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TECHNICAL REPORT

No.: SP/GLR-61-9

Title:

FEEDING DEVICE FOR MAGNETIC ANTENNAS AND PARTICULARLY FERRITE ROD ANTENNAS.

Summary:

The report describes a feeding device for magnetic antennas which generates a defined, homogeneous magnetic field free from an electric field.

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All examinations about the receiving properties of ferrite rod antennas, measurements of sensitivity of receivers with ferrite rod antennas, measurements of sensivity of receivers with ferrite rod antennas as well as the production line control of the finished product require an accurate and easily reproducable method of measurement.
The method proposed by the IEC constists of a screened frame of three turns which is fed via a resistor of 403 Ω. The receiving coil is placed at a distance of 60 cm. The third power of the distance enters the result of the measurements. Here lies the first major difficulty. In the case of a simple coil, which is not too long, its mid-point may be taken as reference point with sufficient accuray. But what shall be considered as the point of reference for the 60 cm distance in the case of a ferrite rod with a length of, e.g., 20 cm and with the coil mounted on one side? This point could naturally be found out, but it would be too laborious even for laborotary purposes. Furthermore, the current through the screening can no longer be neglected at 1500 kc/s which causes an electric field interfering with the wanted magnetic field. This makes the measurement of the image frequency selectivity dependent upon the position of the object measured. And, in addition to that, the magnetic field of this set-up of measurement experiences in the usual 4 m^2 screened rooms a distortion which cannot be neglected. For all these reasons Schaub-Lorenz has chosen another way to feed a ferrite rod antenna.
A device was developed with the aid of which a defined, homogeneous magnetic field of suffiecient extension may be generated into which the receiver may be placed and which is largely free from an electric field within the wanted frequency range of 100 kc/s to 15 Mc/s.
The receiving properties of receivers with regard to the electric field are very much changed due to the connections to the receiver (power supply, tube volt meter) which are necessary for the measurement so that in the presence of electric fields the measurements will be dependent upon the feeding polarity of the ferrite rod antenna.
As a result of extensive experiments the feeding device takes the form of a coil of four turns. Fig. 1 shows the aluminium chassis with the four loops of the coil the exterior screening of which is slotted on top. The volume of the coil is 44 dm^3 of which 24 dm^3

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are useful for the measurements. This chamber is sufficient to measure even larger mains receivers. The handy size of the whole installation allows it to be used in the normal screened rooms. Each single turn has a double screen. They are fed individually. The two outer turns are fed with twice the current of the inner two. This increases very much the homogeneous field. The outer screen consists of a brass pipe, while the second inner screen is given by the screen of the 60 Ω cable.

Fig. 2 represents the principle of a single loop and Fig. 3 shows the whole set-up, with the four loops. Fig. 4 and 5 shows the dimensions of the feeding generator and the size of the useful space in which the error is Δ H.

$$-5\% H \leq \Delta H \leq +5\% H.$$

The avoidance of unwanted resonances within the measuring range and within a useful space of sufficient size was the major difficulty in developing this device. Resonances of the cable mantle with the inner conductor or of the cable mantle with the screening pipe falsify not only the current within the loop which produces the magnetic field, but they also produce strong currents through the screens which in turn causes an unwanted electric field. For this reason each turn is fed separately, which allows the internal resistance of the feeding source to be larger than they would have to be were they fed by a common source. By virtue of these resistances each loop on its own is damped appreciably and decoupled against the others as far as their currents are concerned. In order to even out an increase of the magnetic field strength, which is beginning at 15 Mc/s, the inner screens were also damped. The first resonance of the apparatus occurs at a frequency over 20 Mc/s which is beyond the measuring range. The input resistance of the arrangement is 60 Ω and the values of the resistors were chosen so that the magnetic field strength (H) equals

$$H = 2{,}652 \times 10^{-3} \cdot e \left[\frac{V}{m}\right]$$

(where e is the E.M.F. of the signal generator with an internal resistance Ri = 60 Ω)

It is general practice to refer the receiving properties of magnetic antennas not to the magnetic field strength (H) but to the electric field strength (E). The relationship between those two terms in the

$2,652 \cdot 10^{-3} \cdot 377 \approx 1$

long distance field of a transmitter is

$$E = H \cdot Z_0 \qquad E = 2,652 \cdot 10^{-3} \cdot e \cdot Z_0$$

(where $Z_0 = 377\ \Omega$, the characteristic impedance of free space).

From this formula follows the simple relationship for the feeding generator

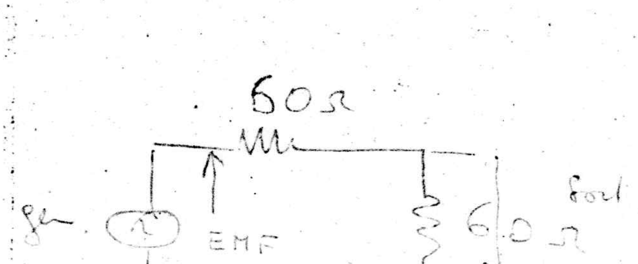
par exemple

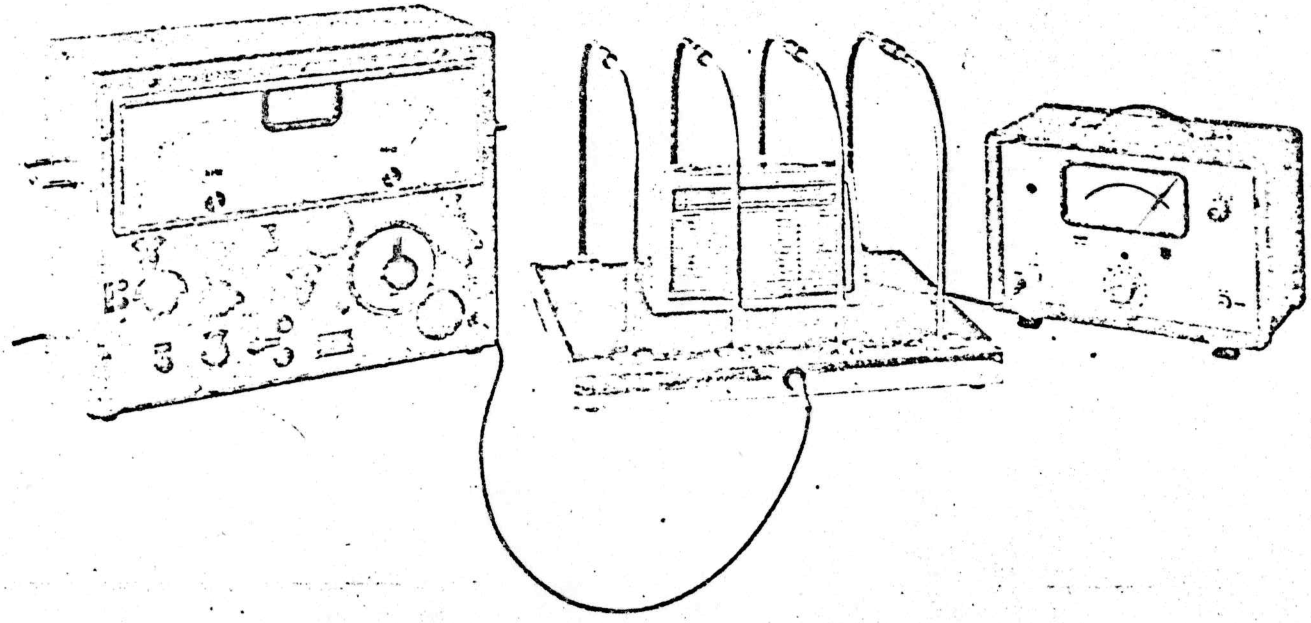
$$E = e \quad \left[\frac{V}{m}\right]$$

i.e., the E.M.F. of the signal generator equals the electric field strength in V/m. The accuracy of the field produced is within ± 10%. Within the useful space a further error of ± 5% is tolerated which gives a total deviation (ΔE) of

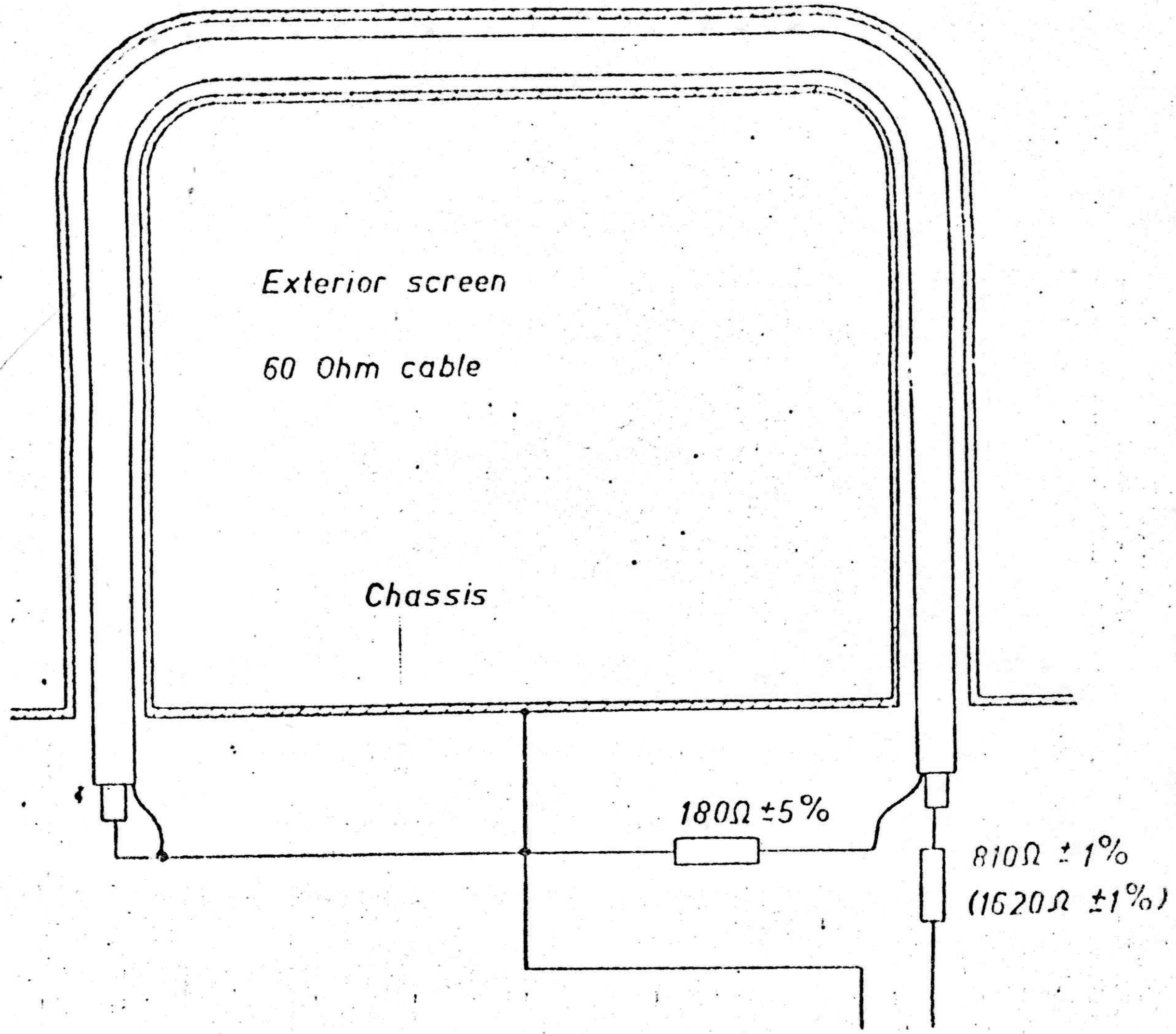
$$-11,5\% \leq \Delta E \leq +11,5\%$$

As the measurement is based upon the interior magnetic field of a coil, the measured values will hardly be influenced by the presence of exterior metal bodies. There is no need for a large space surrounding the whole installation to be free from metal objects as is necessary in the case of the IEC-method. It is, therefore, possible with this arrangement to reproduce all measured values at any place. When measurements are carried out on high quality broadcast receivers which require for a signal-to-noise ratio of 6 dB only 20-32 µV/m, very stringent requirements have to be observed with regard to the screening of the signal generator used. The signal generator used not only has to have a sufficient screening for the electric field, which is usually the case, but also for the magnetic field. A magnetic field which may be present can in many cases be made ineffective by an intelligent arrangement of the signal generator and the feeding apparatus.

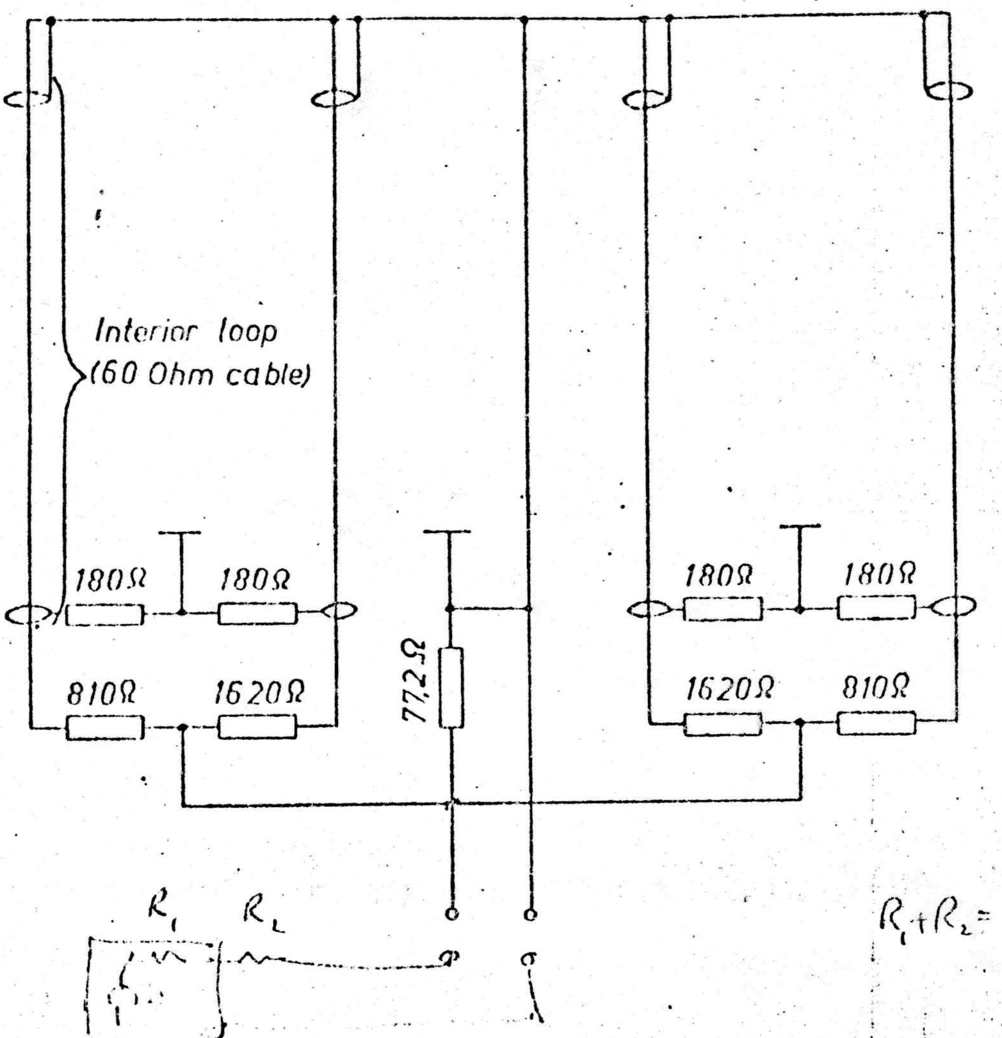




Arrangement of measurement with the feeding device



Schematic diagram of one loop



$R_1 + R_2 = 60\,\Omega$.

Circuit diagram of the four loops

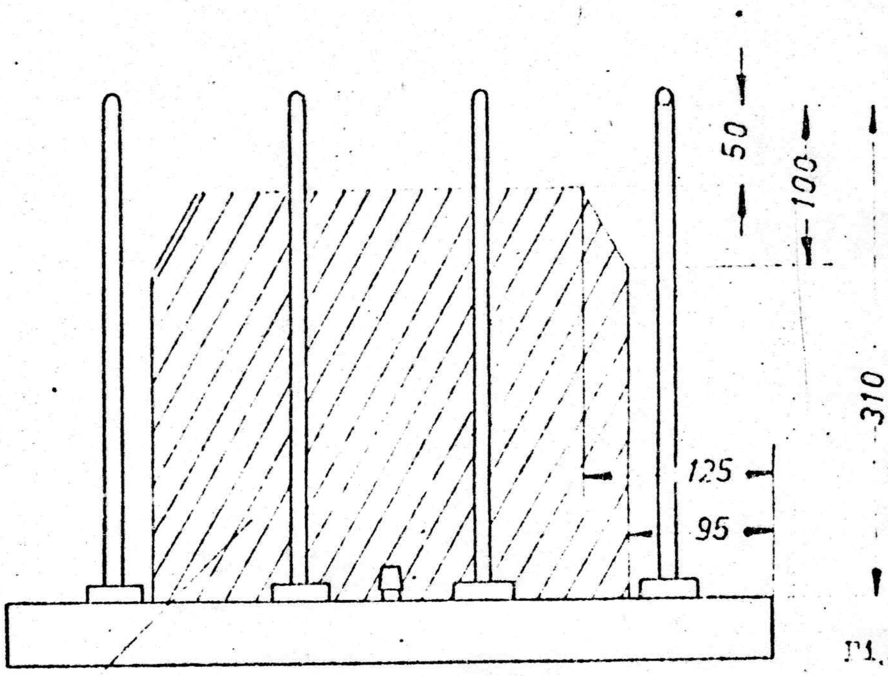


Fig. 4

$-5\% \leqq \Delta E \leqq +5\%$

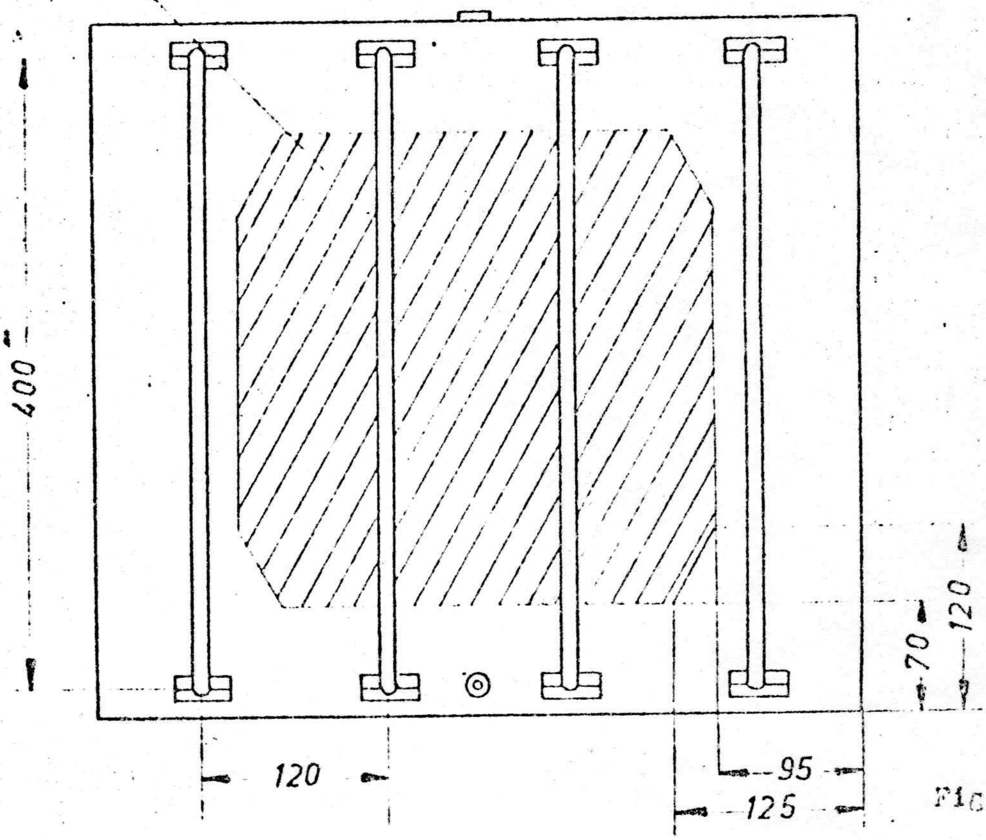


Fig. 5

Dimensions of the feeding device, the shaded areas designate the useful space