



## LXVIII. On the self-demagnetizing factor of bar magnets

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**To cite this article:** Silvanus P. Thompson D.Sc. F.R.S. & E.W. Moss (1909) LXVIII. On the self-demagnetizing factor of bar magnets , Philosophical Magazine Series 6, 17:101, 729-739, DOI: [10.1080/14786440508636649](https://doi.org/10.1080/14786440508636649)

**To link to this article:** <http://dx.doi.org/10.1080/14786440508636649>



Published online: 21 Apr 2009.



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indicates that it is an inert gas, and similar in that respect to the group of monatomic gases. Taking the view that it is monatomic, the emanation is the heaviest gas known with a density 111 times that of hydrogen.

For purposes of comparison, the atomic weight, boiling-point, and density of liquid of the heavier monatomic gases are given below.

	Argon.	Krypton.	Xenon.	Radium Emanation.
Atomic Weights .....	39.9	82	128	222
Absolute Boiling-point...	86°.9	121°.3	163°.9	208°
Density of liquid at Boiling-point ... } ...	1.212	2.155	3.52	5 ?

It is seen from the above table that the boiling-point of xenon is about a mean between that of krypton and the emanation. From the increase of density of the liquid with atomic weight, it might reasonably be expected that the density of liquid emanation should be about 6—a result, as we have seen, not inconsistent with experiment. In a similar way, it is possible to form some idea of the probable critical pressure and temperature of the emanation.

I desire to express my thanks to the Radium Commission of the Vienna Academy of Sciences for the loan of the radium preparation which has made this and other work on the emanation possible.

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LXVIII. *On the Self-Demagnetizing Factor of Bar Magnets.*  
By SILVANUS P. THOMPSON, D.Sc., F.R.S., and E. W. MOSS\*.

[Plate XV.]

**T**HIS paper consists of three parts:—(i.) A discussion of the significance and definition of the self-demagnetizing factor of magnets in general, and of bar-magnets in particular; (ii.) a redetermination of the values of the self-demagnetizing factor for bar-magnets of circular section; (iii.) determination of the values of the self-demagnetizing factor for bar-magnets of rectangular cross-sections of various proportions.

#### PART I.—PRELIMINARY. ON THE SIGNIFICANCE AND DEFINITION OF THE SELF-DEMAGNETIZING FACTOR.

Between any two magnet-poles, whether they are regarded as points, or as regions over which there is a surface-distribution of magnetism, there are magnetic forces. In

\* Communicated by the Physical Society: read February 26, 1909.

the space between any two point-poles the intensity of the magnetic field that is due to these poles, at any point in the line joining them, is expressed by the equation :

$$\mathcal{H}_x = \frac{m_1}{(a+x)^2} - \frac{m_2}{(a-x)^2};$$

where the respective strengths of poles are  $m_1$  and  $-m_2$ ;  $a$  the half of the distance between them, and  $x$  the distance of the point in question from the mid-point between them. The value of this expression in no way depends on the material in the space between the poles, whether non-magnetic or magnetic, or actually magnetized in any manner.

If  $m_1$  and  $-m_2$  are numerically equal, the expression becomes :

$$\mathcal{H}_x = 2m \frac{a^2 + x^2}{(a^2 - x^2)^2}.$$

At the mid-point, under the same condition, the intensity has the minimum value of

$$\mathcal{H}_{\min.} = 2m \div a^2.$$

If the space between the two point-poles be regarded as occupied by a thin, cylindrical, uniformly-magnetized steel magnet the ends of which constitute the point-poles in question, then these equations will be the expressions for a self-produced magnetic field acting in a direction which opposes the actual magnetism of the magnet, and tending to demagnetize it. Each portion of the filiform magnet will be acted upon by a demagnetizing field, strongest towards the poles, weakest at the middle. The supposed uniform magnetization of the magnet will of course be unstable. If it were produced, even for a moment, there would at once be a retrocession of a portion of the magnetization from the ends, with a new distribution of the polarity. On the supposition that the middle part of the rod retains still its full flux, the retrocession of the pole would shorten the effective length of the magnet, diminishing the magnetic moment, but increasing any self-demagnetizing internal action. This tendency to produce a retrocession of the pole may operate to different degrees according to whether the bar consist of soft iron, or hard tungsten steel. In either case the retreat of the pole can be only incomplete; because if we suppose the pole to have actually retreated by any given amount—for example 1 centimetre—the end piece of that length will now be subjected to the magnetizing action of the rest of the bar, and will be remagnetized up to a certain point, namely, such that the

reaction of the magnetism of this piece is equal to the magnetizing action of the whole of the rest of the bar, less the demagnetizing reaction of the bar as a whole. The inevitable result is a distributed pole. It cannot remain concentrated at one point, on the end; it must redistribute itself along the bar with a distribution determined by the conditions of equilibrium at every point.

Also the middle piece of the bar will not be exempt from influence, it, too, must diminish its inherent magnetism, because even in weak fields the magnetism of the hardest steel is subject to cyclical changes; and because any retrocession of the poles is, *pro tanto*, productive of an increase in the self-demagnetizing force at the middle. Only in cases where this self-demagnetizing force at the middle is less than that which suffices to produce an irreversible change in the magnetism of the steel, that is only in cases where the bar is very long in proportion to its cross-section, can the action at the middle be regarded as negligible.

It is clear then, in general, that for every bar-magnet there will be a self-demagnetizing action the value of which, at the middle of the bar, depends, for a given intensity of magnetization, on the length of the bar relatively to its cross-section, on the permeability of its parts, and on the distribution of its surface-magnetism. Owing to the circumstance that with every kind of steel the permeability is neither constant, nor stands in any simple or even single-valued relation to the flux-density, any calculation of the actual polar distribution for rods or bars is exceedingly complicated and indeed impracticable.

As is well-known, the one and only form of magnet that is practicable for calculation is that of the ellipsoid, the properties of which are that for any and every value of the permeability, and when placed in any uniform field, the surface magnetism is so distributed that the magnetic force which this distribution of polarity exerts in the interior is uniform at every point within. Hence the internal demagnetizing force everywhere within is constant; the resultant field at every point of the interior (if the structure is homogeneous and isotropic) is also constant, and the internal flux-density cannot but be uniform.

Du Bois and others have determined by experiment the demagnetizing actions of cylindrical rods of various dimensions, and have compared them with ellipsoids of revolution of similar dimensional proportions.

In the case of ellipsoids, it is natural to compare the value of the intensity of the self-demagnetizing force with the value

of the internal magnetization  $\mathcal{I}$ , because both of these are uniform throughout the interior. For an ellipsoid of revolution of given axial proportions, whether highly or only slightly magnetized, both  $\mathcal{H}_d$  the self-demagnetizing force, and  $\mathcal{I}$ , are proportional to one another. By definition  $\mathcal{I}$  is the quotient of the magnetic moment by the volume. For a given size of equatoreal cross-section of the prolate ellipsoid, the magnetic moment and the volume are both proportional to the axial length. But for ellipsoids of given equatoreal section and of different lengths, the self-demagnetizing force  $\mathcal{H}_d$  (for a given  $\mathcal{I}$ , or a given  $m$ ) does not follow any simple function of the axial length. For small changes of length it is nearly proportional to the inverse square of the axial length, but is accurately expressible only in terms deducible from a rather troublesome elliptic integral. Maxwell and Du Bois (following F. Neumann) have given the general formulæ. But because both  $\mathcal{H}_d$  and  $\mathcal{I}$  are for an ellipsoid of given ellipticity proportional to one another, it was quite natural to regard the quotient of the former by the latter—that is to say the amount of self-demagnetizing force per unit of intrinsic magnetization—as a sort of natural coefficient, and to recognize it as a *self-demagnetizing factor*. Du Bois (following Maxwell) assigns to it the symbol  $N$ . It has a definite value for ellipsoids of revolution of any assigned ellipticity. Thus for an ellipsoid of equatoreal diameter 1 and axial length 10, the value of  $N$  is 0.2549 whatever the degree of magnetization. Thus if an ellipsoid of this form be magnetized so that  $\mathcal{I}$  has the value 100 c.g.s. units, the self-demagnetizing force within the ellipsoid will everywhere have the value of 25.49 gauss. Denoting the dimension-ratio of axial length  $l$  to equatoreal diameter  $d$  by the symbol  $\mathfrak{m} = l \div d$  (in Du Bois' notation), then  $\mathfrak{m}^2 N$  varies from 25.49, when  $\mathfrak{m} = 10$ , to 80 when  $\mathfrak{m} = 1000$ . (See Du Bois, *The Magnetic Circuit*, p. 41.)

But, if we now compare the case of the ellipsoid with that of the cylindrical bar, we find that the matter is not so simple. For with the bar, as stated above,  $\mathcal{H}_d$  is by no means uniform throughout the interior, neither is  $\mathcal{I}$ . The former has its minimum at the middle point of the axis, while the latter has its maximum at the equatoreal section of the bar. To compute the value of  $\mathcal{H}_d$  at the middle point (or at any other) is impossible without knowing the law of surface distribution, and this depends on too many conditions to be of service. But the nett value of  $\mathcal{H}_d$  for the entire bar can be easily determined by comparing the  $\mathcal{B}$ - $\mathcal{H}$  curve of the bar (found

by experiment) with the  $\mathcal{B}$ - $\mathcal{H}$  curve of a ring (or infinitely long rod) of the same iron, and taking the difference of the values of  $\mathcal{H}$  for some assigned value of  $\mathcal{B}$ . On the other hand, values of  $\mathcal{I}$  can be found by experiment, either magnetometrically, giving the mean value, or ballistically, giving either maximum or mean according as whether the exploring coil on the bar is wound over its whole length or over its equatorial zone only. The ratio  $\mathcal{H}_d \div \mathcal{I}$  so deduced may still be called the *self-demagnetizing factor*, and values found for rods of different dimension-ratios.

Magnets of other forms, for example the slit toroid, or anchor-ring with a gap in it, and the horse-shoe magnet with parallel limbs of given proportions, will likewise have self-demagnetizing factors of their own, dependent on their geometry and on the distribution of their polarities. With them also, neither  $\mathcal{H}_d$  nor  $\mathcal{I}$  will have constant values at all points within the substance of the magnet; and for each form therefore the term "self-demagnetizing factor" bears a significance different from that which it possesses for the ellipsoid of revolution or for the cylindrical bar.

All previous writers have defined the term *dimension-ratio* as applied to a bar as the ratio between its length  $l$  and the diameter  $d$  of its circular section. But when we come to deal with forms of cross-section other than circular, it is inconvenient to use this mode of expression. For if we were dealing with a flat bar of breadth  $b$ , the curve for self-demagnetizing factors in terms of the ratio  $l \div b$  would not be comparable with those for cylindrical bars in terms of  $l \div d$ . The preferable way, when such comparison has to be made, is to state a dimension-ratio, for bars of all and every form of section, in terms of the ratio which is borne by the length to the square-root of the area of section. The ratio  $l \div \sqrt{A}$ , we accordingly propose to denote by the symbol  $\lambda$ . For any given bar we have the relation  $\lambda = m \times 1.128$ .

## Part II.—EXPERIMENTAL. ON THE VALUES OF THE SELF-DEMAGNETIZING FACTOR FOR BAR-MAGNETS OF CIRCULAR SECTION.

Several investigators, including Ewing, Fromme, Holz, and Ascoli, have written on the factor of self-demagnetization of cylindrical bar-magnets, and have given experimental values for bars having different ratios of length to diameter. The best-known results are those published by Du Bois, who has compared the values obtained with those for ellipsoids

having similar axial ratios. More recently, Riborg Mann obtained a series of values slightly higher than those obtained by Du Bois, who has accepted them as more correct than his own figures. Ewing's observations ranged over rods the lengths of which varied from 300 diameters down to 50 diameters. Du Bois' results go from a dimension-ratio of 1000 down to one of 10; those of Riborg Mann from one of 300 down to 5. The magnitude of the outstanding discrepancies may be indicated by stating the values found by different observers for the self-demagnetizing factor  $N$  for cylinders having a dimension-ratio of 50. For rods of this proportion Du Bois found  $N = 0.0162$ ; Riborg Mann  $N = 0.01825$ . For the ellipsoid of revolution having the same axial ratio of 50, Du Bois and Riborg Mann agree in assigning the value 0.0181, and presumably the true value for the cylinder is less than that figure. Greater discrepancy is found for shorter cylinders. For a dimension-ratio of 10 Du Bois gives  $N = 0.2160$ , while Riborg Mann gives  $N = 0.25500$ .

To clear up, if possible, such discrepancies a research was undertaken in the laboratory at the Technical College, Finsbury.

The bars used were cut from two long rods of best Swedish iron carefully annealed, and for comparison a ring was forged from the same material. To each and all of the rods the same diameter was given, namely, 1.128 cm., in order that each might have a cross-section of precisely 1 sq. cm. After being turned down to approximate size they were annealed, and then finally turned to the precise size required.

The magnetizing coil used to magnetize the rods was a long coil wound on a brass tube 91.4 cm. in length and 4.75 cm. in external diameter. It was carefully overwound with 5800 turns of wire of No. 20 s.w.g., in seven layers. With this coil a very uniform field could be produced of any desired intensity up to  $\mathcal{H} = 255$ . The uniformity of the field between the ends of this coil was tested by means of a short coil of somewhat smaller diameter, wound on a turned bobbin of hard fibre, of a size fitted to slide inside the brass tube. The wires of this smaller coil were connected with a ballistic galvanometer, the throw of which was observed when the current in the long magnetizing coil was reversed. The field was found to be sensibly uniform for a length of 60 cm.; while the longest specimen of iron was only 40 cm. There was therefore no need to apply any corrections for non-uniformity of field.

The ballistic method was also used for determining the

magnetization of the bars. On the middle of each bar was wound an exploring coil of 10 turns of very fine wire, the breadth of each such coil not exceeding 0.25 cm. The galvanometer was calibrated by the short coil previously mentioned, its dimensions being accurately known. The magnetizing current was measured by a standard commercial amperemeter, the readings of which were calibrated at regular intervals of time by a Crompton potentiometer.

Each specimen was mounted on a carrier by means of which it could be inserted centrally in the middle of the long magnetizing coil. The galvanometer calibration having been effected, a test was made of each bar by subjecting it to a series of reversals in fields varying from  $\mathcal{H}=20$  to  $\mathcal{H}=255$ , the throws of the galvanometer being noted; and for each bar a  $\mathcal{B}$ - $\mathcal{H}$  curve was then plotted.

A similar curve having been plotted from the tests made on the ring, the values of the demagnetizing intensity of field  $\mathcal{H}_d$ , due to the self-demagnetizing action of the poles of each bar, could then be calculated, for any value of  $\mathcal{B}$ , by taking the abscissa, corresponding to that ordinate, in the curve for that bar, and subtracting the corresponding abscissa in the curve for the ring.

Let the field due to self-demagnetization at the mid-point of any bar, for any given flux-density  $\mathcal{B}$ , be called  $\mathcal{H}_d$ . Let the total impressed field due to the magnetizing coil be called  $\mathcal{H}$ ; and let the impressed field required in the ring to produce the same given value of  $\mathcal{B}$  be called  $\mathcal{H}_r$ . Then

$$\mathcal{H}_d = \mathcal{H} - \mathcal{H}_r.$$

Then since, by definition, the self-demagnetizing factor  $N$  has the value

$$N = \mathcal{H}_d \div \mathcal{I},$$

and

$$\mathcal{I} = \frac{\mathcal{B} - \mathcal{H}}{4\pi},$$

we get

$$N = \frac{4\pi \mathcal{H}_d}{\mathcal{B} - \mathcal{H}_r}.$$

Fig. 1 (Pl. XV.) gives the  $\mathcal{B}$ - $\mathcal{H}$  curves for our rods, the dimension-ratios of which varied from 35.6 to 2.66. These curves were sensibly straight lines up to  $\mathcal{B}=12,000$ , or as high as the curves could be carried. The value  $\mathcal{B}=10,000$  was



chosen for the calculation of the self-demagnetizing force and deduction of the self-demagnetizing factor, except for the very short rods in which lesser values of  $\mathcal{B}$  were alone available.

Fig. 2 gives as the final result the curve exhibiting the values of the self-demagnetizing factors found, for rods of different lengths, the corresponding values found by Du Bois and by Riborg Mann being added for comparison.

It will be seen (1) that our values are throughout lower than those found by either of these experimenters; (2) that we have carried the determinations down to shorter rods

TABLE I.—Demagnetizing Factors for Cylindrical Bars.

$\frac{l}{d}$	$\frac{l}{\sqrt{\text{Area}}}$	DEMAGNETIZING FACTORS.			
		Cylinder.			Ellipsoid of Revolution.
		Du Bois.	Riborg Mann.	Thompson & Moss.	
2.66	3.0	...	...	1.2	
3.55	4.0	...	...	0.83	
4.44	5.0	...	...	0.618	
5.0	5.64	...	0.6800	<i>0.53</i>	
5.34	6.0	...	...	0.483	
6.66	7.5	...	...	0.3518	
8.86	10.0	...	...	0.233	
10.0	11.28	0.216	0.2550	<i>0.198</i>	0.2549
10.67	12.0	...	...	0.18	
13.3	15.0	...	...	0.1287	
15.0	16.92	0.1206	0.1400	<i>0.108</i>	0.135
17.72	20.0	...	...	0.0826	
20.0	22.56	0.0775	0.08975	<i>0.069</i>	0.0848
25.0	28.2	0.0533	0.06278	<i>0.049</i>	0.0579
26.6	30.0	...	...	0.0438	
30.0	33.84	0.0393	0.04604	<i>0.036</i>	0.0432
35.6	40.0	...	...	0.0255	
40.0	45.12	0.0238	0.02744	<i>0.0223</i>	0.0266

N.B.—Figures in italics are values got by interpolation.

than those examined by either of them; (3) that the discrepancies between their results and ours are smaller as the dimension-ratios are larger.

The fact that our values are throughout lower than those of Du Bois and Riborg Mann is doubtless due to the circumstance that they used a magnetometric method, whilst we have returned to the ballistic method of Ewing. The values of  $\mathcal{J}$  which they employ are the mean values deduced

from the magnetic moment, and are presumably mean values throughout the length of the bar, whilst our values of  $\mathcal{J}$  are the values deduced from the action of an exploring coil wound round the equator of each bar, and presumably measure the maximum value of  $\mathcal{J}$ . As the self-demagnetizing action of a bar depends on neither the mean value, nor the maximum value of  $\mathcal{J}$ , as we have seen, but on a mean that is impossible to calculate unless the actual surface distribution of the magnetism is known, it appeared to us preferable to take the value of  $\mathcal{J}$  that can be ascertained with precision at the place where the self-demagnetizing force has its minimum, namely the centre of the bar.

One point of criticism on Riborg Mann's results may be permitted us. To give us confidence in our results, we have throughout used substantial bars of 1.128 cm. in diameter, and have raised the lengths. Riborg Mann used a single cylinder of iron 11.850 cm. in length, originally of a diameter 1.526 cm., therefore of a dimension-ratio of 7.76. This he turned down successively to smaller and smaller diameters until he reached a diameter of 0.237 cm., giving a dimension-ratio of 50. How he contrived to turn so thin a wire is remarkable. It would have a sectional area of only 0.0561 sq. cm. Further, while his cylinder was 11.850 cm. in length, his magnetizing coil was only 30 centimetres long and 4 cm. in diameter. The ends of his rod were therefore at points only  $2\frac{1}{4}$  diameters distant from open ends of the coil, where therefore the value of the field would differ by some  $2\frac{1}{2}$  per cent. from the value of the uniform field at the middle of the coil.

### PART III.—EXPERIMENTAL. ON THE VALUES OF THE SELF-DEMAGNETIZING FACTOR FOR BAR-MAGNETS OF RECTANGULAR CROSS-SECTIONS OF VARIOUS PROPORTIONS.

We are not aware that any previous investigator has determined the self-demagnetizing factor for square bars or flat bars of rectangular section such as are often used in magnetic work.

*A priori* we should expect the self-demagnetizing factors to be less than for bars of equal section of circular form and equal length; since the greater perimeter of the rectangular forms is magnetically equivalent to giving to the end parts a polar expansion, reducing the reluctance of the air-paths of the external magnetic flux, and so bettering the magnetic circuit. And such has proved to be the case.

The experiments were made in exactly the same manner  
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as those for the bars of circular section. Rectangular rods of the softest Swedish iron of various proportions were procured, and reduced by milling-cutter to the required form, so as in every case to have a sectional area of 1 square centimetre; the ratios of breadth to thickness being respectively 1 : 1; 2 : 1; 4 : 1; 6 : 1, and 10 : 1. From each of these rectangular rods pieces were cut of lengths of 10, 8, 6, 5, 4, and 3 centimetres respectively. In all 35 different ones were examined. For each of these a  $B-H$  curve was plotted; and the self-demagnetizing-factors were deduced as before.

In figs. 3, 4, 5, 6, 7, and 8 these various curves are plotted; and in fig. 9 the final results are summed up by plotting the several demagnetizing-factors as functions of  $\lambda$  the ratio of the length to the square-root of the area of section.

Table II. gives numerically the values of the self-demagnetizing factors obtained for various ratios of breadth  $b$  to thickness  $t$  of the cross-section, and also for various values of  $\lambda$ . The individual bars were carefully gauged for breadth and thickness, and the slight discrepancies (never exceeding 1 per cent. of the intended ratio) were allowed for; but being small they occasioned no difference in the plotting.

TABLE II.—Demagnetizing Factors for Bars of different lengths and equal Sectional Area, having Rectangular Sections from 10 : 1 to 1 : 1.

$\frac{l}{\sqrt{A}}=3.$		$\frac{l}{\sqrt{A}}=4.$		$\frac{l}{\sqrt{A}}=5.$		$\frac{l}{\sqrt{A}}=6.$		$\frac{l}{\sqrt{A}}=8.$		$\frac{l}{\sqrt{A}}=10.$	
$b/t.$	N.	$b/t.$	N.	$b/t.$	N.	$b/t.$	N.	$b/t.$	N.	$b/t.$	N.
10·03/1	0·828	10/1	0·586	10·05/1	0·44	10/1	0·354	10·2/1	0·2358	10/1	0·178
5·95/1	0·925	5·96/1	0·66	5·99/1	0·488	6/1	0·3885	5·96/1	0·264	5·99/1	0·19
3·98/1	1·02	3·99/1	0·726	3·98/1	0·528	3·96/1	0·415	4/1	0·28	3·98/1	0·206
2·0 /1	1·098	2/1	0·775	2/1	0·575	2/1	0·448	2/1	0·3	2/1	0·22
1·492/1	1·13	1·5/1	0·7980	1·49/1	0·59	1·5/1	0·4645	1·5/1	0·3075	1·495/1	0·224
0·9914/1	1·13	0·99/1	0·8	0·993/1	0·59	0·996/1	0·465	...	...	0·993/1	0·224

It will be noticed that the Table records values also for bars having the ratio of 1·5 : 1; but no curves are given for this ratio, as they were practically the same as those for square

bars. In plotting the  $B-H$  curves for these particular bars, it was possible in two cases only to distinguish the curves from those for the square bars, and in these two cases the difference was extremely small.

For equal values of the ratio of  $l$  to  $\sqrt{A}$ , it was found in general that the self-demagnetizing factor, for bars having a sectional ratio of 2 to 1, was about 93 per cent. of that for bars of square section; while for flat bars, having a sectional ratio of 10 to 1, the value of the self-demagnetizing factor went down to about 75 per cent. of that for bars of square section.

LXIX. *The Absorption of Röntgen Rays.* By C. G. BARKLA, M.A., D.Sc., Lecturer in Advanced Electricity, and C. A. SADLER, M.Sc., Oliver Lodge Fellow, University of Liverpool\*.

THE results of experiments that have been made by a number of investigators on the absorption of X-rays are so complicated by a variety of conditions, and frequently appear so inconsistent, that few general conclusions can be drawn from them.

The heterogeneity of the beams used not only masks any peculiarity in the phenomena connected with a particular constituent, but makes exact comparison between the results of different experimenters, and even of the same experimenter, impossible.

In addition to this, as recent investigations have shown†, there are peculiarities in the absorption phenomena which are intimately connected with certain phenomena of secondary radiation; and a knowledge of these is necessary in order to classify and explain the former.

Through our investigations on the secondary X-rays emitted by substances subject to X-rays, we have been enabled to use almost perfectly homogeneous beams, and have become acquainted with the character of the secondary radiation emitted by many elements.

It has been found that each of the elements Cr, Fe, Co, Ni, Cu, Zn, As, Se, Ag, when subject to a suitable primary beam of X-rays, emits an almost perfectly homogeneous beam of

\* Communicated by the Authors.

The expenses of this research have been partially covered by a Government Grant through the Royal Society.—C. G. B.

† "Homogeneous Secondary Röntgen Radiations," Barkla & Sadler, Phil. Mag. Oct. 1908, pp. 550-584.

FIG. 1.

*B. H* CURVES FOR BARS OF CIRCULAR SECTION.

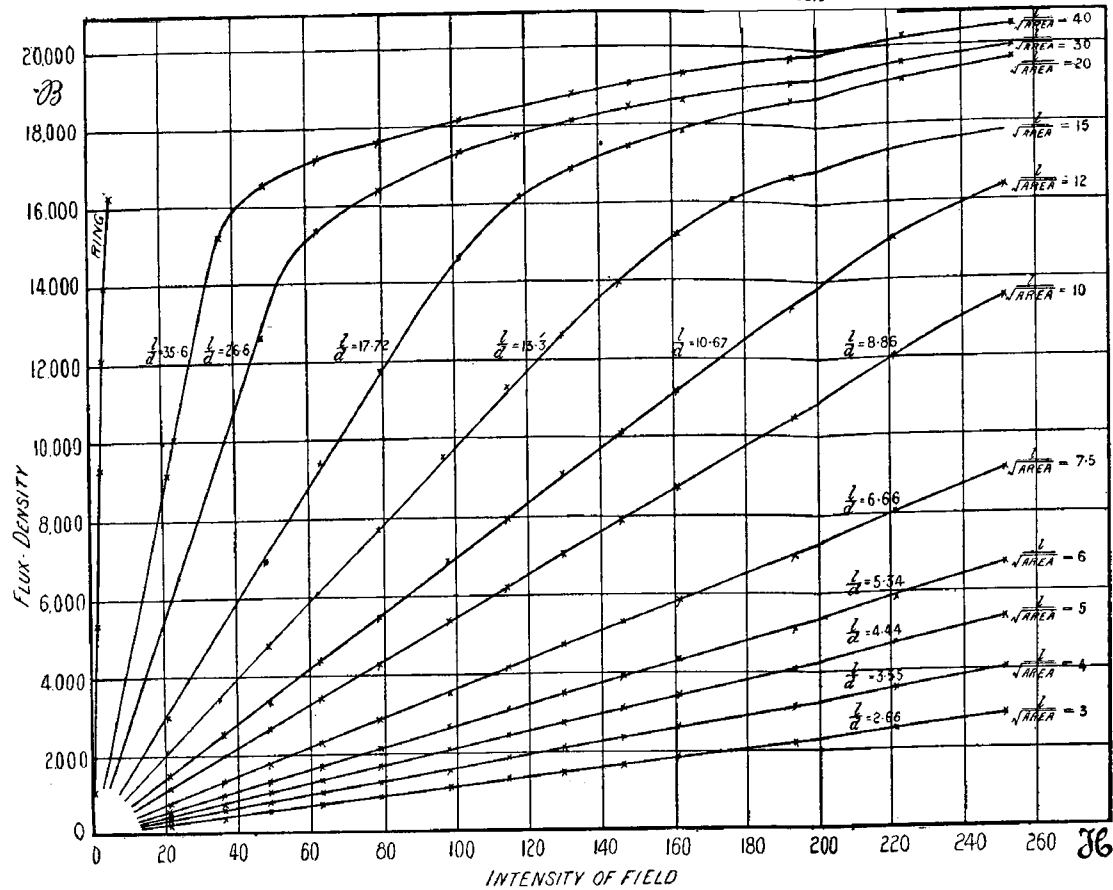


FIG. 4.

*B. H* CURVES FOR BARS OF VARIOUS FORMS OF SECTION. AREA OF SECTION 1 sq. centimetre. LENGTH 80 millimetres.

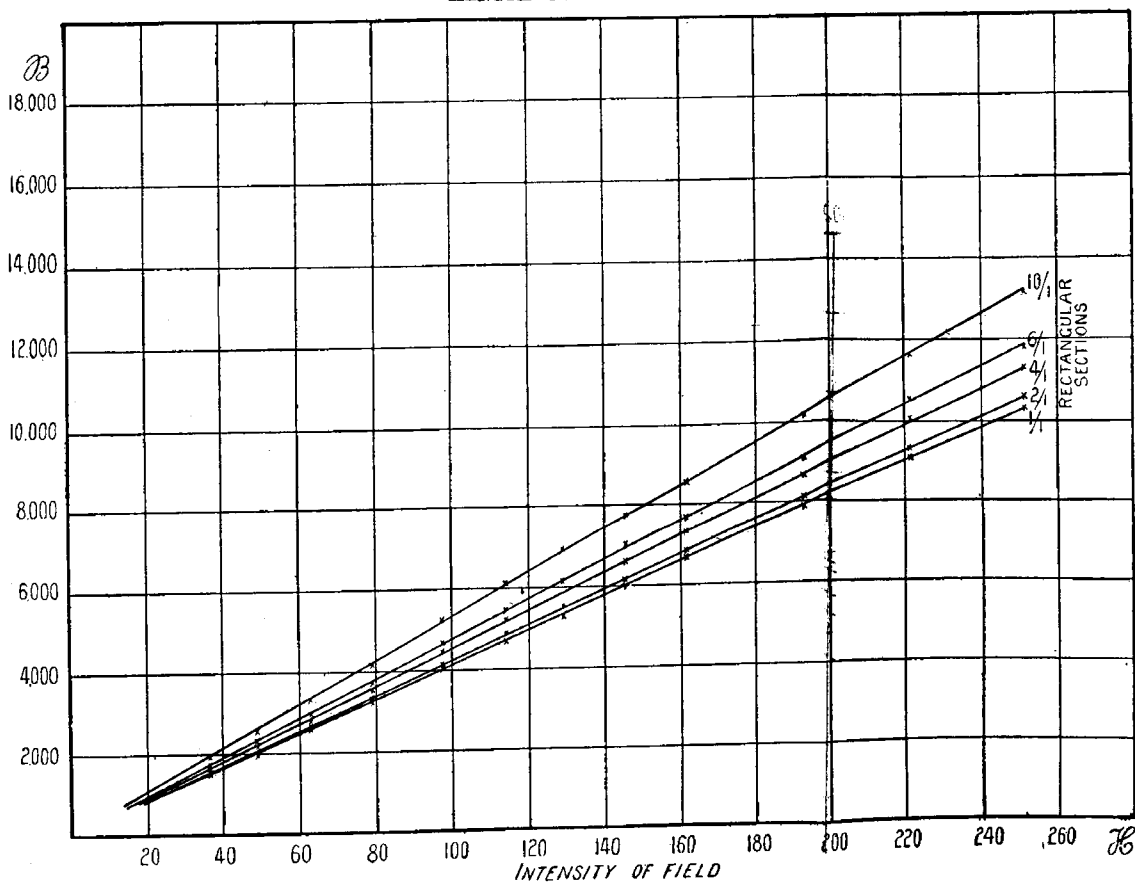


FIG. 7.

*B. H* CURVES FOR BARS OF VARIOUS FORMS OF SECTION. AREA OF SECTION 1 sq. centimetre. LENGTH 40 millimetres.

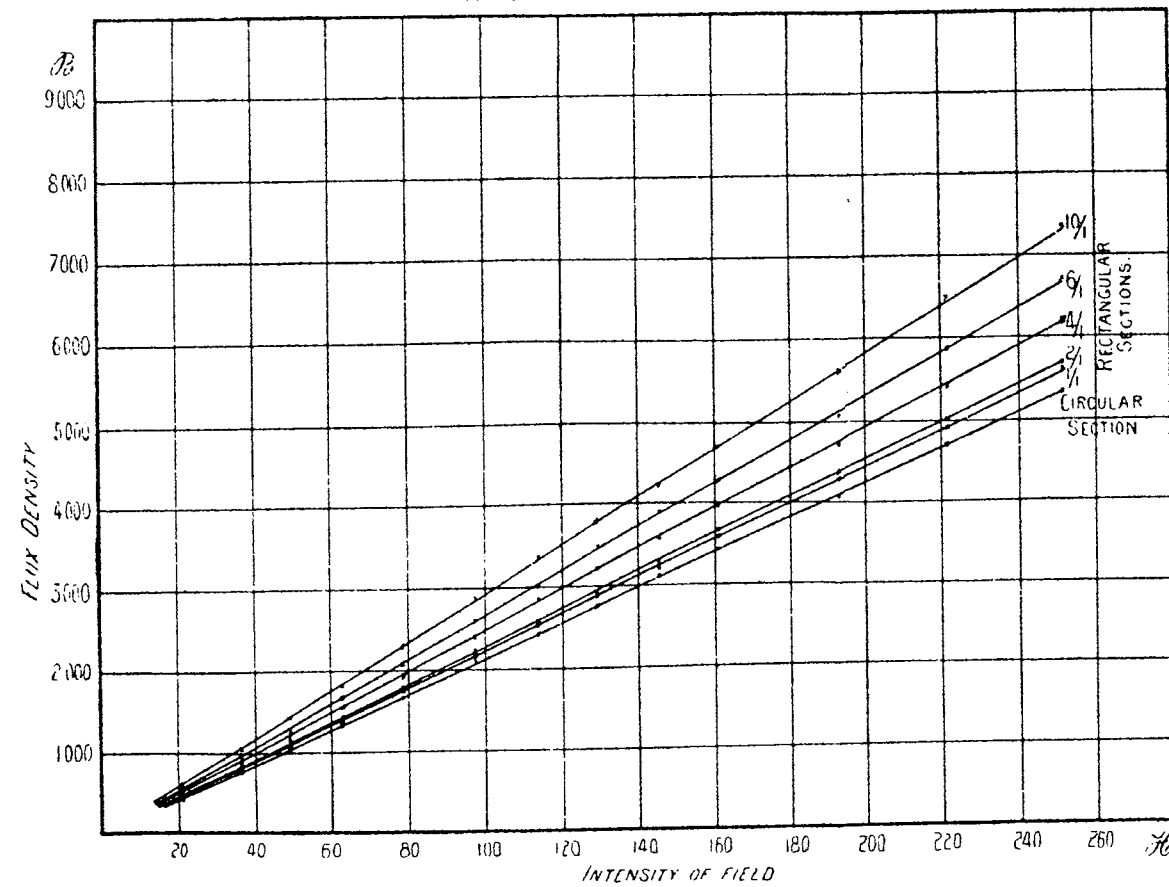


FIG. 2.

COEFFICIENTS OF DEMAGNETIZATION FOR BARS OF CIRCULAR SECTION.

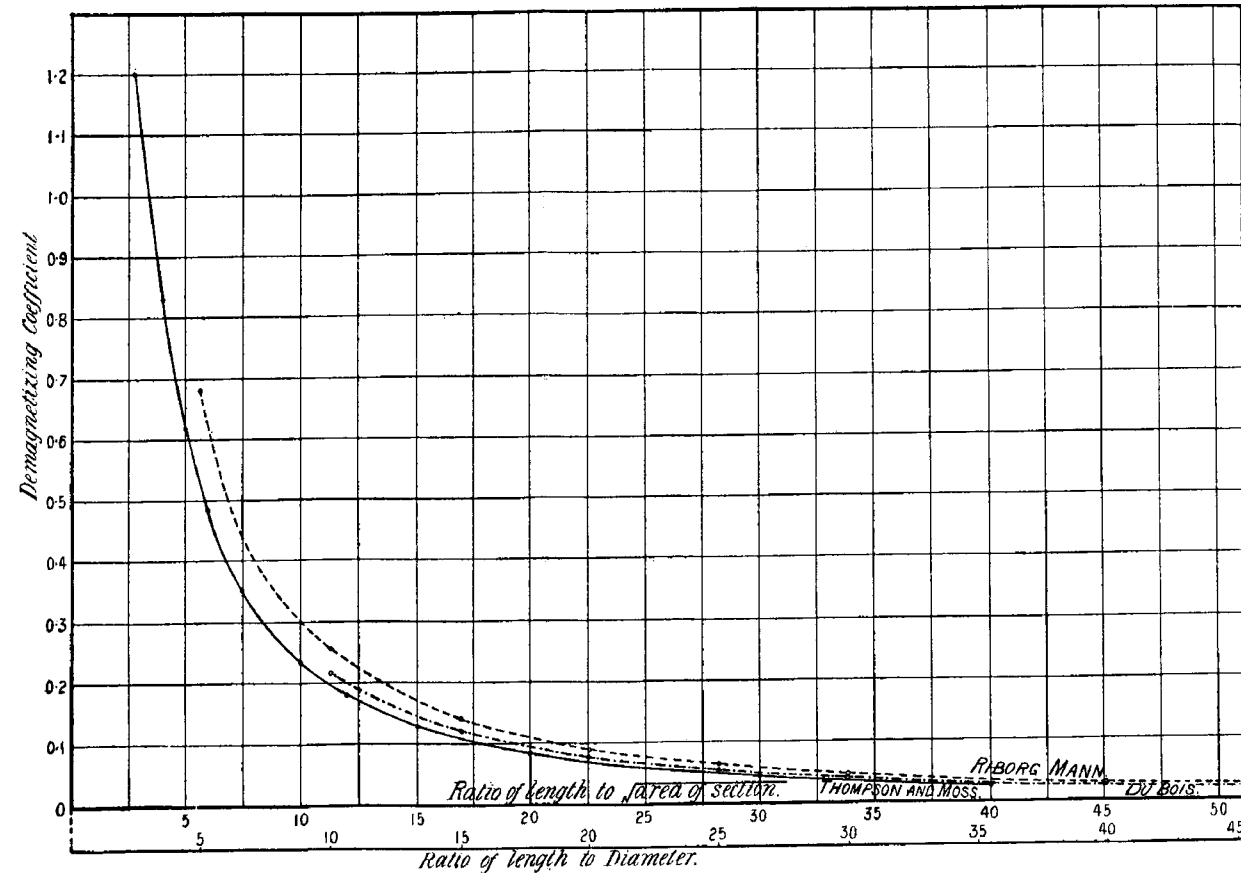


FIG. 5.

*B. H* CURVES FOR BARS OF VARIOUS FORMS OF SECTION. AREA OF SECTION 1 sq. centimetre. LENGTH 60 millimetres.

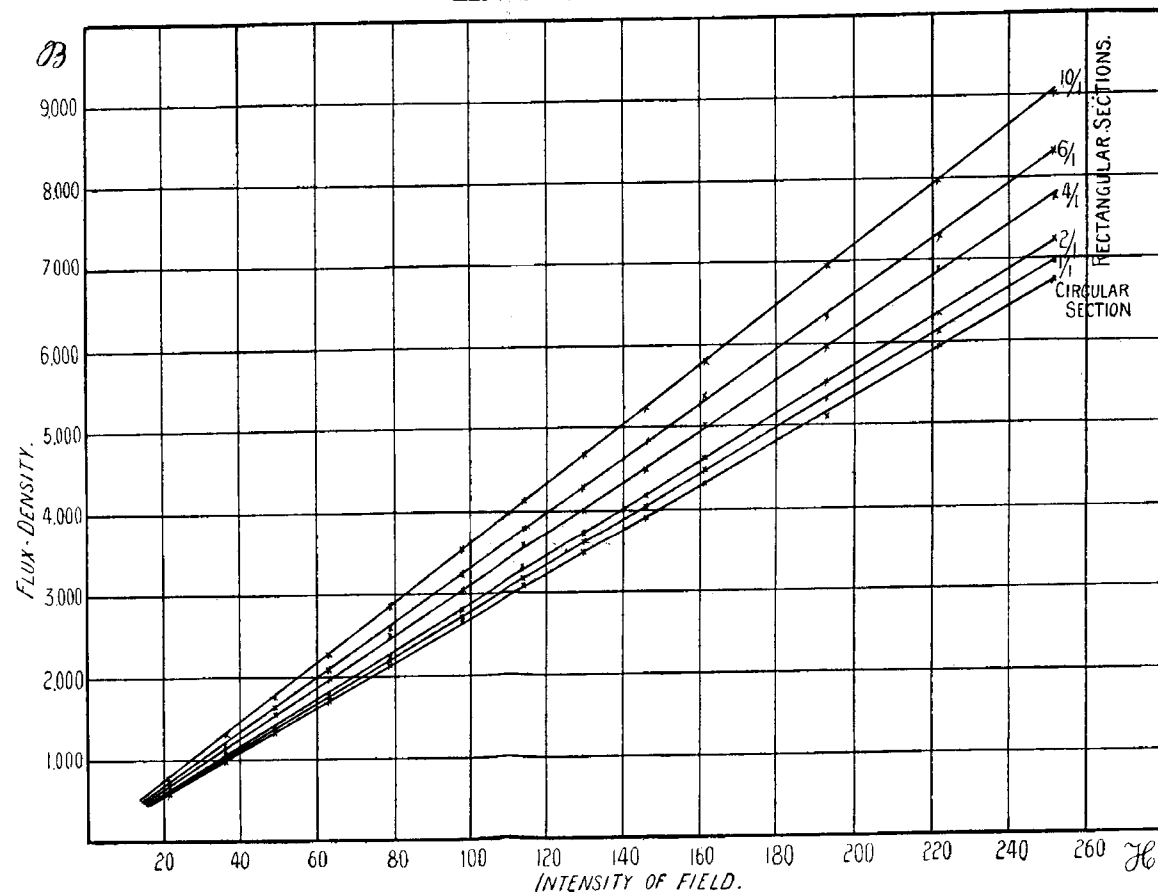


FIG. 8.

*B. H* CURVES FOR BARS OF VARIOUS FORMS OF SECTION. AREA OF SECTION 1 sq. centimetre. LENGTH 30 millimetres.

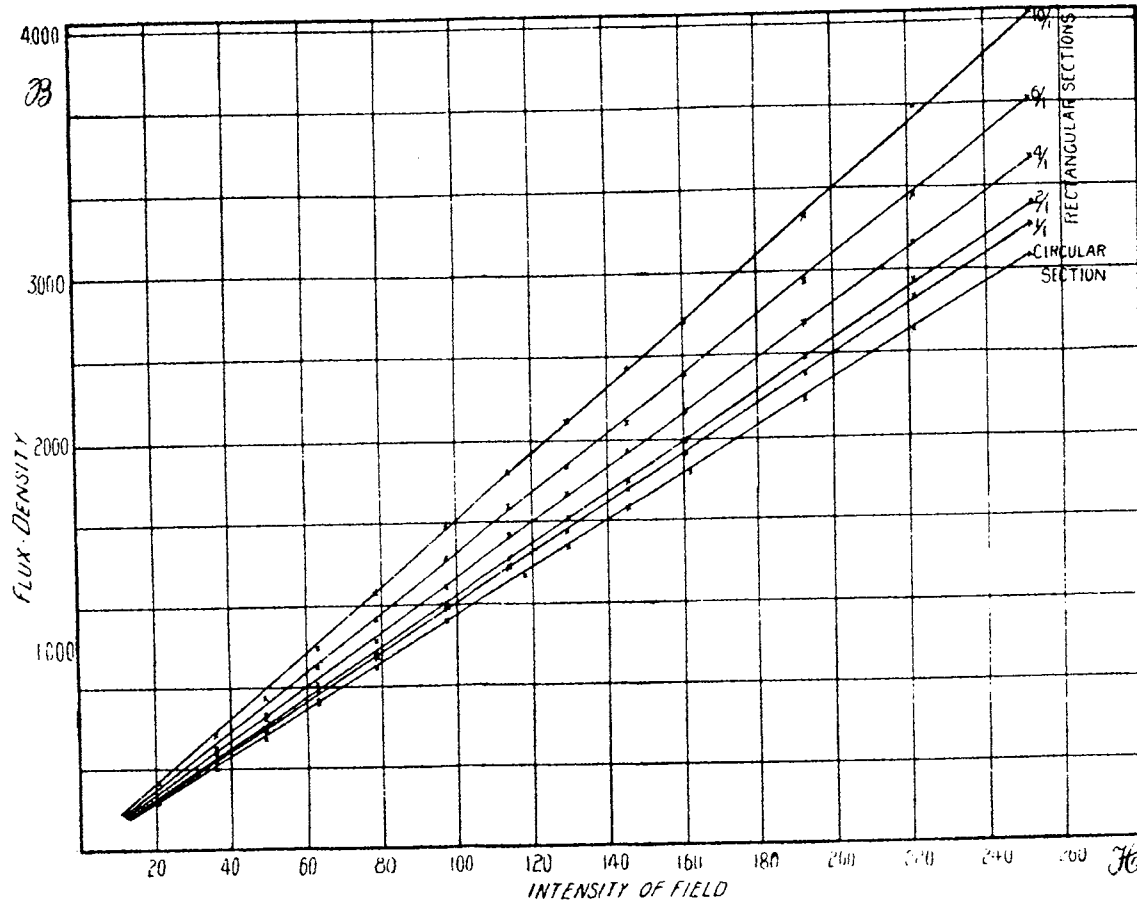


FIG. 3.

*B. H* CURVES FOR BARS OF VARIOUS FORMS OF SECTION. AREA OF SECTION 1 sq. centimetre. LENGTH 100 millimetres.

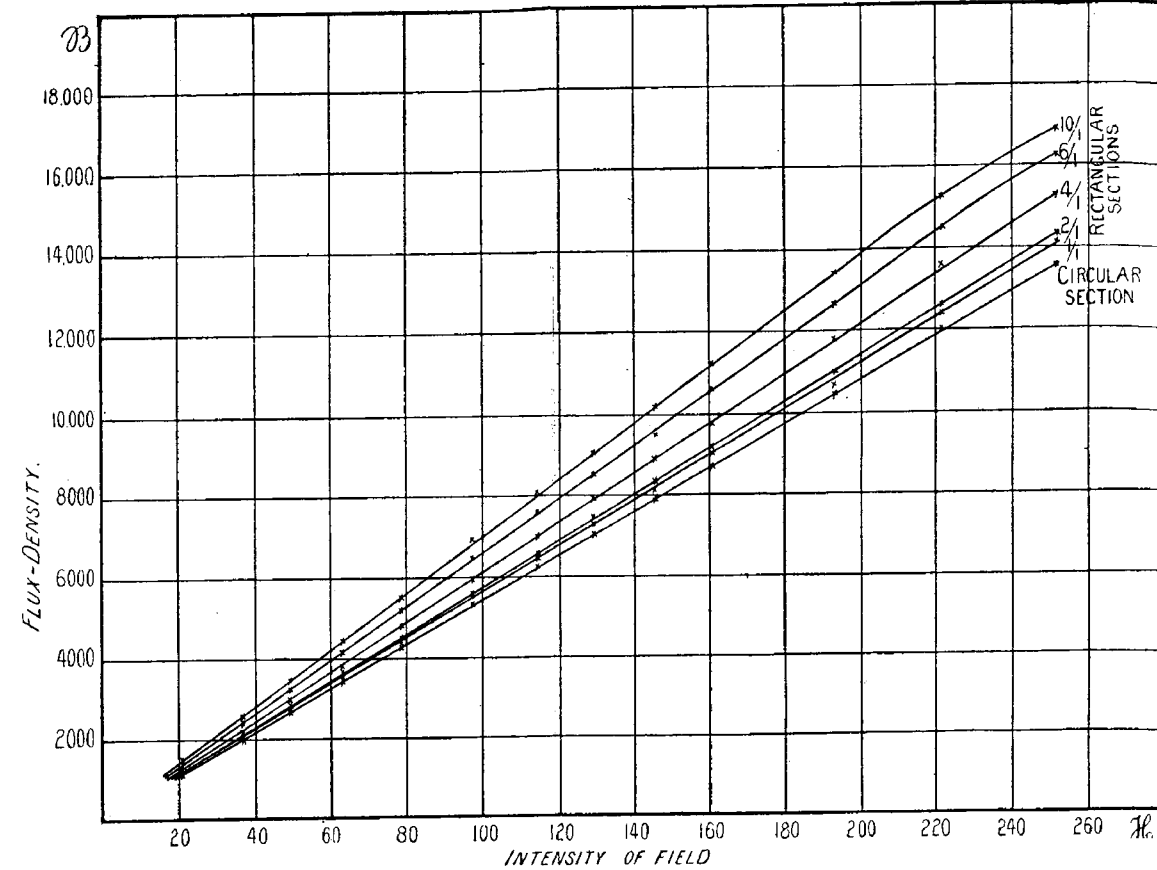


FIG. 6.

*B. H* CURVES FOR BARS OF VARIOUS FORMS OF SECTION. AREA OF SECTION 1 sq. centimetre. LENGTH 50 millimetres.

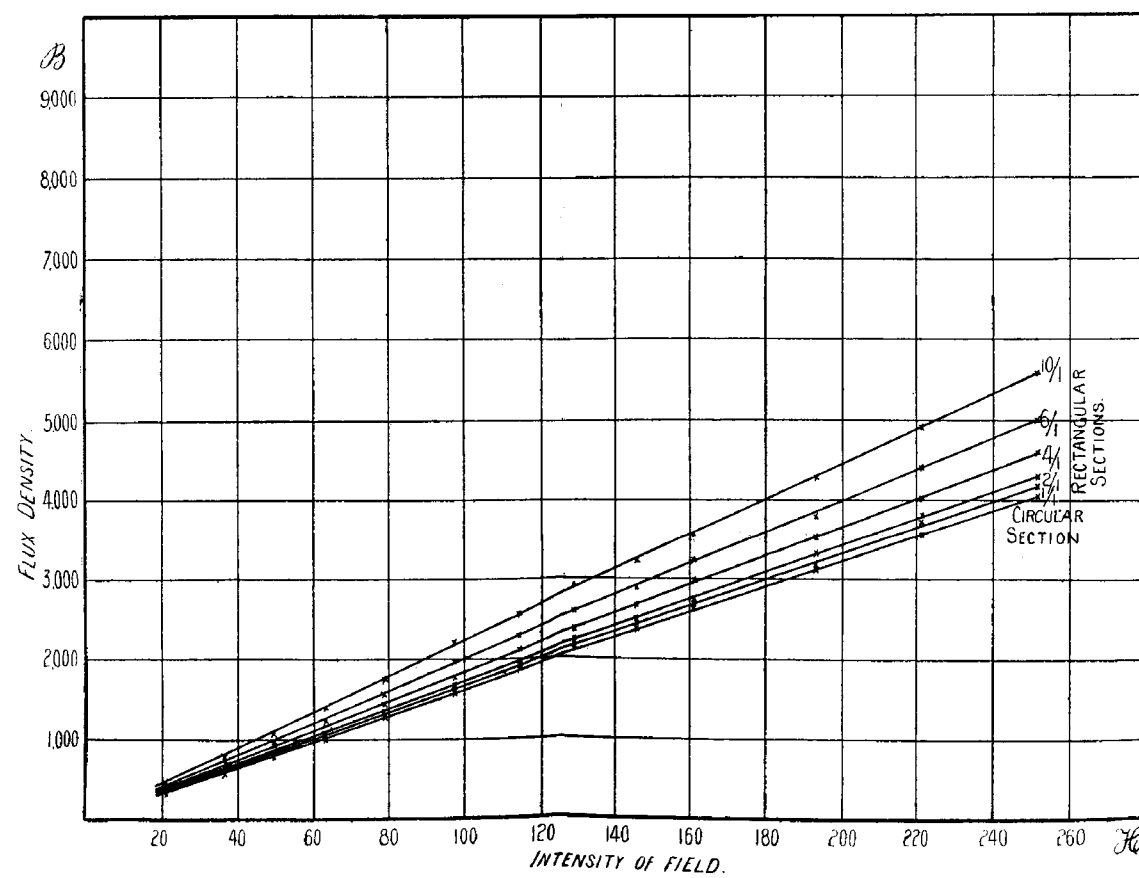


FIG. 9.

COEFFICIENTS OF DEMAGNETIZATION FOR BARS OF VARIOUS LENGTHS AND FORMS OF SECTION.

