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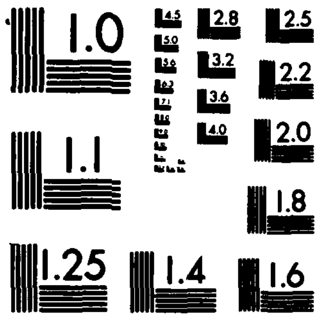
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FOREIGN TECHNOLOGY DIVISION

NMR SENSOR FOR CALIBRATING THE FIELD OF A SUPERCONDUCTING SOLENOID

by

V.B. Pluzhnikov

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EDITED TRANSLATION

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Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*<u>ye</u> initially, after vowels, and after ъ, ь; <u>e</u> elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

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NMR SENSOR FOR CALIBRATING THE FIELD OF A SUPERCONDUCTING SOLENOID

V. B. Pluzhnikov

Submitted 28 April 1972

A description is given of a simple construction of a magnetic-field sensor, making it possible to carry out the absolute calibration of the field of a superconducting solenoid by the NMR method with the help of the IMI-2 (Ye11-2) device which is produced by or own [Soviet] industry.

In recent years abroad the method of nuclear magnetic resonance [NMR] has received wide application for the absolute calibration of the field of superconducting solenoids [1-3]; in our country this has been hindered by the absence of a series-produced gaussmeter with a sensor for operation in liquid helium.

A description is given below of the construction of a NMR sensor for the series-produced [Soviet] IMI-2 (Ye11-2) gaussmeter, used by us for the calibration of the field of a superconducting solenoid in experiments on studying the De Haas-Van Alphen effect (DKhVA) on transition metals [4].

On a paper housing with a diameter and length of 3 mm each a coil made out of nine windings of PELShO brand wire 0.1 mm in diameter was wound, and inside paraffin with a large amount of fine aluminum powder was poured. The dimensions of the grains of powder should be of the order of depth of the skin layer for obtaining the maximum NMR signal from that particular volume of the sample. It turned out that the commercial pigment "serebryanka" [silver steel] is completely suitable for this purpose. The sample prepared in this manner was inserted in a fluoroplastic holder, secured on the end of a rigid coaxial cable, connecting the coil mentioned above with the input of a gaussmeter autodyne, and thus forming its high-frequency oscillatory circuit. The low-temperature section of the cable 1.2 m long was fabricated out of two thin-walled tubes of stainless steel 16 mm and 3 mm in diameter (for reducing heat input and the natural capacitance of the cable), and outside of the cryostat this was ordinary coaxial cable 0.3 m long. The range of frequencies spanned by the autodyne with this NMR sensor turned out to be 5.7-17.4 megahertz and was measured with a Ch4-1 heterodyne wavemeter.

The small modulating field of ~ 30 G, necessary for observing the NMR signal, was created by a cylindrical coil 30 mm in length, powered from a network through a LATR [laboratory autotransformer] and a filament transformer. The axis of the modulating coil coincided with the direction of the magnetic field in the solenoid and was perpendicular to the axis of the high-frequency coil around the sample.

A resonance curve was observed on the screen of the S1-19 oscillograph in fields of 2-4 kG from protons (H^1) in paraffin and from the nuclei of fluoron in fluoroplast (material of the sample holder), and further at 5-16 kG from nuclei of Al^{27} [3]. Signal/noise ratio = 10 V, field 12 kG. Using the point of intersection of the two branches of the resonance curve for marking the field, it is easy to distinguish a change in the field of 1 G. The device was used for calibrating the field of an uncorrected solenoid of the cylindrical type with geometric dimensions of the winding: length - 156 mm, outer diameter - 115 mm, inner diameter - 25 mm, made with a seven-core cable 1 mm in diameter which was made of the superconducting alloy 65-BT. The housing of the solenoid was fabricated from nonmagnetic stainless steel. The current in the winding was measured with the help of a PP-63 potentiometer and an F116 device. The accuracy of recording the current produced an error in the determination of the field of ±10 G. During calibration of the field in the solenoid it turned out that its constant C=H, kG/I, and depends on the field in the same manner as in [1], and its value obtained at 16 kG differed by 0.2% from its magnitude in large fields (greater than 30 kG), determined based on the DKhVA effect [5]. Determination of hysteresis in the solenoid showed that the maximum residual field (on the level of 2 kG) does not exceed 60 G; for solenoids with a Nb-Zr winding it is considerably greater [6].

In conclusion let us note that the method described for the absolute calibration of the field of superconducting solenoids is convenient and does not require special experience.

I express my sincere thanks to I. V. Svechkarev for attention to the work and to V. V. Zhukov and P. S. Kalinin for useful information on the experimental method.

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