MAGNETIC FIELD CONTROL USING NMR GAUSSMETER

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We applied NMR gaussmeters (SCANDITRONICS, NMR 751) to the magnetic field control over two dipole magnets D1 and D2 in a heavy-ion mass-spectrometer which was installed by us, in 1981, in Japan Atomic Energy Research Institute.

In employing the gaussmeters, we focussed our attention on the following items with conventional current control power supplies in mind.

(a) Realization of magnetic field with high stability.

(b) Shorter settling time down to steady state.

(c) As simple an operation as possible.

As for (a), field stability obtainable will depend upon the inherent characteristics for the gaussmeter actually used.

As for (b), even shorter settling time will be expected than those of the current control power supplies, since the system positively searchs for resonance.

As for (c), the operation tends to become complicated because field error is unavailable from the gaussmeter except around the resonance point.

This drawback, however, shall be overcome by constructing the system so that reference field has only to be preset.

The specifications for the magnets are summarized in Table 1.

Table 1.

Parameters		D1	D2
Max. magnetic rigidity	(KG.m)	17	17
Homogeneity of field		5×10^{-4}	5×10^{-4}
Max. ampere turns		1.344×10^{5}	1.680×10^{5}
Max. current/voltage	(A/V)	1020/95	970/130
Pole gap	(mm)	80	100
Field stability	5 hours	1×10^{-5}	1×10^{-5}

Fig.1 shows a simplified schematic diagram of the system, the operation of which will be explained by using Fig.2 as follows.

1. Immediately after a reference field Bo is loaded in a register, a bias circuit increases linealy the coil current towards Io which is near the current corresponding to the reference field.
2. Simultaneously, a triangular-wave signal is produced with an amplitude Is from a current sweeper, being superimposed on Io in the succeeding adder.
3. After Io settles down Is still continues sweeping. When the field approachs the condition for resonance, the gaussmeter generates an error signal with a polarity and an amplitude corresponding to the field deviation. At almost the same time, the sweeping is stopped by a signal, " Resonance Present. "
4. Henceforth, the field will be fully under the gaussmeter control.

Fig.3 shows an example of the variation of magnetic field with time. The stability read off the figure is well within 1 x 10^{-5}/3 hours. Fig.4 shows an example of the transient field response around the resonance. The time required for the resonance to be reached is about three minutes after a reference field of 15.5 KG is loaded in the register, though it is not evident from the figure.

The system described above have been operating satisfactorily since its delivery.

We are deeply grateful to Dr. N. Shikazono and his colleagues of JAERI for the support of this work.

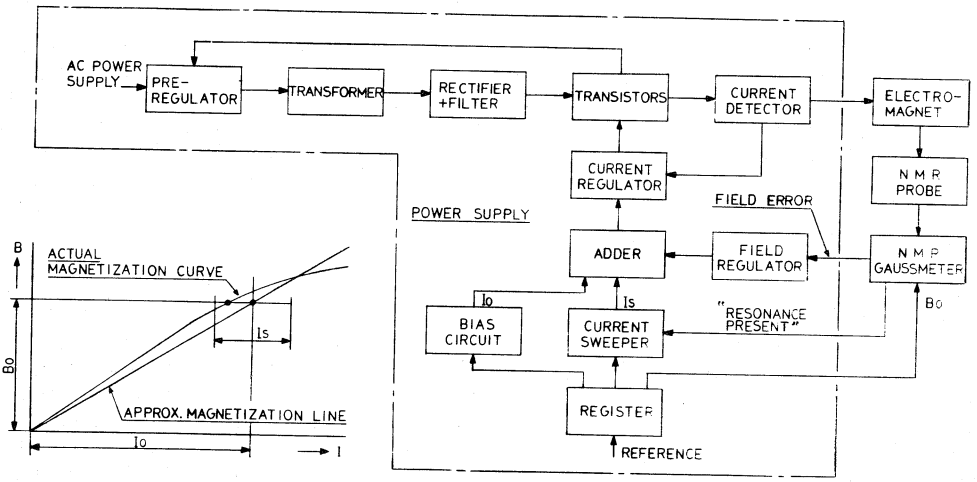

Fig.2 Magnetization curve. Fig.1 Simplified schematic diagram of system.

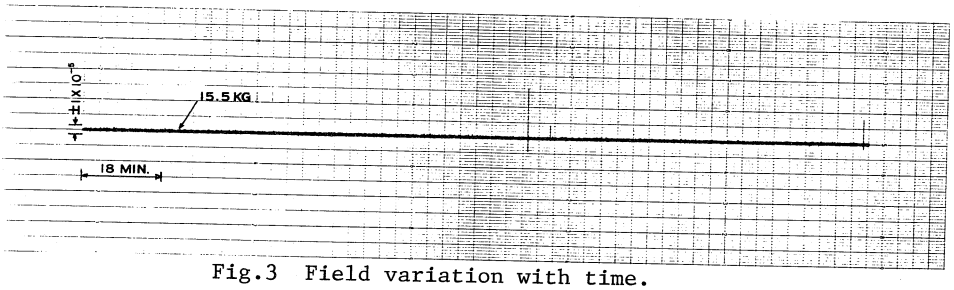

Fig.3 Field variation with time.

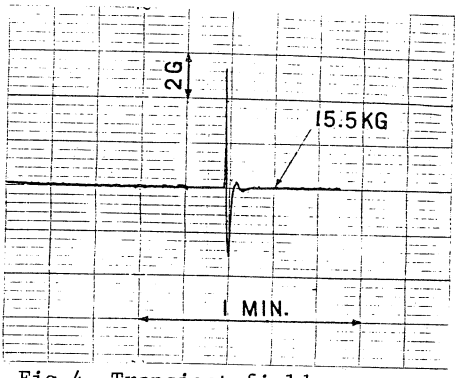

Fig.4 Transient field response.