grounds for inferring the existence of a telegonic influence. But it is clear that if there be anything of the nature either of a periodic or of a secular change in stature going on, then since men are taller than women, any group of younger women will appear closer to their fathers than to their mothers, when compared with a group of elder sisters. Thus, no legitimate argument as to a telegonic influence can be based on such a result. I have purposely considered this method of approaching the problem, because it is the method which first occurred to me, as it probably may do to others. It can very easily, however, lead to our mistaking for a real telegonic influence an effect of periodic or secular evolution, or, indeed, of different conditions of nurture.

(7) In conclusion, we may, I think, sum up the statistics discussed in this paper as follows:—

(i) So far as stature is concerned there is no evidence whatever of a steady telegonic influence of the male upon the female among mankind.

(ii) It is improbable that the coefficients of correlation which measure the strength of heredity between parents and offspring are constant for all classes even of the same race.

For stature in the case of parents and offspring of both sexes, the value 0·42, or say 3/7, may be taken as a fair working value, until more comprehensive measurements are made. This makes hereditary influence in the direct line stronger than has hitherto been supposed.

(iii) The divergence between the results of this memoir and that of the former memoir on "Regression, Heredity, and Panmixia" would be fairly well accounted for, if there be a hitherto unobserved correlation between the hereditary influence and the fertility of woman.

"On the Magnetic Permeability of Liquid Oxygen and Liquid Air." By J. A. Fleming, M.A., D.Sc., F.R.S., Professor of Electrical Engineering in University College, London, and James Dewar, LL.D., F.R.S., Fullerian Professor of Chemistry in the Royal Institution, &c. Received November 20,—Read November 26, 1896.

The remarkable magnetic properties of liquid oxygen were pointed out by one of us in a communication to the Royal Society in 1891,*

* 'Roy. Soc. Proc.,' December 10th, 1891, vol. 51, p. 24. See a letter to the President by Professor James Dewar, F.R.S.

and were subsequently described to the Royal Institution in a lecture delivered in 1892.* We have for some time past directed our attention to the question of determining the numerical values of the magnetic permeability and magnetic susceptibility of liquid oxygen, with the object of determining not only the magnitude of these physical constants, but also whether they vary with the magnetic force under which they are determined.

Although a large number of determinations have been made by many observers of the magnetic susceptibility of different liquids taken at various temperatures, difficulties of a particular kind occur in dealing with liquid oxygen. One method adopted for determining the magnetic susceptibility of a liquid is to observe the increase of mutual induction of two conducting circuits suitably placed, first in air, and then when the air is replaced by the liquid in question, the susceptibility of which is to be determined. A second method consists in determining the mechanical force acting on a known mass of the liquid when placed in a non-uniform magnetic field. Owing to the difficulty of preventing entirely the evaporation of liquid oxygen, even when contained in a good vacuum vessel, and the impossibility of sealing it up in a bulb or tube, and having regard to the effect of the low temperature of the liquid in deforming by contraction and altering the conducting power of coils of wire placed in it, it was necessary to devise some method which should be independent of the exact constancy in mass of the liquid gas operated upon, and independent also of slight changes in the form of any coils of wire which might be used in it. After many unsuccessful preliminary experiments the method which was finally adopted as best complying with the conditions introduced by the peculiar nature of the substance operated upon is as follows:—

A small closed circuit transformer was constructed, the core of which could be made to consist either of liquid oxygen or else immediately changed to gaseous oxygen, having practically the same temperature. This transformer consisted of two coils, the primary coil was made of forty-seven turns of No. 12 S.W.G. wire, this wire was wound into a spiral, having a rectangular shape, the rectangular turns having a length of 8 cm. and a width of 1·8 cm. This rectangular-sectioned spiral, consisting of one layer of wire of forty-seven turns, was bent round a thin brass tube, 8 cm. long and $2\frac{1}{2}$ cm. in diameter, so that it formed a closed circular solenoid of one layer of wire. The wire was formed of high conductivity copper, doubly insulated with cotton, and each single turn or winding having a rectangular form.

The turns of covered wire closely touched each other on the inner circumference of the toroid, but on the external circumference were

* See 'Roy. Inst. Proc.,' June 10th, 1892, "On the Magnetic Properties of Liquid Oxygen." Friday evening discourse, by Professor J. Dewar, F.R.S.

a little separated, thus forming apertures by which liquid could enter or leave the annular inner core.

The nature of this transformer is shown in Fig. 1.

FIG. 1.

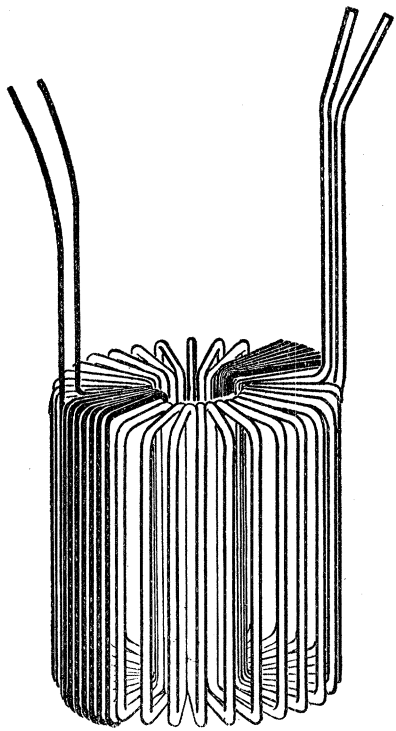


Diagram of the Closed Circuit Transformer used in the Experiments.

The mean perimeter of this rectangular-sectioned endless solenoid was $13\frac{1}{2}$ cm., and the solenoid had, therefore, very nearly 3·5 turns per cm. of mean perimeter. When immersed in liquid oxygen a coil of this kind will carry a current of 50 amperes. When a current of A amperes is sent through this coil the mean magnetising force in the axis of this solenoid is, therefore, represented by 4·375 times the current through the wire, hence it is clear that it is possible to produce in the interior of this solenoid a mean magnetising force of over 200 C.G.S. units. This primary coil had then wound over it, in two sections, about 400 or 500 turns of No. 26 silk-covered copper wire to form a secondary coil. The primary and secondary coils were separated by layers of silk ribbon. The exact number of turns was not counted, and as will be seen from what follows it was not necessary

to know the number. The coil so constructed constituted a small induction coil or transformer, with a closed air-core circuit, but which when immersed in a liquid, by the penetration of the liquid into the interior of the primary coil, became changed into a closed circuit transformer, with a liquid core. The transformer so designed was capable of being placed underneath liquid oxygen contained in a large vacuum vessel, and when so placed formed a transformer of the closed circuit type, with a core of liquid oxygen. The coefficient of mutual induction of these two circuits, primary and secondary, is therefore altered by immersing the transformer in liquid oxygen, but the whole of the induction produced in the interior of the primary coil is always linked with the whole of the turns of the secondary coil, and the only form-change that can be made is a small change in the mean perimeter of the primary turns due to the contraction of the coil as a whole. In experiments with this transformer the transformer was always lifted out of the liquid oxygen into the cold gaseous oxygen lying on the surface of the liquid oxygen, and which is at the same temperature. On lifting out the transformer, the liquid oxygen drains away from the interior of the primary coil, and is replaced by gaseous oxygen of very nearly the same temperature.

The vacuum vessel used had a depth of 60 cm. outside and 53 cm. inside, and an internal diameter of 7 cm. It held 2 litres of liquid oxygen when full; but, as a matter of fact, 4 or 5 litres of liquid oxygen were poured into it in the course of the experiment.

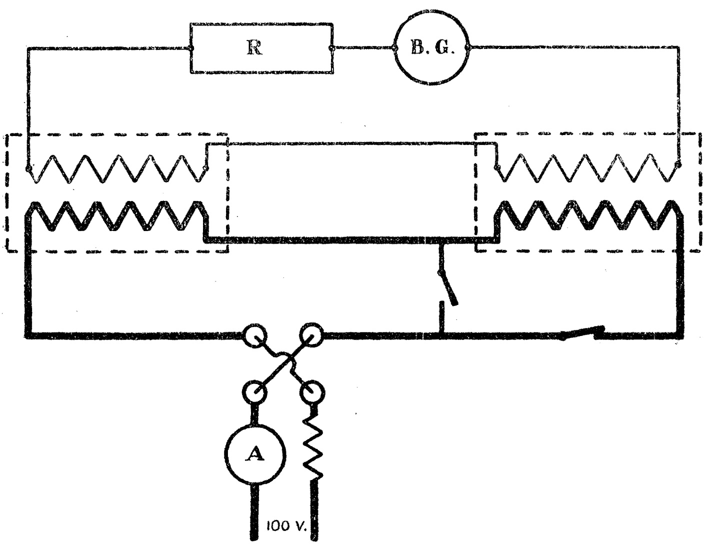
Another induction coil was then constructed, consisting of a long cylindrical coil wound over the four layers of wire, and a secondary circuit was constructed to this coil, consisting of a certain number of turns wound round the outside of the primary coil, and a small adjusting secondary coil, consisting of a thin rod of wood wound over with very open spirals of wire. The secondary turns on the outside of the primary coil were placed in series with the turns of the thin adjusting coil, and the whole formed a secondary circuit, partly outside and partly inside the long primary cylindrical coil, the coefficient of mutual induction of this primary and secondary coil being capable of being altered by very small amounts by sliding into or out of the primary coil the small secondary coil. This last induction coil, which will be spoken of as the balancing coil, was connected up to the small transformer, as just described, as follows:—

The primary coil of the small transformer was connected in series with the primary coil of the balancing induction coil, and the two terminals of the series were connected through a reversing switch and ammeter with an electric supply circuit, so that a current of known strength could be reversed through the circuit, consisting of the two primary coils in series. The two secondary coils, the one on

the transformer and the one on the balancing induction coil, were connected in opposition to one another through a sensitive ballistic galvanometer in such a manner that on reversing the primary current the galvanometer was affected by the difference between the electromotive forces set up in the two secondary coils, and a very fine adjustment could be made by moving in or out the adjusting coil of the balancing induction coil.

The arrangement of circuits is shown in fig. 2.

Fig. 2.



Arrangement of the Circuits of the Transformer and Induction Coil.

For the purpose of standardising the ballistic galvanometer employed, the primary coil of the balancing induction coil could be cut out of circuit, so that the inductive effect in the ballistic galvanometer circuit was due to the primary current of the closed circuit transformer alone. A resistance box was also included in the circuit of the ballistic galvanometer. The resistance of the ballistic galvanometer was about 18 ohms, and the resistance of the whole secondary circuit 30·36 ohms. The experiment then consisted in first balancing the secondary electromotive forces in the two coils exactly against one another, then immersing the transformer in liquid oxygen, the result of which was to disturb the inductive balance, and in consequence of the magnetic permeability of the liquid oxygen core being greater than unity, a deflection of the ballistic galvanometer was observed on reversing the same primary current. The induction

through the primary circuit of the small transformer is increased in the same proportion that the permeability of the transformer core is increased by the substitution of liquid oxygen for gaseous oxygen, and hence the ballistic deflection measures at once the amount by which the magnetic permeability of the liquid oxygen is in excess over that of the air or gaseous oxygen forming the core of the transformer when the transformer is lifted out of the liquid. As a matter of fact it was never necessary to obtain the inductive balance precisely. All that was necessary was to observe the throw of the ballistic galvanometer, first when the transformer was wholly immersed under the surface of liquid oxygen, and, secondly, when it was lifted out into the gaseous oxygen lying on the surface of the liquid, the strength of the primary current reversed being in each case the same. In order to standardise the galvanometer and to interpret the meaning of the ballistic throw, it was necessary to cut out of circuit the primary coil of the balancing induction coil, and to reverse through the primary circuit of the small transformer a known small primary current, noting at the same time the ballistic throw produced on the ballistic galvanometer, this being done when the transformer was underneath the surface of liquid oxygen. It will be seen, therefore, that this method requires no calculation of any coefficient or mutual induction, neither does it involve any knowledge of the number of secondary turns on the transformer, nor of the resistance of the secondary circuit; all that is necessary for a successful determination of the magnetic permeability of the liquid oxygen is that the secondary circuit of the transformer should remain practically of the same temperature during the time when the throw of the ballistic galvanometer is being observed, both with the transformer underneath the liquid oxygen and out of the liquid oxygen. If then the result of reversing a current of A amperes through the two primary coils in series when the secondary coils are opposed is to give a ballistic throw, D, and if the result of reversing a small current a amperes through the primary coil of the transformer alone is to produce a ballistic throw, d, then if μ is the magnetic permeability of liquid oxygen, that of the gaseous oxygen lying above the liquid and at the same temperature being taken as unity, we have the following relation :—

$$\frac{\mathrm{D}}{\frac{\mathrm{A}}{a}d} = \mu - 1,$$

which determines the value of μ.

Deferring for a moment the correction to be applied to determine the value of the magnetic permeability of liquid oxygen in terms of that of a vacuum, the following are the results of observation :—

Observations on Magnetic Permeability of Liquid Oxygen.

Throws of Ballistic Galvanometer. Induction Coils balanced.

Exp. I.	4·0 mm. to left 4·2 ,, ,, 4·3 ,, ,,	The transformer in liquid oxygen. Primary current = 37·8 amperes reversed through primary coils.
Exp. II.	17·0 mm. to right 17·5 ,, ,, 18·5 ,, ,,	The transformer lifted out of liquid oxygen into cold gaseous oxygen at the same temperature. Primary current = 37·8 amperes reversed through primary coils.
Exp. III.	3·2 mm. to left 2·5 ,, ,, 2·8 ,, ,,	The transformer in liquid oxygen. Primary current = 37·2 amperes reversed through primary coils.
Exp. IV.	20·0 mm. to right 21·0 ,, ,, 21·3 ,, ,,	The transformer lifted out of liquid oxygen into cold gaseous oxygen at the same temperature. Primary current = 36·8 amperes reversed through primary coils.

Throws of Ballistic Galvanometer in Standardising Observations. Primary Coil of Balancing Coil disconnected.

Exp. V.	24·0 mm. to right 25·0 ,, ,, 25·0 ,, ,, 24·5 ,, ,, 25·0 ,, ,,	Corresponding to 0·1145 ampere reversed through primary coil of the transformer, the transformer being in liquid oxygen. The mean of these ballistic throws is the quantity denoted by d, and the current 0·1145 ampere is the a in the formula above.

Standardising Observations repeated with another Current.

Exp. VI.	58·0 mm. to right 58·0 ,, ,,	Corresponding to 0·2639 ampere reversed through primary coil of transformer, the transformer being in liquid oxygen.

Throws of Ballistic Galvanometer. Induction Coils balanced.

Exp. VII.	4·0 mm. to right 4·0 ,, ,,	The transformer lifted out of liquid oxygen into cold gaseous oxygen at same temperature. Primary current = 8·037 amperes reversed through primary coils.
Exp. VIII.	0·4 mm. to left 0·4 ,, ,, 0·2 ,, ,,	The transformer in liquid oxygen. Current = 8·095 amperes reversed through primary coils.
Exp. IX.	4·5 mm. to left 4·8 ,, ,, 4·2 ,, ,,	The transformer in liquid oxygen. Current = 28·8 amperes through primary coils.

Exp. X.	12·0 mm. to right 12·0 ,, ,, 12·2 ,, ,,	The transformer lifted out of liquid oxygen into cold gaseous oxygen at the same temperature. Current = 28·1 amperes reversed through primary coils.
Exp. XI.	1·2 mm. to left 1·3 ,, ,,	The transformer in liquid oxygen. Current = 28·1 amperes reversed through primary coils.

Exp. XII.

The transformer in liquid oxygen.		The transformer lifted out of liquid oxygen into cold gaseous oxygen at same temperature.	
Current reversed in primary coils, in amperes.	Ballistic throw in millimetres. Deflection to the right.	Current reversed in primary coils, in amperes.	Ballistic throw in millimetres. Deflection to the right.
58·8	10·5	—	—
—	—	50·2	47·0
50·2	15·0	—	—
—	—	50·8	48·5
50·2	17·0	—	—
—	—	50·0	49·0

The above table shows the results of the observations made with the small transformer alternately placed underneath the surface of liquid oxygen, and then lifted up into the cold gaseous oxygen lying above the surface of the liquid oxygen. It will be noticed that the ballistic throws in each set of observations are not constant, but that there is a tendency, usually, for the throw to increase if repeated, whilst the transformer is still maintained in the same condition, This is in all probability due to the fact that the continued passage of the primary current heats the primary circuit of the balancing induction coil, and hence heats, also, by radiation, the secondary coil of the balancing induction coil, and, therefore, by enlarging the area of the adjusting coil, continually breaks down the inductive balance. It was found necessary, therefore, to take the observations in groups at equal intervals of time. First, a group of three observations was taken, the transformer being in liquid oxygen, the balance being, as nearly as possible, obtained. Then the transformer was lifted out of the liquid oxygen, and the ballistic throws again taken, reversing the same primary current; next again immersed in liquid oxygen, and finally once more taken out of the liquid oxygen. Taking the sets

of observations marked I, II, III, IV, the mean of the means of the three observations in Sets I and III, corrected for the variation in the primary current, were taken as the result of the measurement in liquid oxygen, and this result was then compared with the ballistic throws in Set II.

Again, the mean of the means of sets of observations II and IV, properly corrected for variation of primary current, were compared with the mean of the observations in Set III, and the result is to give the data for calculating the permeability of the liquid oxygen for a primary current through the primary coil of the transformer of about 37 amperes, corresponding very nearly to a mean magnetising force of 166 C.G.S. units. The sum or difference of these means of the throws, taken in the liquid oxygen and out of the liquid oxygen, depending on whether they are on the opposite or the same side of the zero of the scale, gives us the value of the quantity denoted by D in the Table I below, and in the formula for the value of μ.

The above sets of observations, I, II, III, and IV, refer to a primary current of about 37 amperes; but similar sets of observations were taken with a primary current of about 8 amperes, 28 amperes, and 50 amperes respectively, and the results of all these observations, which are included in the sets of observations, I to XII, above given, have been reduced in Table I below to show the magnetic permeability of the liquid oxygen corresponding to different megnetising currents. The set of observations marked Experiment V and Experiment VI in the above table of results, gives the observations for standardising the ballistic galvanometer. In the first case the primary coil of the balancing induction coil was cut out, and a primary current, having a value of 0·1145 ampere, was reversed through the primary coil of the transformer alone, and gave ballistic deflections as stated in the observations in Set V. These observations serve to standardise the galvanometer and interpret the meaning of the throw obtained when the large current is reversed through the primaries of the two induction coils, the secondaries of which are opposed. It will be noticed that one important advantage of the above-described method is that the quantity which we desired to know, viz., the amount by which the presence of the liquid oxygen increases the magnetic permeability of the core of the transformer, is the quantity which is measured directly, and that any error in the measurement of this quantity does not affect the permeability to anything like the same proportional extent. An error of about 10 per cent. in the measurement of the ballistic throw would only affect the fourth place of decimals in the number representing the permeability of the liquid oxygen.

The results of all the above observations, when reduced, are comprised in the following table:—

Table I.—Table of Results of Observations on the Magnetic Permeability of Liquid Oxygen.

A = primary current, in amperes, passing through primaries of the transformer and balancing coil.	Corresponding mean magnetising force in C.G.S. units in primary circuit of transformer.	Total ballistic throw which would be produced if primary current of A amperes were reversed through primary of transformer alone $=\frac{A}{a}d$.	Ballistic throw of galvanometer resulting from immersion of the transformer in liquid oxygen. Transformer and balancing induction coil being opposed = D.	μ = permeability calculated from $\mu-1=\frac{D}{\frac{A}{a}d}$.
8·037	35·2	1734	4·33	1·00250
28·13	123·0	6068	14·9	1·00246
37·8	165·4	8153	21·18	1·00260
36·8	161·0	7938	23·57	1·00297
50·5	220·9	10894	32·98	1·00304

The values of the permeability given in the foregoing table are not all of equal weight.

The calculated value of μ—1 depends upon the observed ballistic throw, and this cannot be read to a high degree of accuracy when the throw is as small as 4 millimetres. We consider that the best result is obtained by taking the mean of the values for the primary currents, 37·8, 36·8, and 50·5 amperes, and these values give $\mu = 1·00287$, with a probable accuracy of $\pm$ 0·0002. This value of the permeability of the liquid oxygen corresponds to a magnetising force lying between 166 and 220 C.G.S. units. It will be seen that this method is best applicable to the determination of the permeability under large magnetising forces; and that these observations do not, in themselves, allow us to state whether the permeability is a constant for all forces, or is a function of the value of the force.

In the next place the value is a relative one. The number 1·00287 is the ratio of the magnetic permeability of liquid oxygen to that of the gaseous oxygen nearly at the same temperature resting upon the surface of the liquid. We were not able by this method to detect the difference between the permeability of the cold gaseous oxygen lying on the surface of the liquid oxygen when in quiet ebullition, and which has a temperature of about −182° C., but a density of at least three times that of oxygen at 0° C., when compared with that of gaseous oxygen at ordinary temperature, and under the normal pressure. In a very valuable memoir on the determination of magnetic susceptibilities, M. P. Curie* has examined the susceptibility of gaseous

* 'Thèses présentées à la Faculté des Sciences de Paris pour obtenir le grade de Docteur ès Sciences Physiques,' par M. P. Curie, Paris, 1895.' This memoir is of remarkable interest in many ways.

oxygen at different temperatures, and shown that between the limits of 0° C. and 452° C. the magnetic susceptibility of oxygen (K) per unit of mass is a function of the absolute temperature T, such that

$$10^6\,K = 33700/T,$$

and that the value of K (per gram) at 0° C. is, therefore, $123/10^6$. The mass of 1 c.c. of oxygen gas at 0° C. and 760 mm. is 0·0014107 gram, and, reciprocally, the volume of one gram is 708·9 c.c. at 0° C. and 760 mm.

Hence the magnetic susceptibility of gaseous oxygen at 0° C. and 760 mm. per unit of volume (one c.c.) would be $123 \times 0{\cdot}00141 \times 10^{-6} = 0{\cdot}173 \times 10^{-6}$, which is not very different from that obtained by other observers.*

If then it could be supposed that gaseous oxygen followed the same law down to −182° C., and taking the gas in a condition when the density is nearly 0·00423, the volume susceptibility (k) at −182° C. would be $1{\cdot}6 \times 10^{-6}$, and hence the permeability (μ), where

$$\mu = 1 + 4\pi k,$$

should be 1·00002.

It is, however, certain that the susceptibility per unit of mass will not continue to increase in accordance with the hyperbolic law, because this would imply that at the absolute zero of temperature the susceptibility would be infinitely great, and hence the above number 1·00002 gives a superior limit for the permeability of the gaseous oxygen at −182° C. lying on the surface of the liquid oxygen.†

The conclusion is that the correction to be applied to the above observed value of μ for the liquid oxygen, viz., 1·00287, to refer it to a vacuum taken as unity, is altogether masked by the unavoidable errors of experiment, and hence, pending further more exact measurements, this may be taken as the value of the constant. We have, however, at the present time, arranged a method which will enable us we hope to determine directly the magnetic susceptibility of liquid

* Faraday, 'Experimental Researches,' vol. 3, p. 502, gives a value for the susceptibility of gaseous oxygen at 60° F., referred to an equal volume of water as unity, which, when reduced to absolute values by taking the magnetic susceptibility of water as $0{\cdot}79 \times 10^{-6}$, gives the value of the susceptibility as $0{\cdot}143 \times 10^{-6}$. Becquerel found a value not very different.

† The critical temperature of oxygen is −118° C. The corresponding absolute temperature is 155°. If we then put T = 155, in Curie's formula, $10^6K = 33700/T$, we get $10^6K = 217{\cdot}4$, as his deduced extrapolated value for the susceptibility per unit of mass. Since the density of liquid oxygen, as determined by one of us (J. Dewar) is 1·1375, our value for the susceptibility per unit of mass of the liquid oxygen is 228/1·1375 = 200·7. These figures show that the hyperbola does not represent the value of the susceptibility per unit of mass below the critical temperature.

oxygen with far greater accuracy. This method consists in observing the mechanical force which acts upon a vacuum bulb or mass of matter of known and very low susceptibility when it is suspended free from gravity in a vessel of liquid oxygen, and in a variable magnetic field. Under these conditions a vacuum bulb of very thin glass would behave like a strongly diamagnetic body, and if the magnetic susceptibility of the vacuum bulb or test mass is k_1, and that of liquid oxygen is k_2 for equal volumes, then the apparent diamagnetic susceptibility of the mass will be $-(k_2 - k_1)$, and the actual paramagnetic susceptibility of liquid oxygen may be deduced from a knowledge of k_1 and $-(k_2 - k_1)$. By this method we hope to be able to determine whether the permeability of liquid oxygen is a function of the magnetising force. The latest experimental results and measurements made with solutions of iron salts, such as those made recently by Mr. J. S. Townsend,* appear to show that the magnetic permeability of solutions of these iron salts is a constant quantity at least for a range of magnetic forces varying from 1 to 9 C.G.S. units.

The value, viz. 1·00287, as determined by us for the magnetic permeability of liquid oxygen, shows that the magnetic susceptibility (k) per unit of volume is $228/10^6$. It is interesting to compare this value with the value obtained by Mr. Townsend for an aqueous solution of ferric chloride, and which he states can be calculated by the equation

$$10^6 k = 91{\cdot}6\,w - 0{\cdot}77,$$

where w is the weight of salt in grams per cubic centimetre, and k the magnetic susceptibility. Even in a saturated solution, w cannot exceed 0·6, hence, from the above equation, we find the value of the magnetic susceptibility of a saturated solution of one of the most paramagnetic iron salts, viz., ferric chloride, is $54/10^6$ for magnetic forces between 1 and 9. This agrees fairly well with other determinations of the same constant. On the other hand, the magnetic susceptibility of liquid oxygen for the same volume is $228/10^6$, or more than *four times as great.* The unique position of liquid oxygen in respect of its magnetic susceptibility is thus strikingly shown. It is, however, interesting to note that its permeability lies far below that of certain solid iron alloys generally called non-magnetic.

The 12 per cent. manganese steel of Mr. R. A. Hadfield is usually spoken of as non-magnetic, yet the magnetic permeability of this last substance has been shown to be 1·3 or 1·4.

We have applied the foregoing method also to the determination of the magnetic permeability of liquid air. Since liquid air which

* See 'Phil. Trans.,' A, vol. 187, 1896, "Magnetisation of Liquids," J. S. Townsend, M.A.

has been standing in a vacuum vessel for any length of time has a composition which varies with the time and which may contain as much as 75 or 80 per cent. of oxygen, it was not to be expected that very closely consistent results could be obtained in the case of air. The following figures show, however, the observational results :—

PERMEABILITY OF LIQUID AIR.

Throws of Ballistic Galvanometer. Induction Coils balanced.

Exp. I.	1·5 mm. to right 1·2 ,, ,, 1·1 ,, ,,	The transformer in liquid air. Current = 38·0 amperes reversed through primary coils.
Exp. II.	17·0 mm. to left 17·5 ,, ,,	The transformer lifted out of liquid air into cold gaseous air at the same temperature as before. 37·5 amperes reversed.
Exp. III.	0·3 mm. to right 0·3 ,, ,,	The transformer in liquid air. Current = 37 amperes reversed through primary coils.
Exp. IV.	17·0 mm. to left 17·0 ,, ,, 17·3 ,, ,,	The transformer lifted out of liquid air into cold gaseous air, and at the same temperature as before. Current = 37 amperes reversed through primary coils.
Later.		
Exp. V.	2·8 mm. to left 2·8 ,, ,,	The transformer in liquid air. Current = 36·7 amperes reversed through primary coils.
Exp. VI.	18·8 mm. to left 19·2 ,, ,, 19·4 ,, ,, 19·8 ,, ,,	The transformer lifted out of liquid air into cold gaseous air, at the same temperature as before. Current = 37 amperes reversed through primary coils.
Exp. VII.	3·5 mm. to left 3·4 ,, ,,	The transformer in liquid air. Current = 36·7 amperes reversed through primary coils.
Exp. VIII.	22·0 mm. to left 22·0 ,, ,, 22·0 ,, ,,	The transformer in liquid air. Primary circuit of balancing coil cut out of circuit and 0·1118 ampere reversed through primary of transformer to standardise the ballistic galvanometer.

The results of these observations, when reduced, show that corresponding to a primary current of 37·5 amperes, or a mean magnetising orce of 164 C.G.S. units, the apparent magnetic permeability of liquid air in terms of gaseous air of the same temperature is 1·00240.

At the time of these observations the liquid air used had probably become almost entirely liquid oxygen by the evaporation of the nitrogen. The figure, however, serves to check approximately that of the liquid oxygen.

In conclusion, we desire to express our thanks to Mr. J. E. Petavel for the assistance he has given to us in the above work. We hope shortly to be able to make a further contribution to this portion of the investigations on which we are engaged, on the electrical and magnetic constants of liquid oxygen, and which will include a determination of the dielectric constant of liquid oxygen, made with the object of determining the extent to which this substance obeys Maxwell's law connecting magnetic permeability, dielectric constant, and optical refractivity.

November 30, 1896.

ANNIVERSARY MEETING.

Sir JOSEPH LISTER, Bart., F.R.C.S., D.C.L., President, in the Chair.

The Report of the Auditors of the Treasurer's Accounts, on the part of the Society, was presented as follows :—

"The total receipts on the General Account during the past year, including balances carried from the preceding year, amount to £8,928 1*s.* 3*d.*, and the total receipts on account of Trust Funds, including balances from the preceding year, amount to £5,009 0*s.* 2*d.* The total expenditure for the same period amounts to £7,287 12*s.* 3*d.* on the General Account (including £300 on loan to the Coral Boring Committee), and £3,347 11*s.* 7*d.* on account of Trust Funds, leaving a balance on the General Account of £1,605 9*s.* 4*d.* at the bankers (which includes £1304 17*s.* 3*d.* on deposit—Dr. Ludwig Mond's gift, £54 10*s.* Publication Grant Account, and £29 11*s.* 10*d.* Water Research Account), and in the hands of the Treasurer a balance of £34 19*s.* 8*d.*; leaving also at the bankers a balance on account of Trust Funds of £1,661 8*s.* 7*d.*"

The thanks of the Society were voted to the Treasurer and Auditors.

FIG. 1.

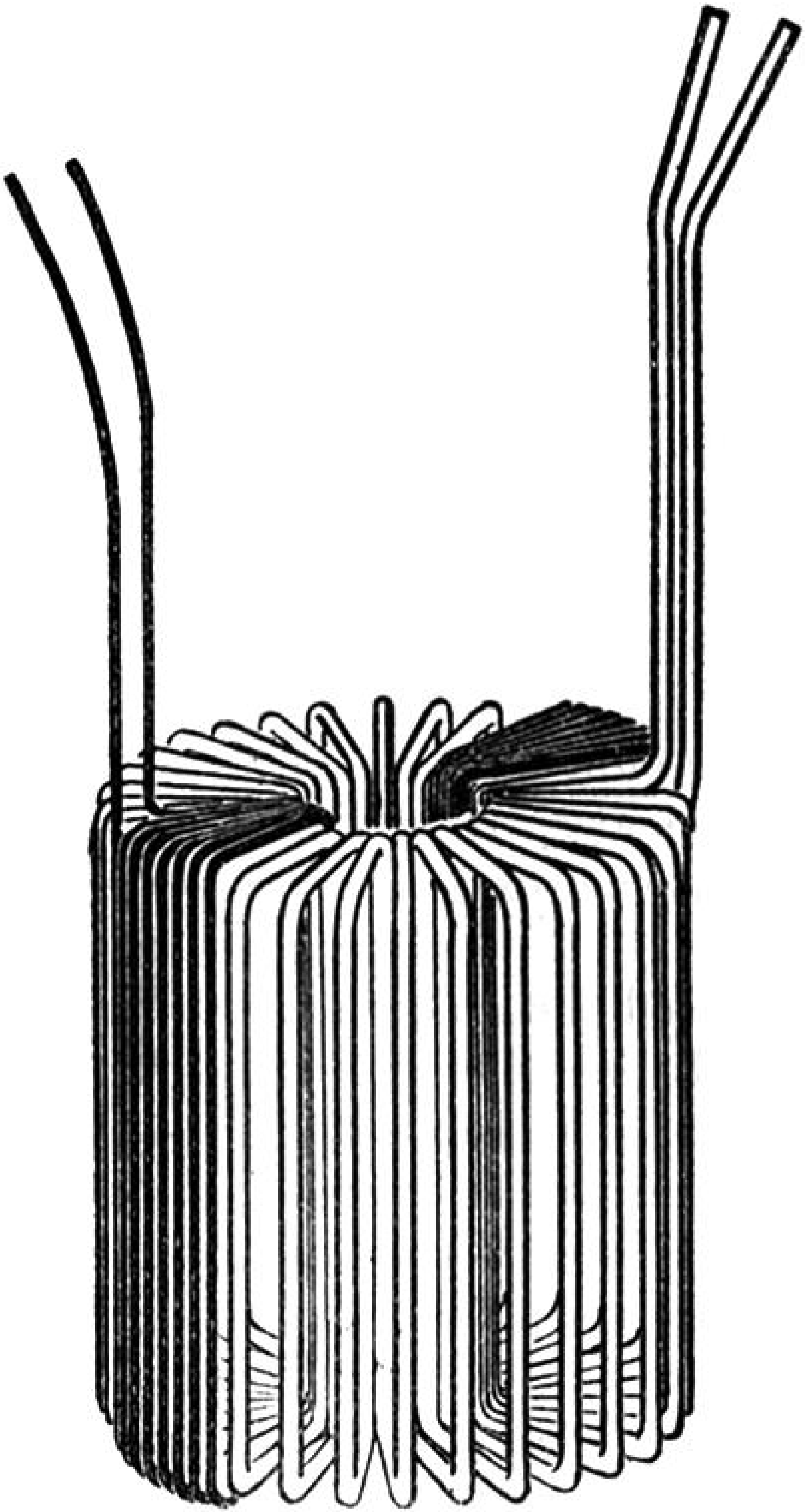


Diagram of the Closed Circuit Transformer used in the Experiments.