PS/Int./MG/VA 60-40
30.11.1960.

THE MAGNETIC FIELD DISPLAY SYSTEM

INTRODUCTION.

Starting in 1958, a system has been developed for measuring and checking the most interesting properties of the main magnetic field of the C.P.S. and of some apparatus associated with the production of this field. To this effect a number of field sensitive devices have been installed in the 101-st magnet unit and the necessary measuring apparatus has been provided in the Main Control Room. Originally, the system was thought to be used mainly for rather occasional checks. With the coming into operation of the C.P.S. it turned out, however, that it could render useful services more frequently and consequently it was somewhat modified for displaying more information and for using it more conveniently. The development has now reached a stage where it seems reasonable to report on the methods of measurement employed, the characteristics of the final apparatus and the results of the calibrations and measurements, the detailed electronic circuits having been described previously [1),2),3)].

The report is subdivided as follows :

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1. Measurements of the remanent field :

1.1 Aim of measurements.

From the measurements on the steel employed for the C.P.S. magnet it is known that the remanent field slowly increases with time due to aging. It was therefore thought interesting to provide the possibility of measuring the change of the remanent flux density and its gradient.

Secondly, the magnetic length of a magnet unit was thought a quantity worth checking in a routine fashion as it influences the injection timing and the accelerating frequency programme.

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Thirdly, for general studies, one wanted to have the possibility of measuring remanent fields anywhere around the machine.

1.2 Method of measurement.

Peaking strips [4), 5)] are used for all measurements of the remanent field, one strip for the measurement of the flux density and two strips for the measurement of the gradient. The design of the adjustable stabilized current supply and the precision current meter is based on the idea that one normally wants to check the constancy of the remanent flux density as opposed to measure its unknown value. The main effort was therefore put into making routine readings comparatively easy and yet precise. The block diagramme of the resulting magnetometer is shown in Fig. 1.

Each peaking strip is surrounded by a signal coil, a quadrupole bias coil and a modulation coil. In a zero external field, the 50 Hz current periodically magnetizes the strip positively and negatively. As its hysteresis loop is practically square, two sharp signals are induced in the signal coil for each magnetization cycle. If the sweep speed of the scope is adjusted such that every 100 Hz trigger signal starts one sweep, the two signals from one cycle will appear exactly on top of each other (Fig. 2).

If an external field is applied, the two signals are displaced in opposite directions. The bias current is then adjusted in the strip until the bias field exactly cancels the external field. This condition is reached when the two signals again precisely coincide. As the scope trace is triggered for each half cycle (as opposed to being swept forth and back by the modulating voltage), the accuracy of the measurement is not influenced by any eddy current effects. They merely displace both signals in the same direction by equal amounts.

The quadrupole winding makes the calibration of the bias field less dependent on any highly permeable material placed close to the magnetometer.

The schematic diagram of the current meter is shown in Fig. 3. The voltage drop across the fixed precision resistor S caused by the bias current is compared to the voltage drop across this resistor and the variable resistor R, caused by an auxiliary current from the stabilized voltage source - V. If R is adjusted to make the potential difference between points A and B zero, one has :

$$I\,[\mathrm{mA}] = \frac{V\,(R + S)}{r\,S} = R[k\Omega]\frac{V\,[v]}{S\,r\,[k\Omega, k\Omega]} + \frac{V\,[v]}{r\,[k\Omega]} \qquad (1)$$

For five of the six positions of the magnet cycle selector, the bias current is set to certain preset values by switching in fixed values of the resistor T in Fig. 3. Simultaneously R is changed to the corresponding preset values. In the sixth position, the magnet cycle selector connects the points A and B to an external resistance box and switches E and F onto a built-in 5 decade box (This box can be used for checking the fixed resistors R as described in 1.4).

1.3 The magnetometer.

1.3.1 Peaking strip assembly.

The peaking strip assembly is shown in Fig. 4, the holder for the strips in Fig. 5 and the position of the strips No. 1 to 3 in the 101-st magnet unit in Fig. 6. An identical strip (No. 4) is available for general measurements anywhere around the machine.

The peaking strips were made from a 0.05 mm diameter Permalloy C wire containing 78 o/o nickel, 18 o/o iron and 4 o/o molybdenum. While being submitted to a stress of about 10 kg/mm^2, the wire has been tightly encased along its entire length in a glass tube of 1,2 mm outer diameter by heating up the glass. The pieces of strips for the magnetometer were cut from this tube and individually tested in a special assembly. Only strips giving narrow and identical signals were chosen for the present magnetometer.

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The strips were then glued into their perspex holder with a cold setting Araldite. Next the 2500 turns of the signal coil (0.03 mm diameter Cu wire) were wound directly on the glass casing of the strip by the firm PYROR S.A.

The formers of the bias coils were made from two types of materials. A ceramic former was used for the strips for the gradient measurement in order to ensure the required geometrical stability with time. Perspex formers were used for the other bias coils as they are non-breakable and easier to manufacture.

The bias coil was designed to produce a flux density of 25×10^{-4} Wb/m^2 for 20 mA excitation current. In order to obtain a net zero external moment, the number of windings was chosen to satisfy the relation [6] (See Fig. 4 for definition of R_i).

$$\frac{N_1}{N_2} = \frac{R_{2o}^2 + R_{2o} R_{2i} + R_{2i}^2}{R_{1o}^2 + R_{1o} R_{1i} + R_{1i}^2} , \qquad (2)$$

where N_1 is the number of turns on the inner winding L_2 , and N_2 the number of turns on the opposing outer winding L_4. The resulting numbers were L_2 = 6500 turns and L_4 = 2500 turns, both coils being wound from 0.1 mm diameter Cu wire.

The modulation coil (300 turns of 0.23 mm Cu wire) was designed to saturate the strip completely with 100 mA (r.m.s.) modulation current without heating up the bias coil appreciably.

It was found difficult to wind the bias coils so evenly that the magnetic field inside the coil was completely uniform. Finally the coils for the magnetometer were selected from a larger number by using the criterion that the bias field did not broaden or render asymmetric the signal from the peaking strip.

A special jig was used for positioning the strips No. 1 and 2 symmetrically about the equilibrium orbit in block No. 6 after mounting them on their support (Fig. 7).

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1.3.2 Measuring ranges.

Four of the five values of the bias current for the strips No. 1 to 3 are set for checking the remanent field corresponding to the magnetization cycles with 90 o/o, 75 o/o, 50 o/o and 25 o/o voltage applied to the magnet. The fifth value is set for the apparent remanent field at the end of the 3 sec. - 90 o/o voltage cycle. This field is higher than the true remanent field on account of the influence of the decaying eddy currents.

In the sixth position of the magnet cycle selector switch, flux densities of about 24×10^{-4} Wb/m^2 can be measured as described in 1.6

1.3.3 Calibration.

For the calibration of the peaking strips, the Helmholtz coil arrangement of the Magnet Group was used whose two coils are spaced by 135 mm (from centre to centre).

First, this coil was recalibrated with the aid of the nuclear resonance probe of the Hall computer. For an excitation current of 19.83 A, a mean resonance frequency of 1490 kHz was measured. With the frequency/field ratio 4.25767×10^4 kHz Wb^{-1} m^2 for the nuclear resonance, this leads to a coil constant of 17.65×10^{-4} Wb m^{-2} A^{-1}.

Next, the peaking strip assembly to be calibrated was fixed in the centre of the Helmholtz coil in such a way that the axes of all coils coincided accurately. The whole set-up was then rotated until the component of the earth's magnetic field along the axis of the bias coil was exactly zero. This condition was established by measuring this field with the peaking strip itself, i.e. by observing the position of the two induced signals as explained in 1.2.

Once the alignment of the coils with respect to each other and to the earth magnetic field was considered satisfactory, the Helmholtz coil was energized to produce a flux density of 6.62×10^{-4} Wb/m^2, the

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excitation current being measured with a class 0.1 current meter. The current through the peaking strip bias coil was then adjusted until the two signals from the strip were again exactly on top of each other. For the measurement of this current, a precision resistor and a digital voltmeter were used. Finally the measurement was repeated at a flux density of exactly twice the first value. Only such peaking strip assemblies were accepted which then required a bias current precisely twice as strong. The constants found in this way are reproduced in Table I. The uncertainty of the calibration is estimated to be ± 2 parts in thousand.

Table I : Calibration constants of peaking strip assemblies

Peaking strip	No. 1	(cable No. 13011)	1.221×10^{-7} Wb m^{-2} A^{-1}
Peaking strip	No. 2	(cable No. 13012)	1.238×10^{-7} Wb m^{-2} A^{-1}
Peaking strip	No. 3	(cable No. 13013)	1.268×10^{-7} Wb m^{-2} A^{-1}

For facilitating the measurement of the bias current with the built-in precision meter, the value of the resistance r in the circuit shown in Fig. 3 has been adjusted to make the constant part of eq. (1) $V / r = 1.000$ mA. The calibration of this meter by means of a resistor and a digital voltmeter leads to the result (cp eq. (1).)

$$I_{[mA]} = 1.000 + 0.2653 \ R_{[k\Omega]} \qquad (1a)$$

After mounting the strips in the 101-st unit, the values of the 30 fixed resistors T and R (Fig. 3) were determined experimentally, using suitable resistance boxes. As shown in Fig. 8 the built-in elements are composed of a fixed resistor and a potentiometer mounted behind the front panel for screw-driver adjustment (Fig. 9). The final calibration was made by adjusting these potentiometers until the peaking strip signals again coincided exactly and the built-in precision meter indicated zero on the 3 o/o scale. The results are summarized in Table II.

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Table II : Results of final calibration in July 1960

Magnet Cycle			Peaking Strip No. 1			Peaking Strip No. 2			Peaking Strip No. 3		
Voltage [o/o]	Rise time [s]	Rep. rate [s]	R [k Ω]	I [m A]	B_1 [10^4 Wb/m^2]	R [k Ω]	I [m A]	B_2 [10^4 Wb/m^2]	R [k Ω]	I [m A]	B_3 [10^4 Wb/m^2]
90	0.98	3	49.623	14.16	17.29	42.083	12.16	15.05	21.553	6.82	8.47
90	0.98	10	47.942	13.72	16.75	40.651	11.78	14.58	10.601	3.81	4.83
75	1.22	10	48.943	13.98	17.07	41.376	11.98	14.83	11.571	4.07	5.16
50	1.90	10	50.016	14.27	17.42	42.314	12.23	15.14	16.446	5.36	6.80
25	4.00	10	53.018	15.07	18.40	44.673	12.85	15.90	28.226	8.49	10.77

1.4 Carrying out of check measurements.

After switching on the apparatus, and allowing a few minutes for warming up, the magnet cycle selector is switched to the appropriate setting. With the scope input selector in the position "peaking strip" the two signals (Fig. 2) should appear on the screen of the 502 scope.

If these signals do not coincide exactly, the bias current should be adjusted by turning the helipot 5 (Fig. 9) until this condition is reached. After checking the zero reading the bias current is then read on the precision current meter 8 and any change from the normal current is noted. On this meter the relative change can be read in parts per thousand on the 3 o/o scale and in percent on the 15 o/o scale. For correct relative readings the meter constant has to be adjusted for the absolute value of the bias current. This is done by setting the correction knob 11 (Fig. 9) to the current value read on the rough bias current meter 4.

If the change in bias current is more than a few parts in thousand, it is advisable to check the built-in fixed resistors R. For this the selector switch S_2 (Fig. 9) is put into the position "measure" and the high precision (0.02 o/o) 5 decade resistance box 12 is set to the value found in the initial calibration given in Table II. The meter 8 should then read the same value as before. If this is not the case, the apparatus should be recalibrated as described in 1.3.3.

1.5 Reduction of measured data.

The quantities measured are the remanent flux densities B_1, B_2 and B_3 in the locations No. 1 to 3 shown in Fig. 6.

The remanent gradient $\partial B_{o_{rem}} / \partial r$ equals :

$$\frac{\partial B_{o_{rem}}}{\partial r} = \frac{B_1 - B_2}{d} \qquad (3)$$

where $d = 3.01 \times 10^{-2}$ m is the distance between the two peaking strips No. 1 and No. 2.

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Assuming a purely linear field, the flux density on the equilibrium orbit, $B_{o_{rem}}$ is

$$B_{o_{rem}} = 0.5 \quad (B_1 + B_2) \qquad (4)$$

In reality B_{rem} increases somewhat more than linearly with r (cp Fig. 6 of PS/MM 25), the approximate amount being

$$\frac{\partial^2 B_{o_{rem}}}{\partial r^2}_{[Wb/m^4]} = \frac{B_o}{R_o} \frac{\partial n}{\partial r} = 4.3 \, B_{o_{[Wb/m^2]}} \qquad (5)$$

From the relations :

$$B_1 = B_o + \frac{\partial B_o}{\partial r} \Delta r + 0.5 \frac{\partial^2 B_o}{\partial r^2} (\Delta r)^2 \qquad (6a)$$

$$B_2 = B_o - \frac{\partial B_o}{\partial r} \Delta r + 0.5 \frac{\partial^2 B_o}{\partial r^2} (\Delta r)^2 \qquad (6b)$$

one gets with eq. (5) and $\Delta r = 1.505 \times 10^{-2}$m :

$$B_{o_{rem}} = 0.499 \quad (B_1 + B_2) \qquad (4a)$$

Using this equation one obtains with the values of B_1 and B_2 from Table II for $B_{o_{rem}}$, $\partial B_{o_{rem}} / \partial r$ and n_o $\left(= \frac{R_o}{B_o} \frac{\partial B_{o_{rem}}}{\partial r}\right)$, the values listed in Table III.

Table III : Computed values of B_o and $n_{o_{rem}}$

Voltage [o/o]	Magnet cycle Rise time [s]	Rep. rate [s]	B_o [10^4 Wb/m^2]	$\partial B / \partial r$ [10^6 Wb/m^3]	$n_{o_{rem}}$ [-]
90	0.98	3	16.14	0.744	323.0
90	0.98	10	15.63	0.721	323.2
75	1.22	10	15.92	0.744	327.5
50	1.90	10	16.25	0.757	326.5
25	4.00	10	17.12	0.830	339.7

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As will be obvious from Table III, the measured values of B_{Orem} vary by about 10 o/o with the different magnet cycles. This may partly be due to the fact that the strips No. 1 and 2 are not located in the centre part of the magnet unit. If this question should become important, one could measure $B_{Orem} = f(\theta)$ in the block No. 7, which is still unoccupied (Fig. 6).

The values of n_{Orem} are typical for a closed block (cp PS/MM 25). They depend much less on the particular type of magnet cycle.

The peaking strip No. 3 has been placed in a position where the change of B_3 with the type of magnet cycle is rather strong (cp Table II). The constancy of B_3 is therefore a good indication of the constancy of the particular magnet cycle. If quantitative results of this measurement of the magnetic length of magnet unit No. 101 were required, one would once have to measure the complete curve $B_{Orem}(\theta)$ in the region of the fringing field for each magnet cycle. This could of course be done with the peaking strip No. 3 itself.

From previous measurements it is known that the difference in the total magnetic length of a unit for a fast and a slow magnet cycle amounts to about 3.5 o/o at remanent field.

1.6 Measurements of remanent fields around the machine.

Peaking strip No. 4 is foreseen for measurements in the range 0 to 25×10^{-4} Wb/m^2 anywhere around the machine. For its connection to the measuring rack MR 44 in the Main Control Room, a co-axial cable and four wires of a multicore cable are required.

For the adjustment of the bias current, an external resistance box can be connected to the plug T3F 121 (Fig. 8) mounted at the back of the rack.

With the selector switch S_2 (Fig. 9) in the position "measure", the built-in precision current meter can be used for the measu-

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rement of the bias current (The constants have been given in 1.3.3). For highest accuracy the zero of the meter should be checked before every reading.

The total width of the peaking strip signal (Fig. 2) is about 50×10^{-7} Wb/m^2. At a sweep speed of 50 µs (1 ms sweep with 20 x magnification) this width corresponds to about 1.5 square on the CRO screen. The two signals can be placed on top of each other with an uncertainty of less than 5×10^{-7} Wb/m^2.

2. Dynamic measurements of the flux density and of the n-value :

2.1 Introduction.

The principle of the measurement [7] and the basic design of the apparatus [1] correspond closely to the scheme used for the testing of the magnet blocks and will therefore not be dealt with here. Certain modifications and the detailed performance characteristics of the electronic apparatus have already been described [1].

Provision has been made since for starting and stopping the integration anywhere along the magnet cycle [9]. The device contains a transistor controlled relay which connects or disconnects the signal coil(s) to the integrator input. Both start and stop are triggered with standard pulses.

Also, a switch has been incorporated, which switches the integrator automatically back to "reset" every second cycle [9]. Since the setting to zero takes some time, the integrator is only usable one cycle in two, which is however perfectly adequate for routine check measurements.

2.2 Measurements of the flux density.

2.2.1 Relative measurements.

The integrator input circuit is shown in Fig. 10. With the switch in the position " ΔB " the coils No. 1 and 2 are connected

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to the integrator input via the resistance chain R_1 to R_3. For zero integrator output voltage one has :

$$\frac{B_1}{B_2} = \frac{R_{coil\ 1} + R_1 + R_2 + r_1}{R_{coil\ 2} + r_2 + R_3} \qquad (7)$$

where B_1 and B_2 are the densities of the flux through coils No. 1 and 2, respectively.

If one puts coil No. 2 on the equilibrium orbit of magnet unit No. 101, coil No. 1 can be used to measure flux densities anywhere around the machine in terms of B_0. In cases where coil No. 1 is located far from the Main Control Room, particular care must be taken with its cable connections if accurate results are to be obtained at low flux densities [7].

2.2.2 Absolute measurements.

For certain purposes, e.g. the adjustment of the slope of the "flat-top" of the magnet cycle, absolute flux measurements are required. After replacing coil No. 1 by a short-circuit (as shown in Fig.10) the resistance chain can be used to reduce the integrator input signal in the ratio

$$\frac{B_{integrated}}{B_{total}} = \frac{r_2 + R_3}{R_1 + R_2 + r_1 + r_2 + R_3 + R_{coil},} \qquad (8)$$

to suit the particular requirements and to stay within the permitted output voltage range of the integrator [1].

At present the round coil in block No. 6 of unit No. 101 (Fig. 6) is used for the measurement of the flux density during the "flat-top". By means of the special switch [9] mentioned in 2.1, the coil is connected to the integrator input somewhat after X_1 and disconnected somewhat after X_2. In this fashion flux densities less than 100×10^{-4} Wb/m^2 can be measured conveniently and accurately at any field level up to the highest (1.4 Wb/m^2).

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One way of calibrating this set-up is to integrate over the entire cycle (after adjusting R_1 and R_3 suitably) and to equate the value of the top field (in terms of squares on the CRO screen) to that read on the B 10 fluxmeter. If then the dividing resistance chain (and maybe also the scope sensitivity) are again adjusted for higher sensitivity, the calibration factor can be found from eq. (8) and/or the changed scope amplifier setting, as the case may be.

Instead of the X_1 and X_2 pulses, the B 10 pulses from the B trigger can be connected to the device for starting and stopping the integration (Fig. 11). The integration (and the sweep of the scope) can then be started and stopped anywhere during the magnet cycle by adjusting the four decade selector switches correspondingly.

2.3 Measurement of the n-value.

With the selector switch S_4 (Fig. 10 and 11) in the position "n", coils No. 3 and 4 (located in block No. 9 / cp Fig. 6) are connected to the integrator input.

Assuming that coil No. 3 is in the higher field region and coil No. 4 at distance d in the lower one, one has for $R_2 = 0$ [7]

$$\frac{B_o\left(1 - \frac{n_o}{R_o}\,\frac{d}{2}\right)}{B_o\left(1 + \frac{n_o}{R_o}\,\frac{d}{2}\right)} = \frac{R_{coil} + R_1 + r_1}{R_{coil} + r_2 + R_3} \qquad (9)$$

With

$$R_1 = r_1 + r_2 + R_3 \qquad (10)$$

i.e. $R_1 + r_1 - (r_2 + R_3) = 2r_1$, one obtains from eq. (9) after rearranging

$$n_o = \frac{2\,R_o}{d}\;\frac{2\,r_1}{2\,R_{coil} + R_1 + r_1 + r_2 + R_3} \qquad (11)$$

For the routine measurements R_3 is set to $90\ k\Omega$.

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On the 10 kΩ Muirhead box situated below the CRO (Fig. 10) one reads for zero integrator output at mean fields $r_1 = 6.180\ \Omega$

With $R_o = 70.079$ m, $d = 0.02997$ m and $R_{coil} = 200.5\ \Omega$

one calculates therefore from eq. (11) $n_o = 288.4$.

3. Measurement of the rate of rise of the flux density on the orbit :

For the measurement of the rate of flux rise on the orbit a coil with an accurately known value of area-turns has been installed symmetrically about the orbit in block No. 6 (Fig. 6). With the scope input selector in the position "$\dot{B}$" the coil output voltage is directly connected to the CRO input and the full voltage is displayed for rough routine checks of $\dot{B}$.

For highest precision the coil output voltage should be measured by balancing it exactly against a known d.c. voltage.

A faster method is to overload the CRO very heavily, which some types of newer Tektronix will stand without drift, and to use the built-in calibration voltage.

Good agreement (2 o/oo) was found between the results obtained by both methods. With a value for the area-turns of $A = 0.3077\ m^2$ the rate of rise at injection was measured as $\dot{B} = 1.425\ Wb\ m^{-2}\ s^{-1}$ for the 90 c/o voltage cycle.

4. Measurement of p.f.w. and lens currents :

For the measurement of the p.f.w. and lens currents a shunt had been incorporated in each of the supply loops. The voltage across these shunts can be connected to both CRO inputs by switching the scope input selectors to the appropriate setting. The shunt constants are given in Table IV.

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Table IV : Shunt constants.

Pole face windings	Quadrupoles	Sextupoles	Octupoles
0.5 A/mV	0.66 A/mV	10 A/V	10 A/V

It should be noted that the current in the p.f.w. and lenses, which is measured, needs not necessarily to be equal to the current supplied by the generators on account of the voltages induced by the main magnetic field.

5. Measurement of the programme voltages :

This measurement is mentioned here only for completeness sake; all the details have already been given previously [1].

6. Facilities for calibrating and checking the measured values :

As a first facility for calibrating and checking the measured values, a two beam scope has been chosen and provision has been made for displaying a signal either simultaneously on both channels or together with another relevant signal. The various possibilities will be apparent from Table V.

Table V : Scope input selectors.

Scope input No. 1 (Upper trace)		Scope input No. 2 (Lower trace)	
Integrator	(B_{dyn}, n_{dyn})	$\dot{B}$	(rate of flux rise)
Peaking strips	(B_{rem}, n_{rem})	Ampli 1-4	
B pulses	(B 10 pulse train)	Programmes	
Shunts	(p.f.w. and lens currents)	Shunts	(p.f.w. and lens currents)
0 scope check	(input short-circuited)	0 scope check	(input short-circuited)
		TIT - 35 pulse	(Injection)

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The possibility to short-circuit the scope input between measurements and the availability of the TIT-35 pulse have proved particularly useful for measuring accurately the main p.f.w. current at injection, which should be zero. This measurement is important because a current as low as 700 mA markedly upsets the proper behaviour of the circulating beam. Its execution needs a certain care as the voltage to be measured is only a few hundred microvolts (cp Table IV) and varies noticeably with time. By short-circuiting the scope input before and after this measurement, any drift of the scope amplifier (which may be of the same order as the voltage to be measured) can be allowed for immediately. Provided it falls on the screen, the TIT-35 pulse on the lower trace determines the x co-ordinate at which the reading of the voltage on the upper trace has to be taken, independently of the scope trigger, the horizontal sweep speed and the given particular rate of flux rise.

The second special feature is the possibility to start and stop the CRO trace at any time during the magnet cycle [1] thus enabling one to expand any part of a particular curve which one wants to study. At the same time the occurrence of any particular point can be located in time, in terms of the flux density on the equilibrium orbit.

The facilities for starting and stopping the integration at freely chosen moments have already been explained in 2.1.

7. Acknowledgements :

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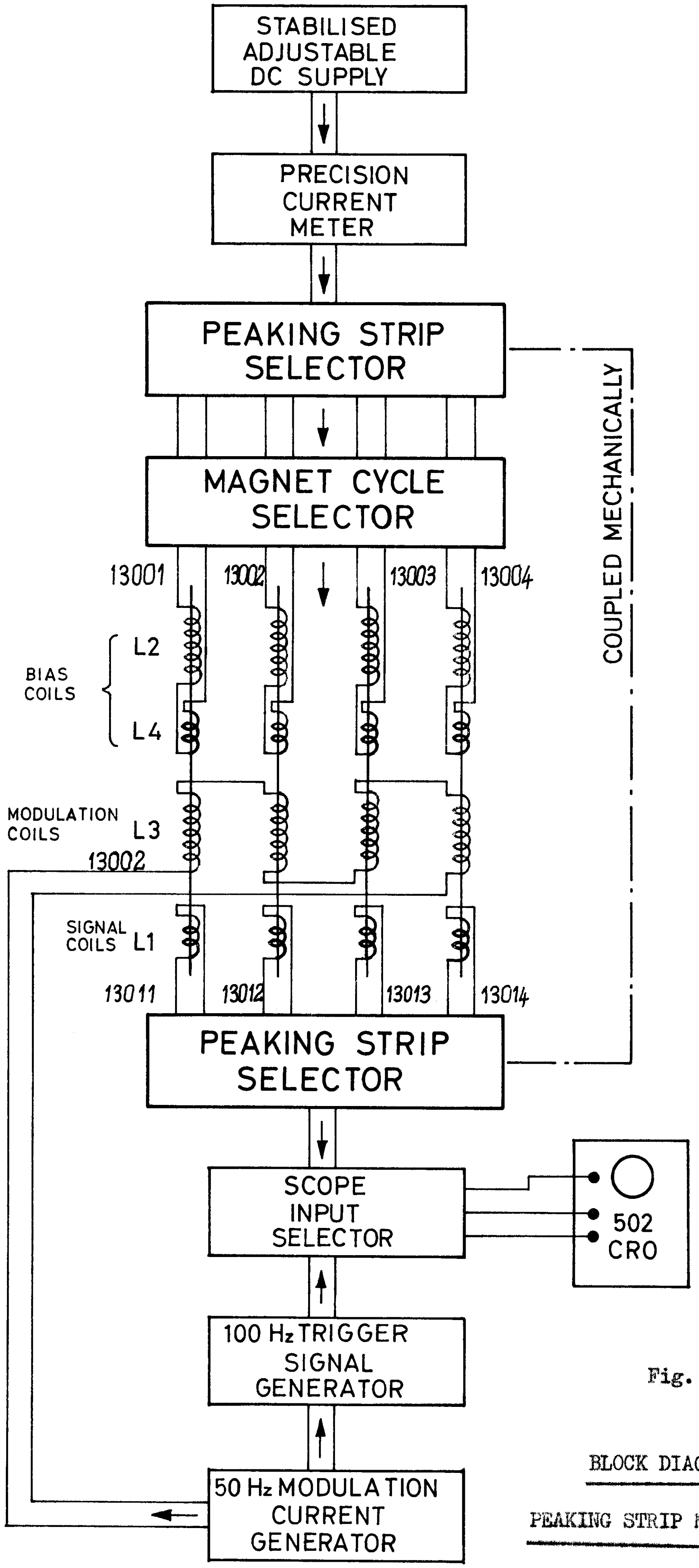


Fig. 1

BLOCK DIAGRAM OF

PEAKING STRIP MAGNETOMETER

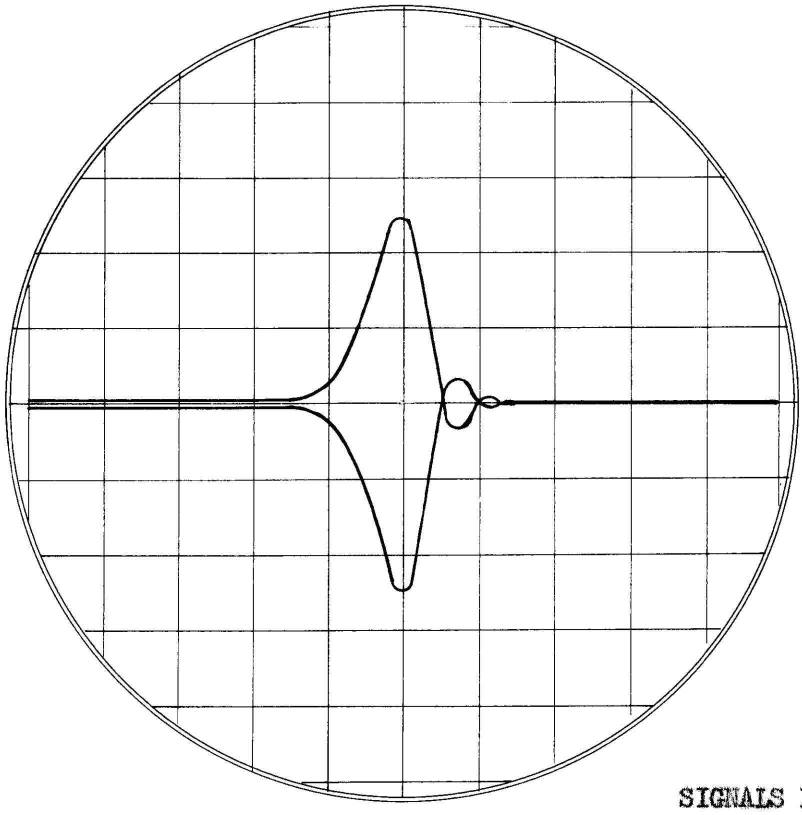


Fig. 2

SIGNALS FROM PEAKING STRIP

IN ZERO MAGNETIC FIELD

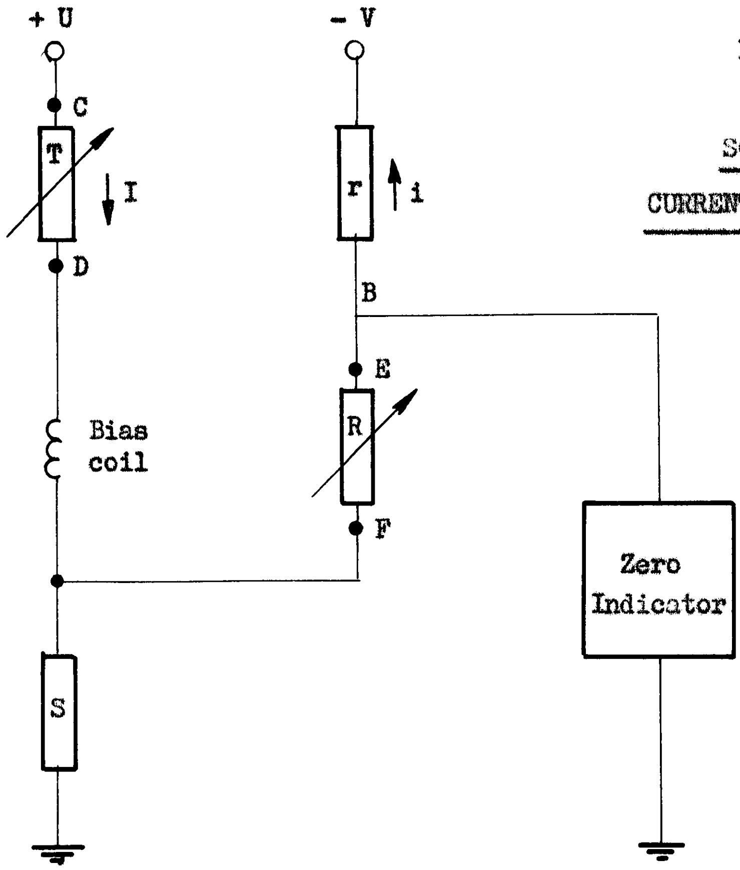


Fig. 3

SCHEME OF

CURRENT MEASUREMENT

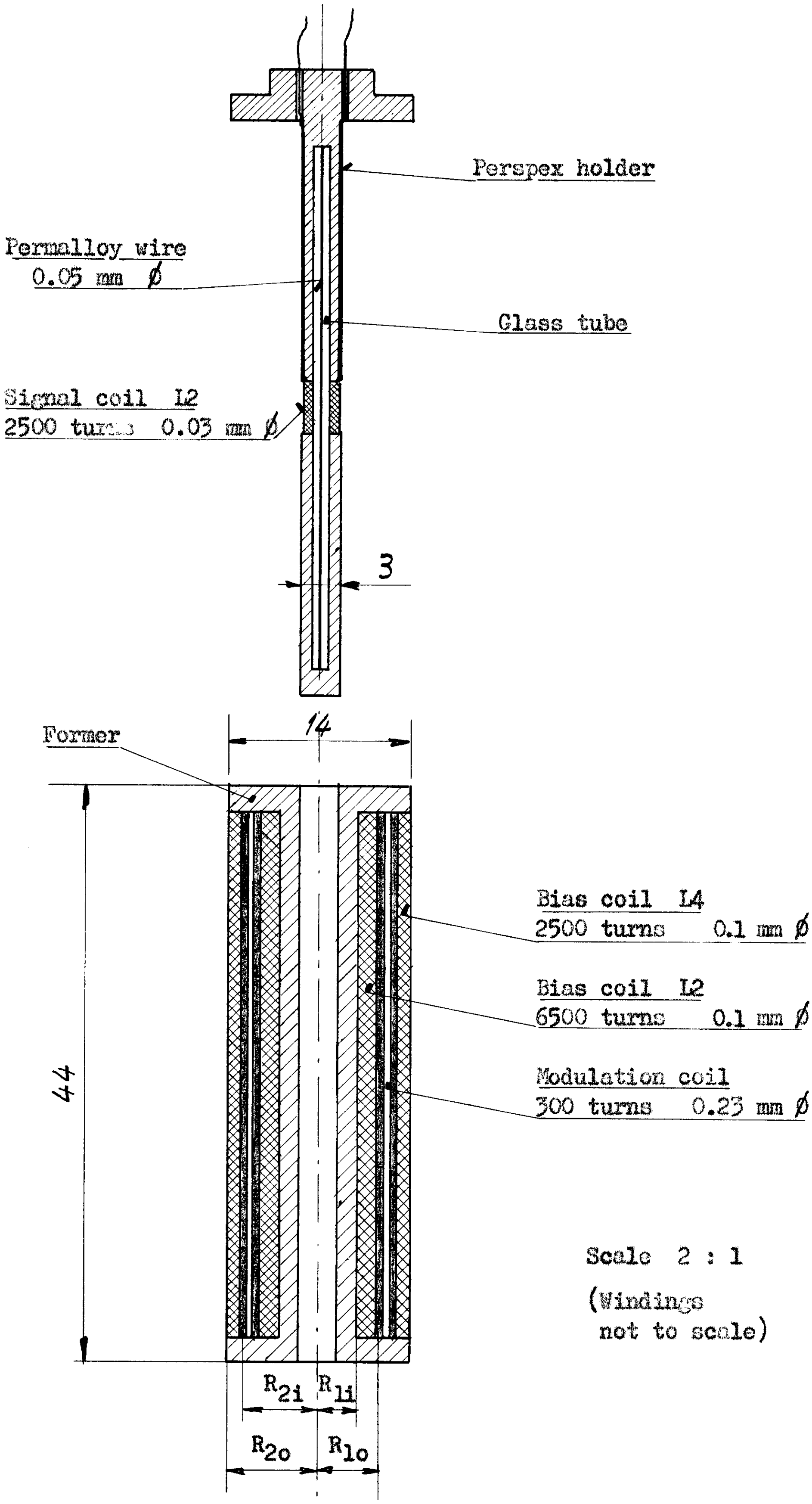


Fig. 4

PEAKING STRIP AND COIL ASSEMBLY

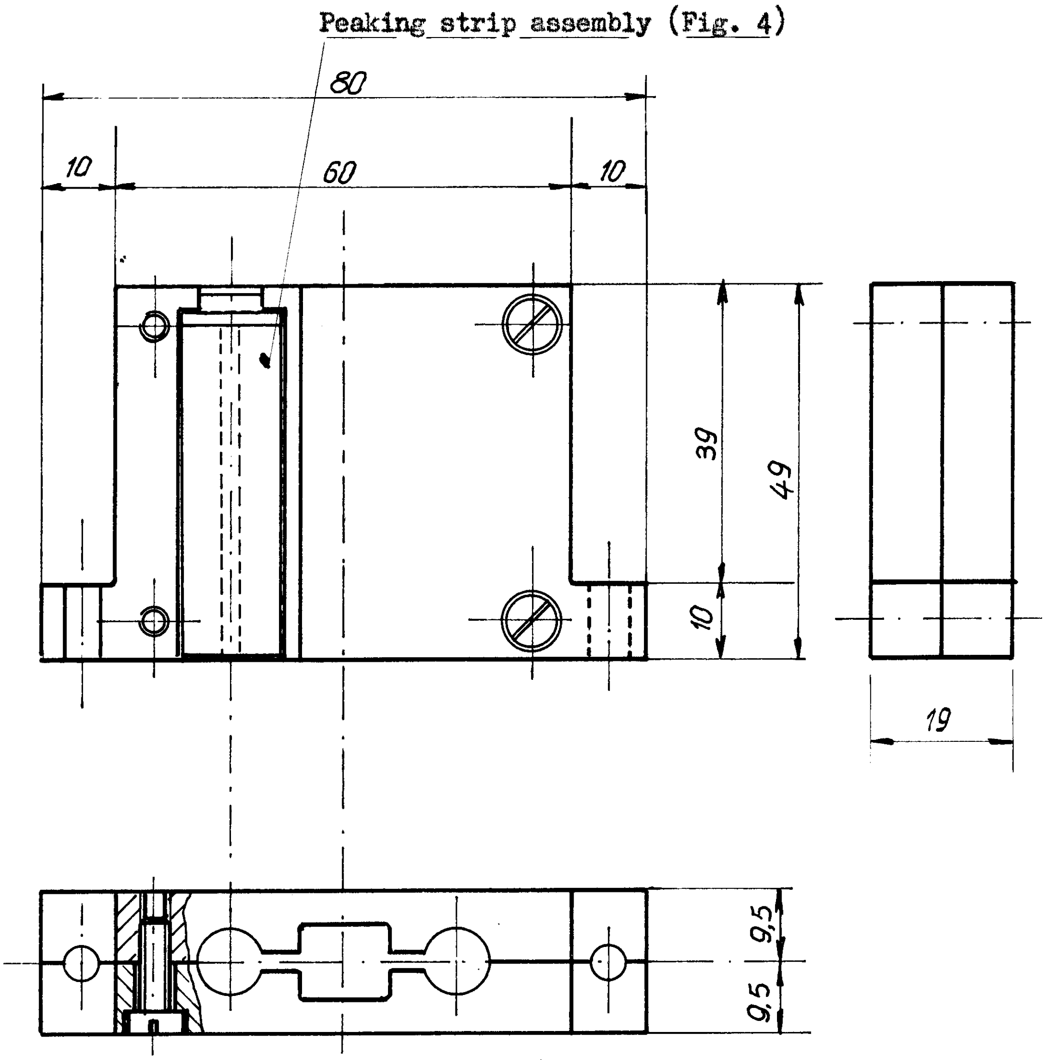


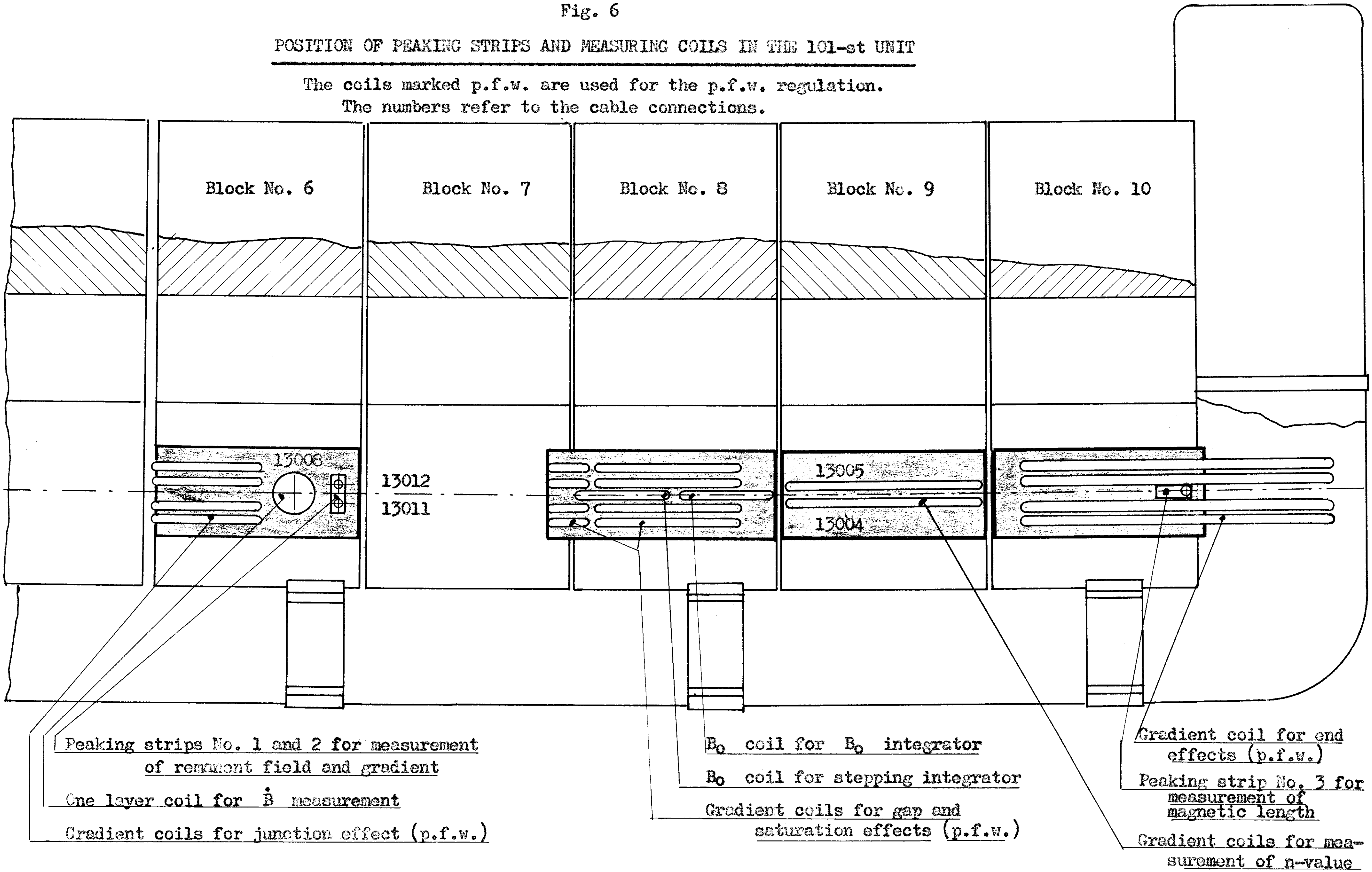
Fig. 5

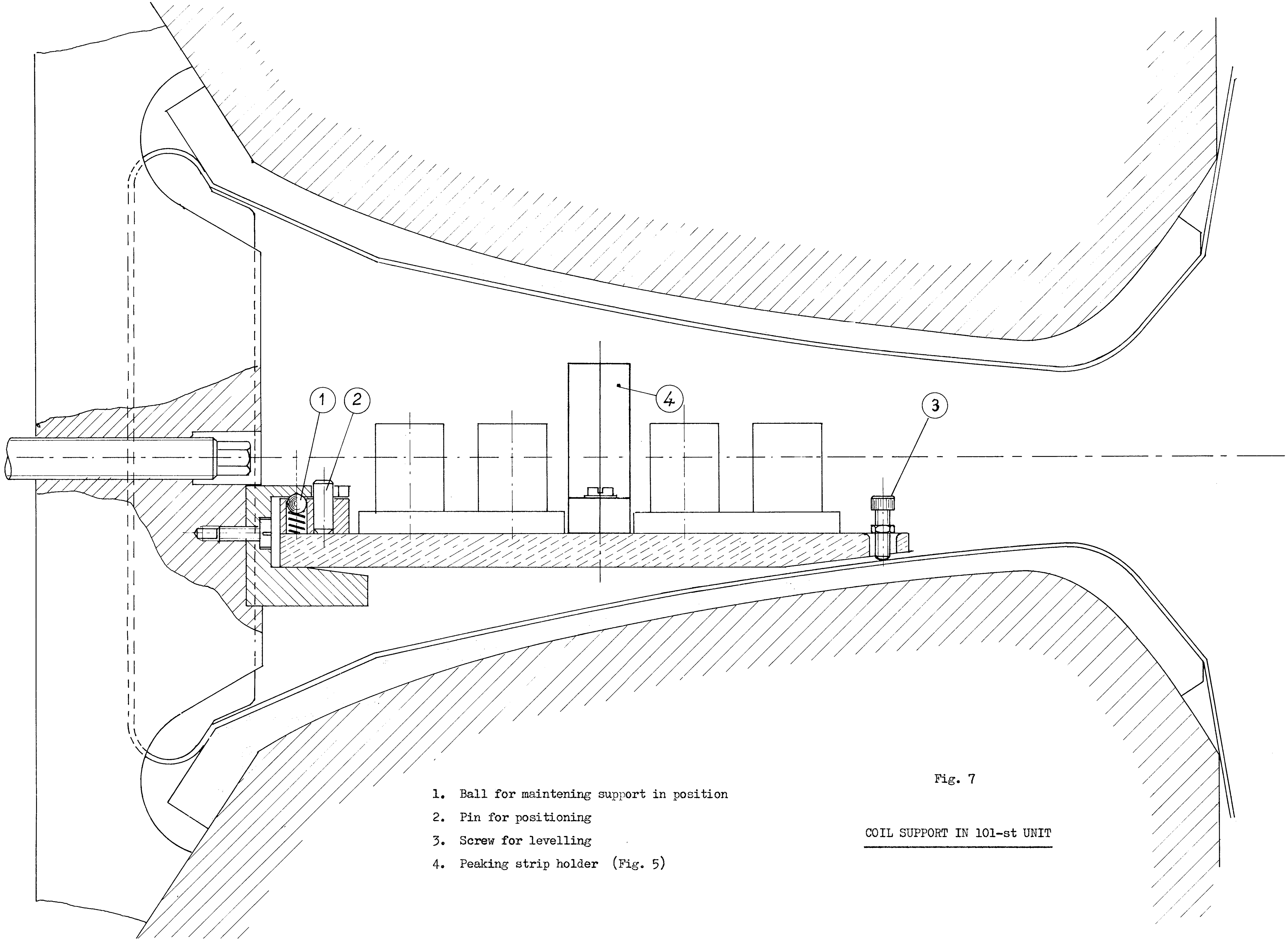
HOLDER FOR PEAKING STRIPS

Fig. 6

POSITION OF PEAKING STRIPS AND MEASURING COILS IN THE 101-st UNIT

The coils marked p.f.w. are used for the p.f.w. regulation.
The numbers refer to the cable connections.

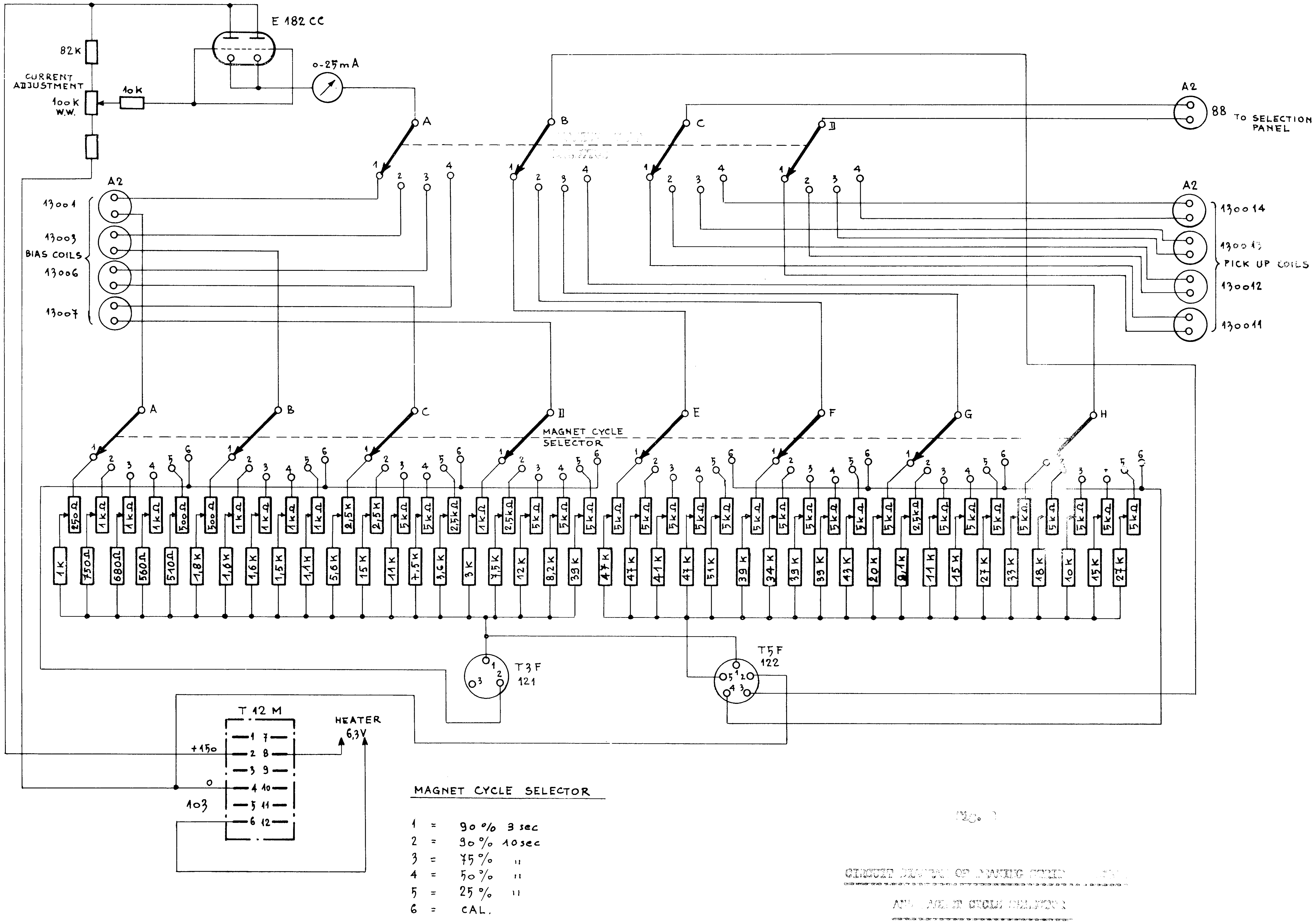




1. Ball for maintening support in position
2. Pin for positioning
3. Screw for levelling
4. Peaking strip holder (Fig. 5)

Fig. 7

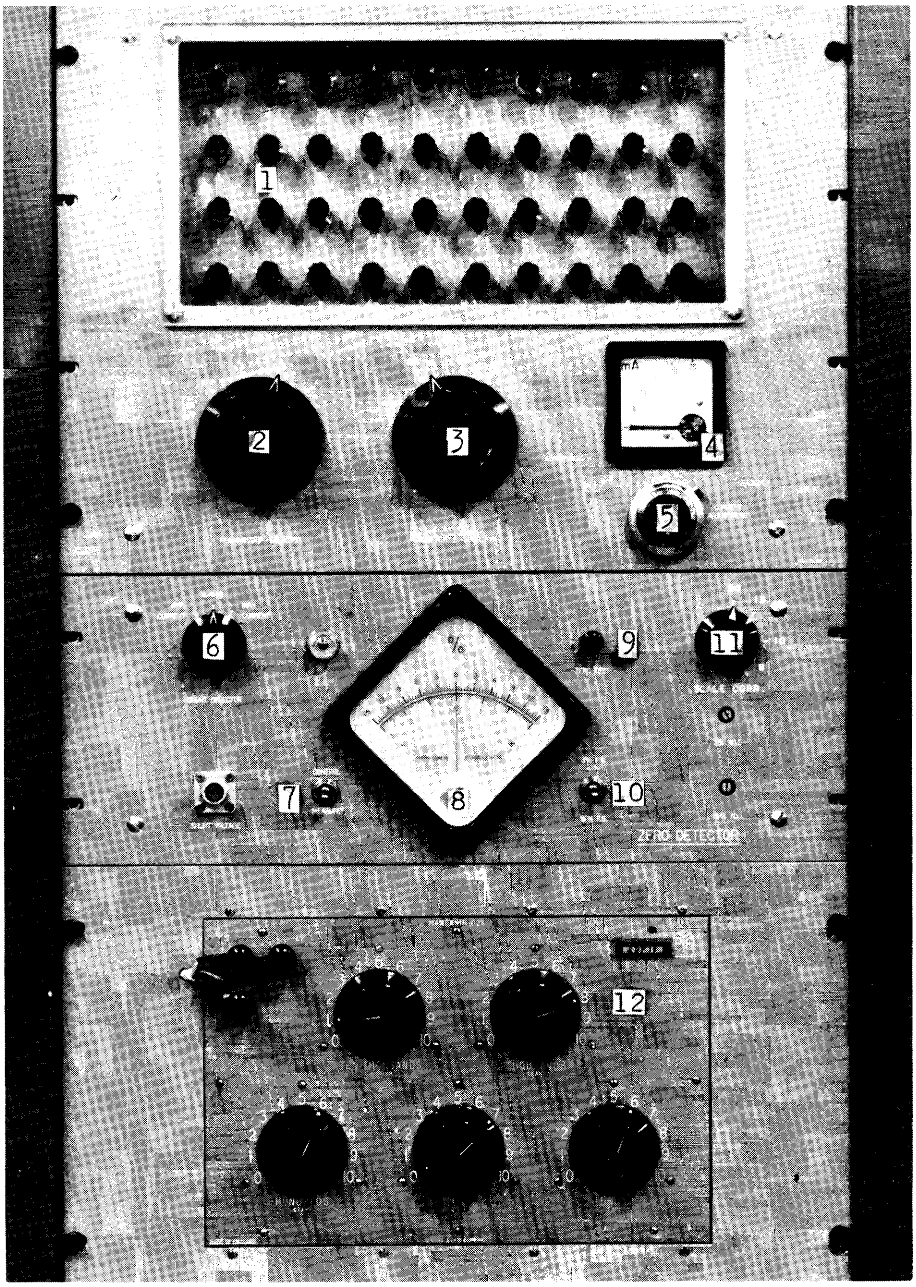
COIL SUPPORT IN 101-st UNIT



E 182 CC
82 K
CURRENT ADJUSTMENT
100 K W.W.
10 K
0-25 mA
A2
88
TO SELECTION PANEL
BIAS COILS
13001
13003
13006
13007
PICK UP COILS
130014
130013
130012
130011
MAGNET CYCLE SELECTOR
T 3 F
121
T 5 F
122
T 12 M
HEATER 6,3 V
+150
0
103
MAGNET CYCLE SELECTOR
1 = 90 % 3 sec
2 = 90 % 10 sec
3 = 75 % "
4 = 50 % "
5 = 25 % "
6 = CAL.

Fig. 9

CONTROLS FOR PEAKING STRIP MAGNETOMETER



1. Potentiometers for adjusting fixed values of bias current (cp Fig. 8)
2. Peaking strip selector
3. Magnet cycle selector
4. Bias current meter
5. Adjustment of bias current
6. Shunt selector
7. Switch S_2 for changing over from built-in fixed resistors to box No. 12
8. Zero indicator
9. Zero test
10. Scale selector
11. Scale correction
12. Resistance box (R of Fig. 3)

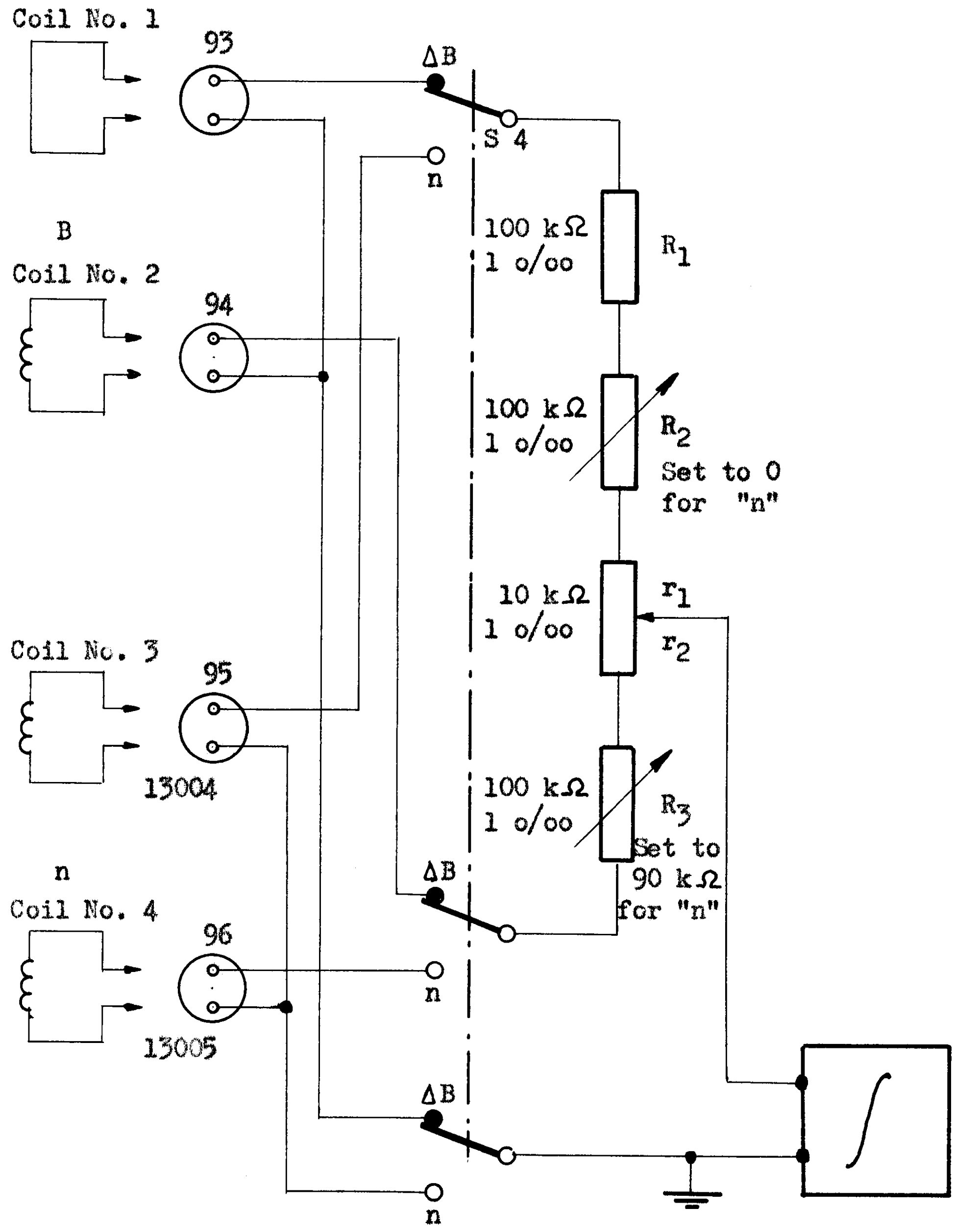
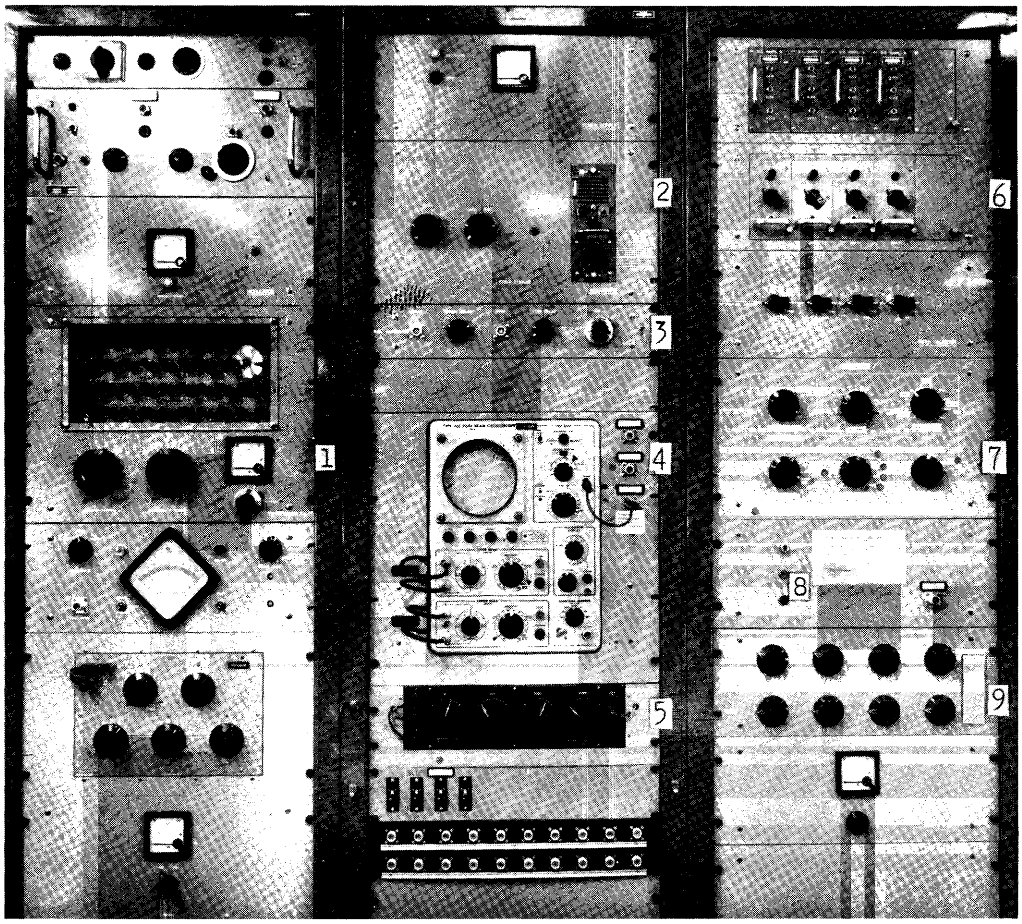


Fig. 10

INTEGRATOR INPUT CIRCUIT

Fig. 11

FIELD DISPLAY RACKS IN MAIN CONTROL ROOM



1. Peaking strip magnetometer (cp Fig. 9)
2. Integrator for dynamic measurements
3. Input panel for integrator on and off trigger
4. Scope trigger; lowest plug connected to No. 9
5. Resistance box for n and $\triangle$B measurements (r_1, r_2 of Fig. 10)
6. Amplifiers for signal distribution
7. Scope input selector
8. Output plugs for No. 9
9. Timing unit for on and off pulses