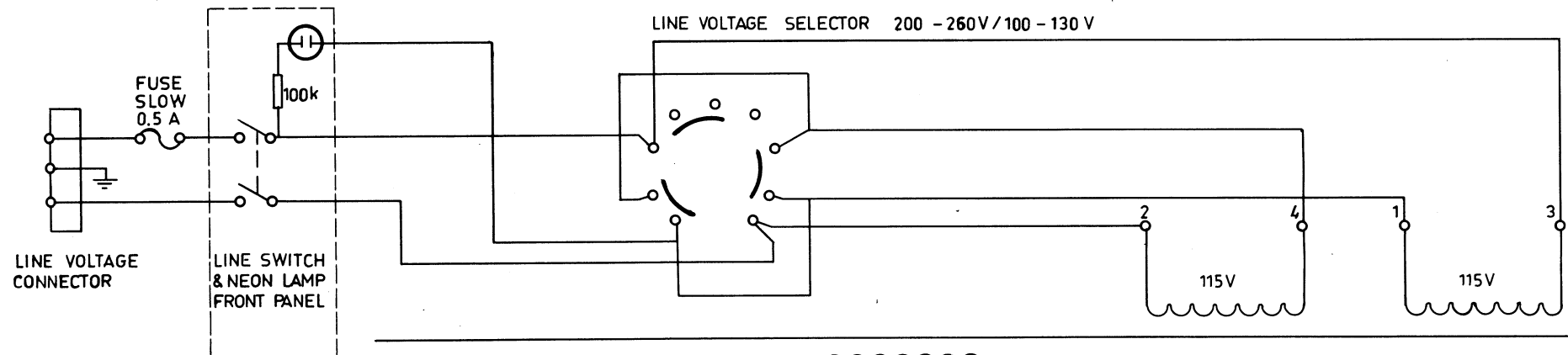
change in RII.

4.8

CRITICAL COMPONENTS

The amplifiers A3 and A4 are selected and matched units and replacement pairs should be ordered from Danbridge.

All ratio resistors on the range switch as well as the decade resistors are matched in value to better than 0.01% and if any of these resistors are faulty the instrument should be returned to Danbridge for repair and re-adjustment.



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A/s DANBRIDGE.

MB 3 & MB 5
POWER SUPPLY

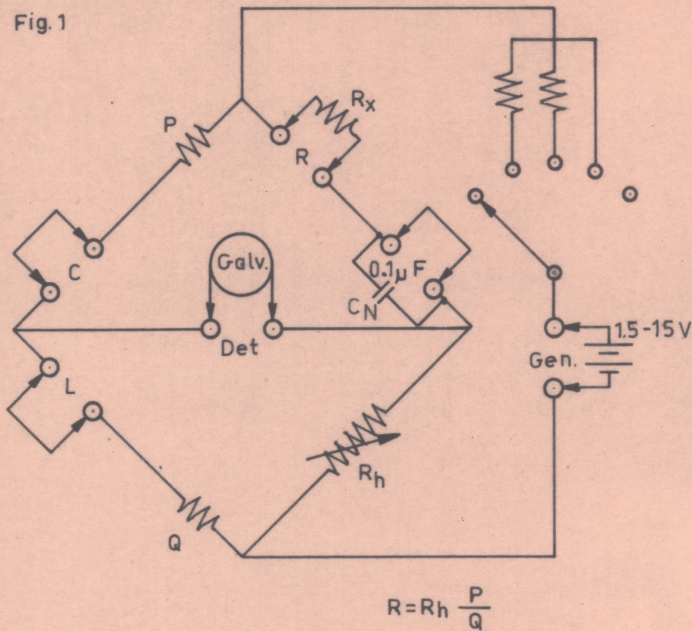
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TEGNET	210574 B. Ras.		
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UNIVERSAL BRIDGE TYPE UB1

MEASURING CIRCUITS FOR R, L, C

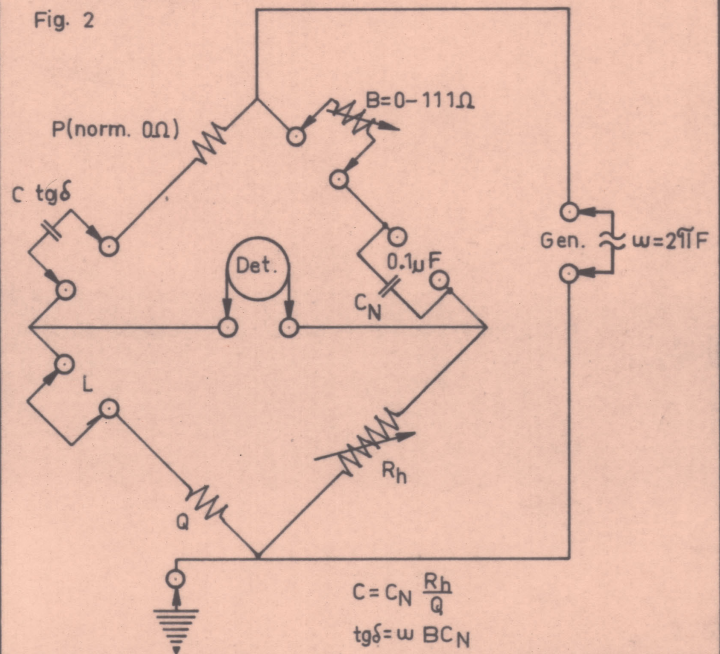
RESISTANCE

Fig. 1



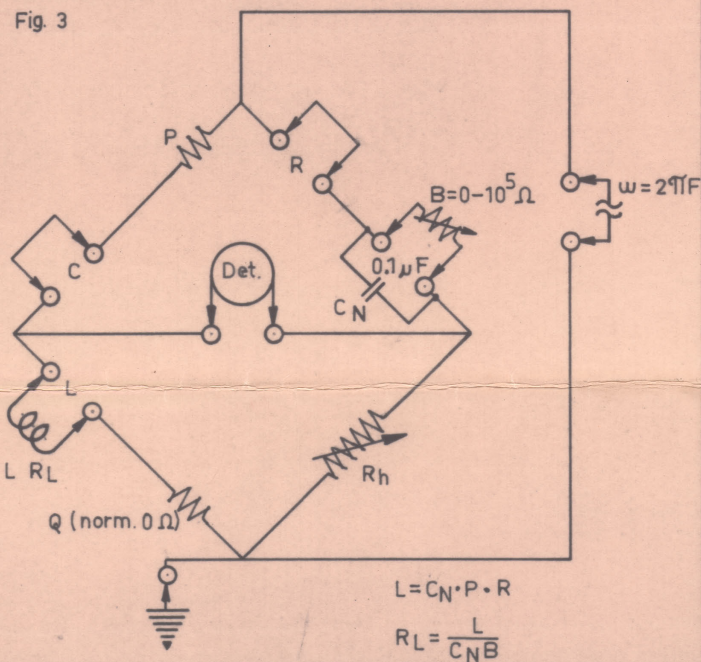
CAPACITANCE

Fig. 2



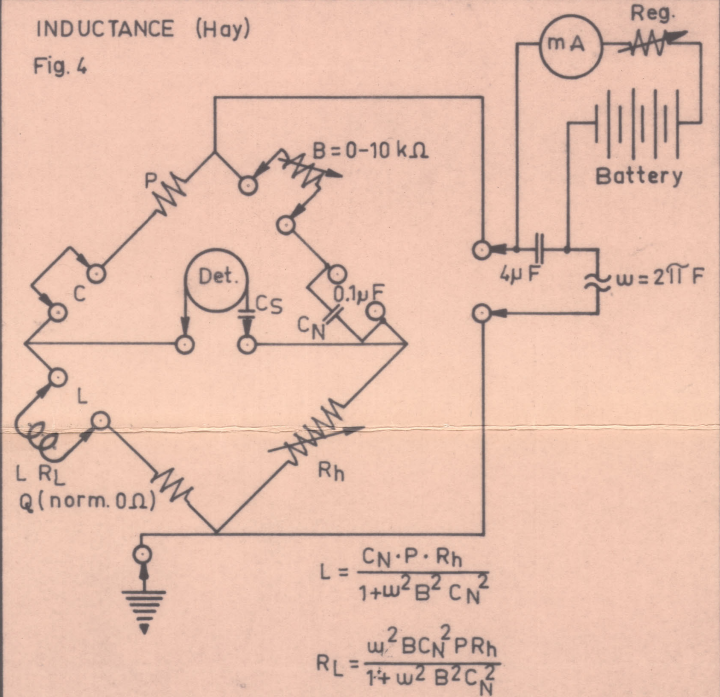
INDUCTANCE (Maxwell)

Fig. 3



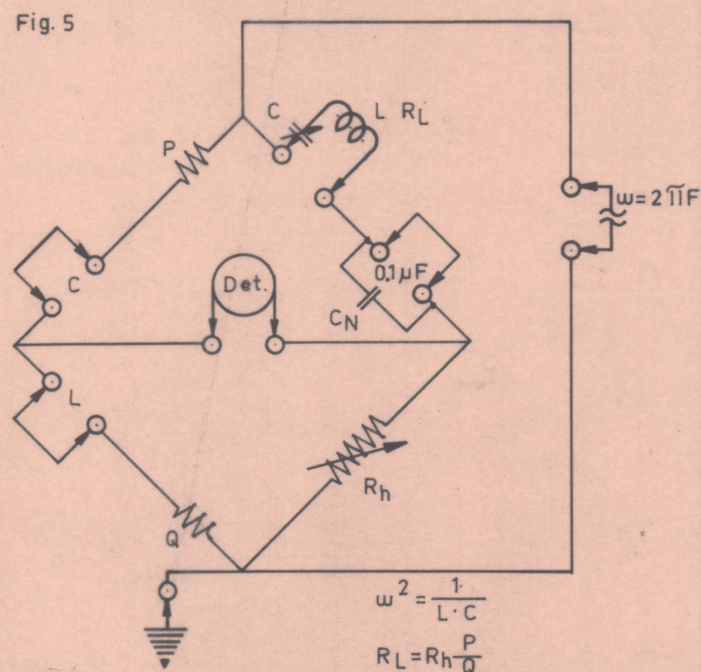
INDUCTANCE (Hay)

Fig. 4



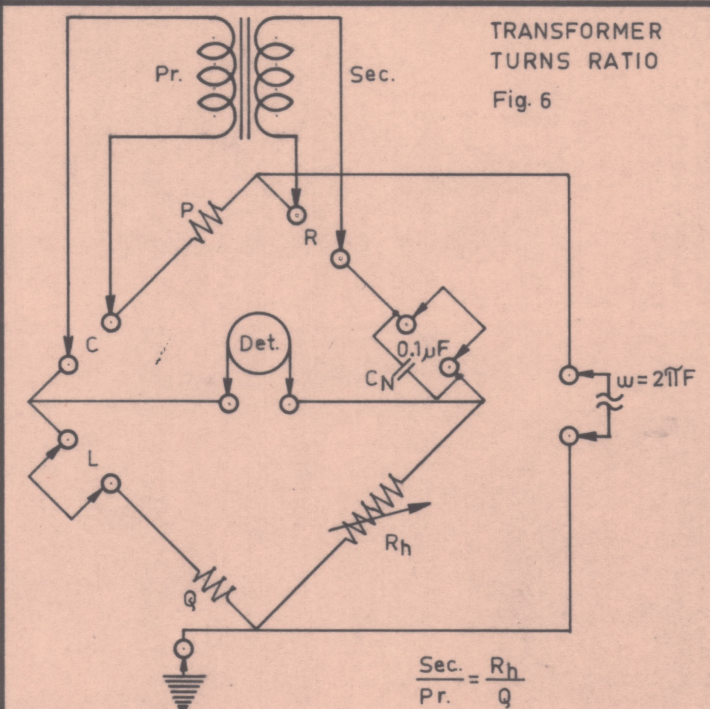
SERIES RESONANT BRIDGE

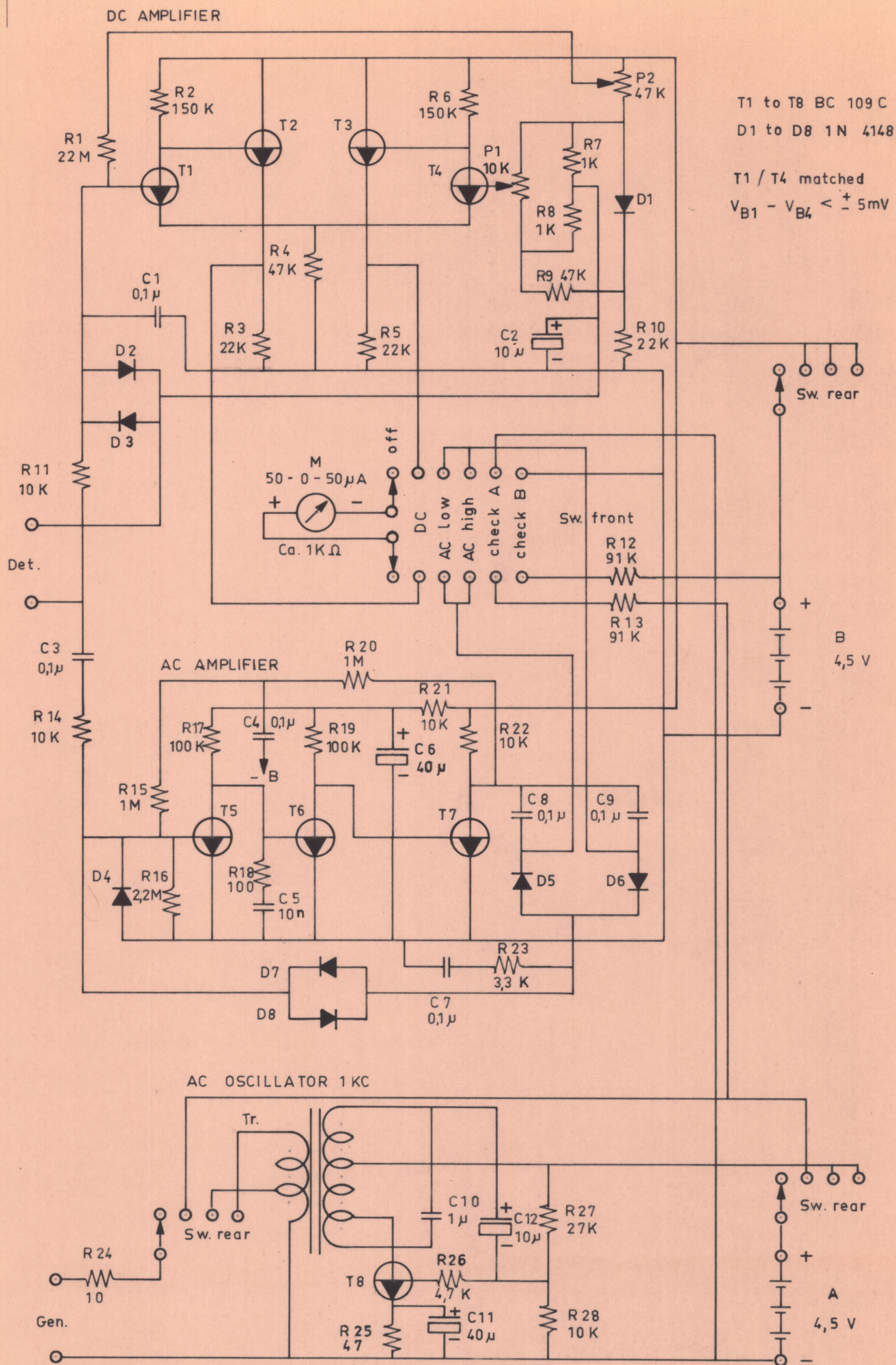
Fig. 5



TRANSFORMER TURNS RATIO

Fig. 6





A/S DANBRIDGE

OSCILLATOR AND DETECTOR UNIT
TYPE OG1
CIRCUIT DIAGRAM