Michael Faraday

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REVIEWS

OF

MODERN PHYSICS

FARADAY'S DIARY

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MICHAEL FARADAY was, according to the general estimate, one of the greatest experimental philosophers who ever lived. The judgment is a fair one whether we consider the skill of his experiments and the brilliance of his arguments, or the influence which he has exercised on the thought of the world, or the industrial developments that have been based on his discoveries. It cannot but be of extraordinary interest to know how he worked, to be told of his methods and be admitted to his thoughts. And this is exactly what we are enabled to do by the study of the diary which he kept all through his working years.

The diary is in his own handwriting. The first entries were made in the early twenties of the last century, the last in the sixties when old age obliged him to give up his researches. The greatest part of it has been written on loose foolscap sheets, subsequently bound up into several volumes, some of them by his own hands. It is to be remembered that in his youth he was a journey-man bookbinder. There are over a million words in all. The diary has never been published. It is probable that no one has ever read the whole of it, though various passages have been quoted from time to time on account of their special interest. The writing is neat and shapely, but after a while it is somewhat tiring to the eye. The managers of the Royal Institution have recently decided that publication would be welcomed, not only by students of science but by many others also: and they have been influenced by the approach of the Faraday Centenary celebrations. The first volume is to appear within a few weeks: others will follow in due course.

The diary refers only to Faraday's researches: no details of his private life are recorded, nor is there any reference to public events. Yet it is much more than a collection of laboratory notes. He was in the habit of discussing the progress of his work, arguing as he wrote. Sometimes he filled pages with his expectations and plans before the actual laboratory work was begun. Again he records his difficulties and perplexities, describing cases of apparent contradiction between his results, and suggesting means of resolving them. Some of the most delightful entries are those which express his pleasure at a good day's work or his elation at the appearance of some new law. Altogether his document is most human. Faraday talks to this diary making it his confident and the reader feels that he may take the place of the diary.

From time to time Faraday summed up the results of his work in papers submitted to the Royal Society. Consequently it must not be expected that the diary will be found to contain unpublished discoveries of importance. His well-known volumes of Experimental Researches describe the gist of his life's work, being reprints of the Royal Society communications. Nevertheless the reader continually meets with interesting comments and suggestions. And of course the diary possesses a value quite peculiar in showing how Faraday

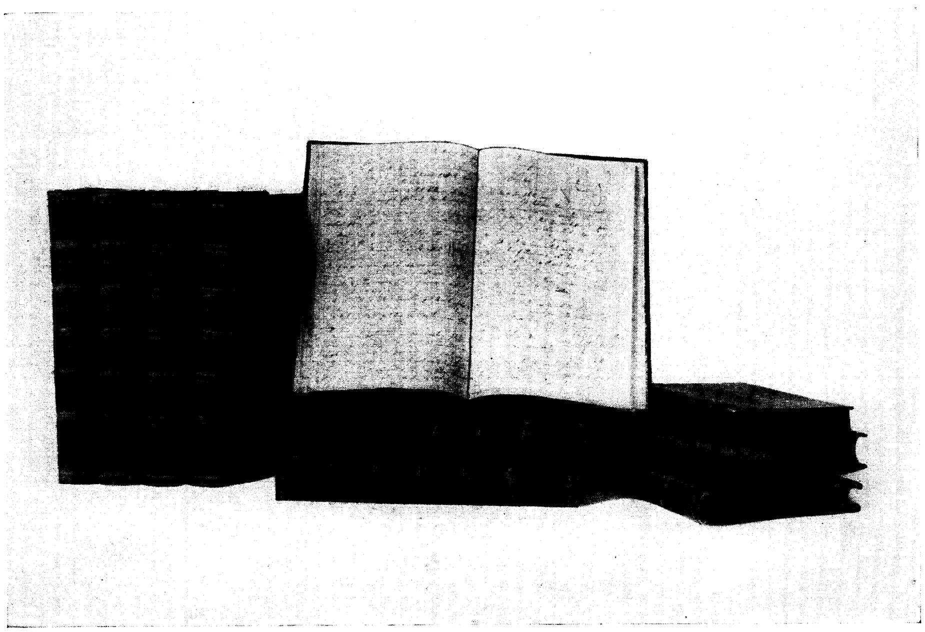


Fig. 2. The eight folio and two quarto MS. volumes of laboratory notes, commonly known as Faraday's Diary, in the possession of the Royal Institution. Open at the page illustrating his first dynamo.

felt his way to his conclusions. The results at which he aimed are now so well known that men have forgotten the perplexities and labors which hindered their establishment, especially the vague ideas of electricity and magnetism in the beginning of the last century have been cleared away, replaced by clear cut laws. But in Faraday's time the researcher had nothing to guide him in the attempt to make his way through a most perplexing country. Nor was he furnished with all the aids which now exist in such aptness and plenty. To take a simple example, there was no covered wire for electrical experiments. There was a cotton covered iron wire in use for bonnet-making, and so-called bell-wire which tugged the swinging bells in the servants' quarters. But when Faraday wanted a coil of wire to carry electricity round and round an iron bar, he found it best to wind bare copper wire and string in alternating strands, separating the layers by tape.

A few extracts from the diary will illustrate its character. The first of those that follow was written on November 28, 1825.

Experiments on induction by connecting wire of Voltaic battery. A battery of 4 troughs, ten pairs of plates each, arranged side by side.

Expt-I. The poles connected by a wire about 4 feet long, parallel to which was another similar wire separated from it only by 2 thicknesses of paper. The ends of the latter wire attached to a galvanometer exhibited no action.

Expt-II. The battery poles connected by a silked helix—a straight wire passed through it and its ends connected with the galvanometer—no effect.

Expt-III. The battery poles connected by a straight wire over which was a helix, its ends being connected with the galvanometer—no effect.

Could not in any way render any induction evident from the connecting wire.

The interest lies here in the fact that Faraday was searching for some form of electromagnetic induction which he, and no doubt then, believed to exist. But his trials were negative in the experiments here recorded because he

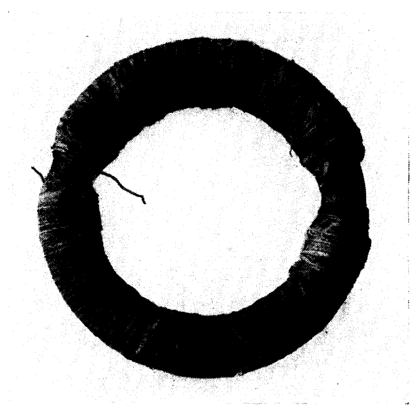


Fig. 3. Historic ring of soft iron, wound with separate coils of copper wire connected to battery and galvanometer respectively, used by Faraday in his first successful experiment in electromagnetics.

was not looking for the effect in the right place. On August 29, 1831, he looked for the effect in the right place and saw it, and so made the famous discovery which is to be commemorated this year. The argument seems to have run in this way: Oersted had shown in 1819 that the wire joining the two poles of the Voltaic battery could deflect a magnet. Ampere had shown that the wire could attract or repel a similar current-carrying wire placed parallel to itself. Arago and Davy had observed that the wire could magnetise iron and steel. In fact the first of the four great rules of electromagnetism had been extablished. A wire carrying an electric current had magnetic effects. The other three rules were to follow later.

Now a magnet induces magnetism in a neighboring piece of iron. Should not therefore a wire carrying a current induce a current in a neighboring piece of wire in a similar manner? Might not Faraday reasonably expect that when he laid his two wires parallel to one another as the diary records, the current in the first should induce a current to run in the second so long as they lay side by side? He tried, and failed to find such an effect: as of course he ought to have failed, because the effect does not exist.

It is evidence of the confused notions of the time that it was six years before Faraday made the successful experiment. He tried again on August 29, 1831. He does not tell us what led him to make the apparatus which enabled him to get at the truth: it was in fact what is now called a transformer. Let him describe the apparatus and the experiment in his own words.

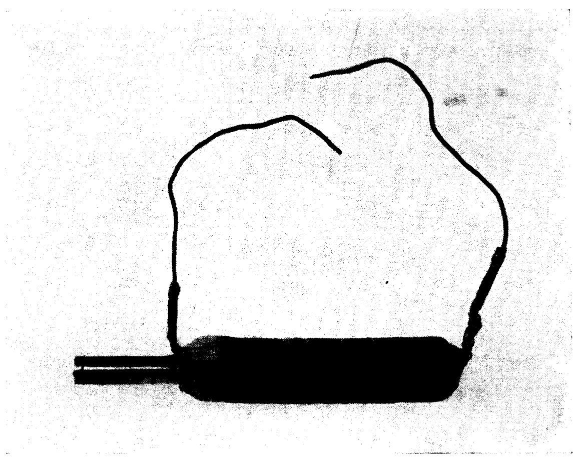


Fig. 4. Helix of copper wire and bar magnet used by Faraday. It is with this apparatus that he first induced an electric current by plunging the magnet into the coil.

August 29th, 1831

1. Expts. on the production of Electricity from Magnetism, etc, etc.

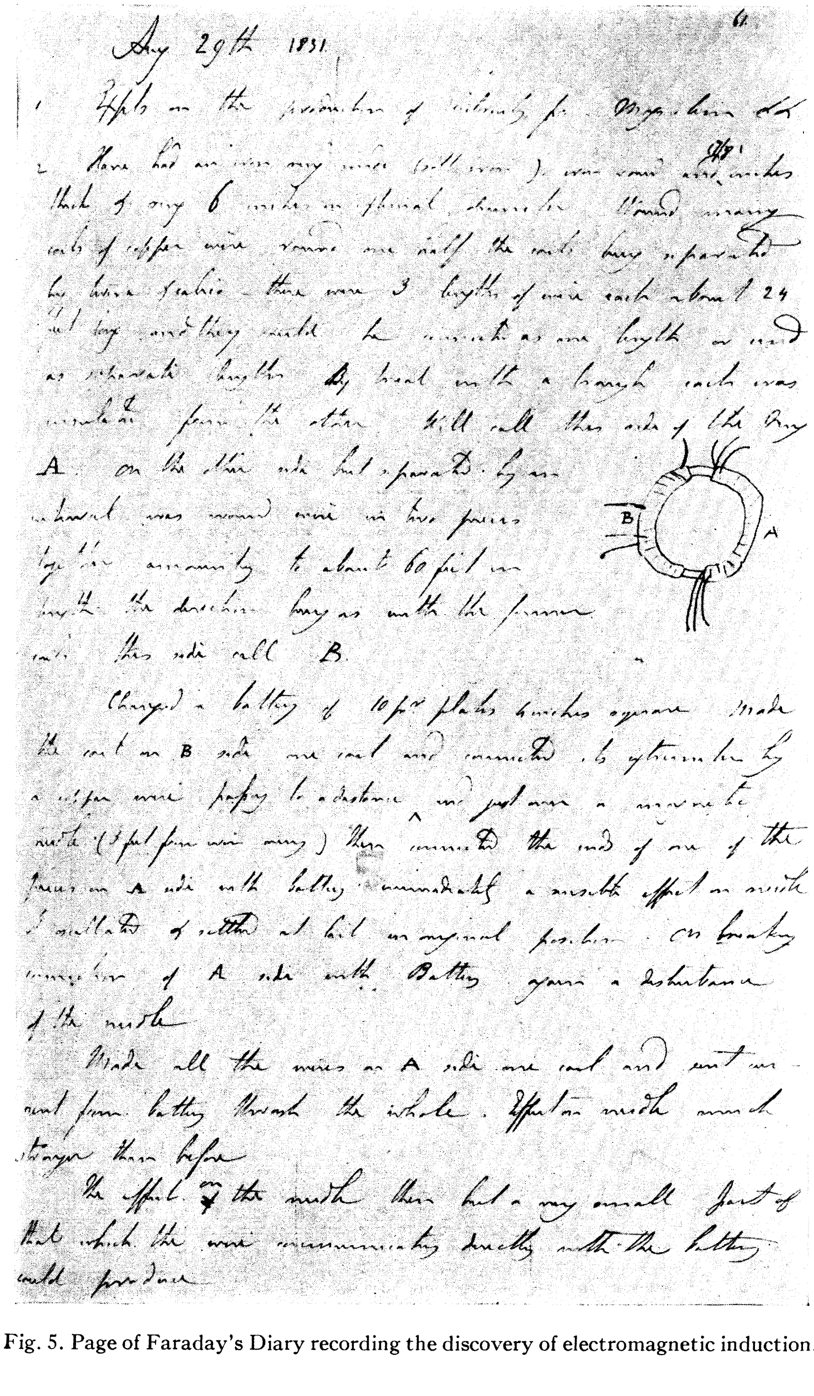
2. Have had an iron ring made (soft-iron), iron round and 7/8 inches thick and ring 6 inches in external diameter. Wound many coils of copper wire round one half, the coils being separated by twine and calico—there were 3 lengths of wire each about 24 feet long, and they could be connected as one length or used as separate lengths. By trial with a trough each was insulated from the other. Will call this side of the ring *A*. On the other side but separated by an interval was wound wire in two pieces together amounting to about 60 feet in length, the direction being as with the former coils; this side call *B*.

3. Charged a battery of 10 pr. plates 4 inches square. Made the coil on *B* side one coil and connected its extremities by a copper wire passing to a distance and just over a magnetic needle (3 feet from iron ring). Then connected the ends of one of the pieces on *A* side with battery: immediately a sensible effect on needle. It oscillated and settled at last in original position. On breaking connection of *A* side with battery again a disturbance of the needle.

. . . .

8. Hence effect evident but transient: but its recurrence on breaking the connection shows an equilibrium somewhere that must be capable of being rendered more distinct.

Thus Faraday had found the reciprocity which, he believed, must exist: though not in the form he had anticipated. Instead of saying that because an



Aug 29th 1831.

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Charged a battery of 10 pr. plates 4 inches square. Made the coil on B side one coil and connected its extremities by a copper wire passing to a distance and just over a magnetic needle (3 feet from iron ring). Then connected the ends of one of the pieces on A side with battery; immediately a sensible effect on needle. It oscillated & settled at last in original position. On breaking connection of A side with Battery again a disturbance of the needle.

Made all the wires on A side one coil and sent current from battery through the whole. Effect on needle much stronger than before.

The effect on the needle then but a very small part of that which the wire communicating directly with the battery could produce.

Fig. 5. Page of Faraday's Diary recording the discovery of electromagnetic induction.

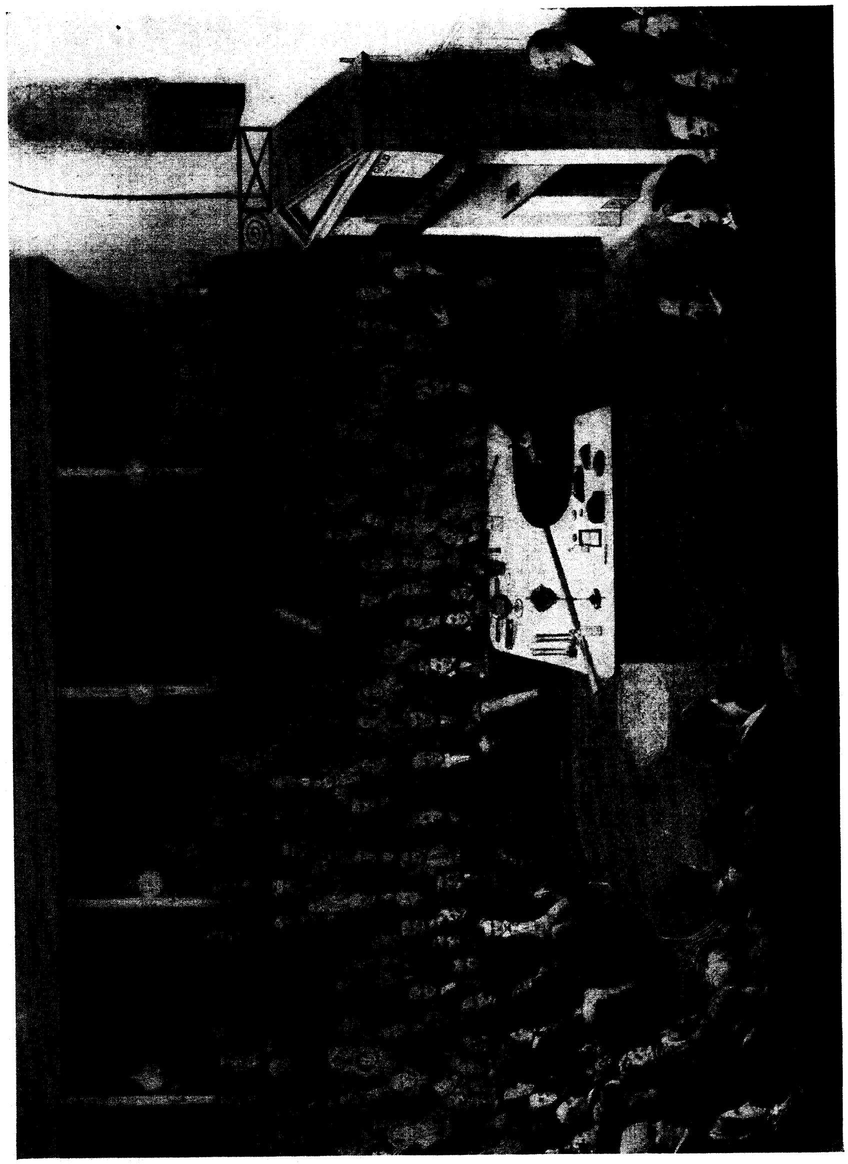


Fig. 6. Faraday in the Lecture Theatre of the Royal Institution. Christmas Juvenile Lectures on Metals, 1855–56.
The Prince Consort in the Chair.

electric current could call a magnet into existence and therefore one might expect that a magnet would call a current into existence, one ought to argue that because moving electricity had magnetic effects, therefore moving mag-

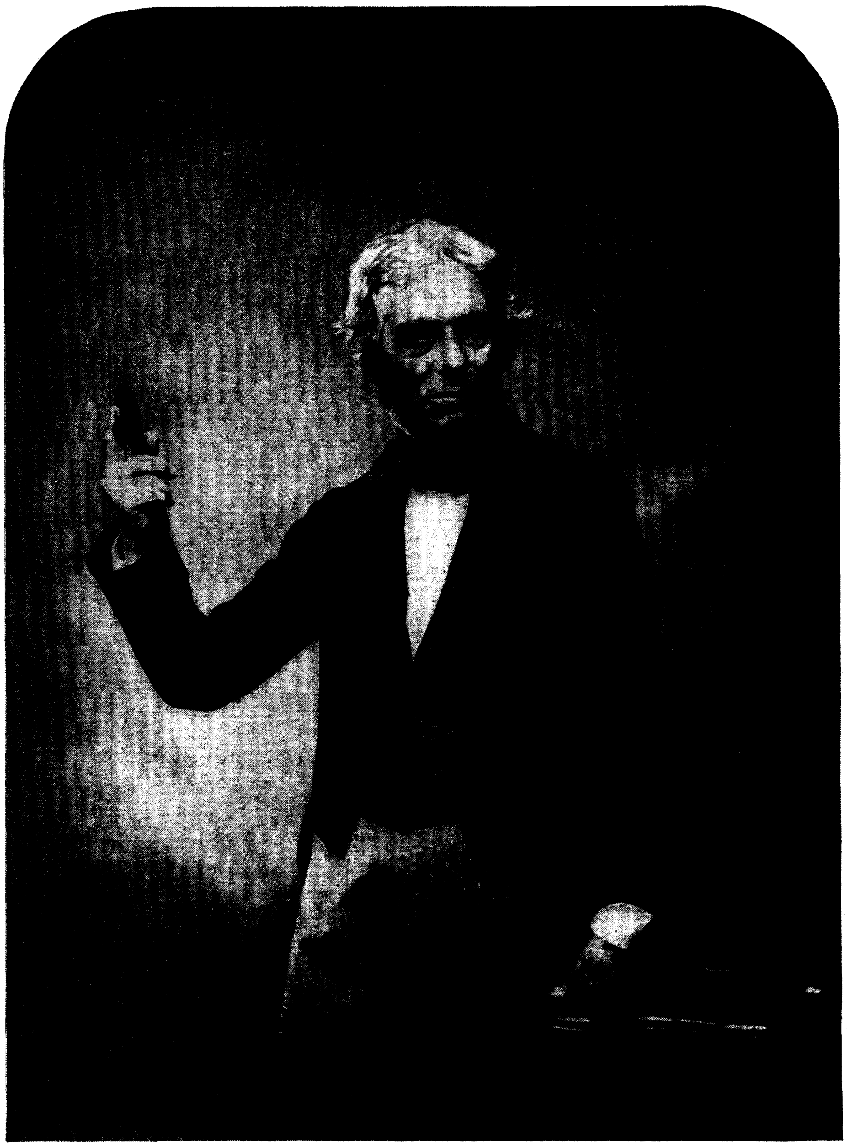


Fig. 7. Portrait of Faraday with bar of his heavy glass.

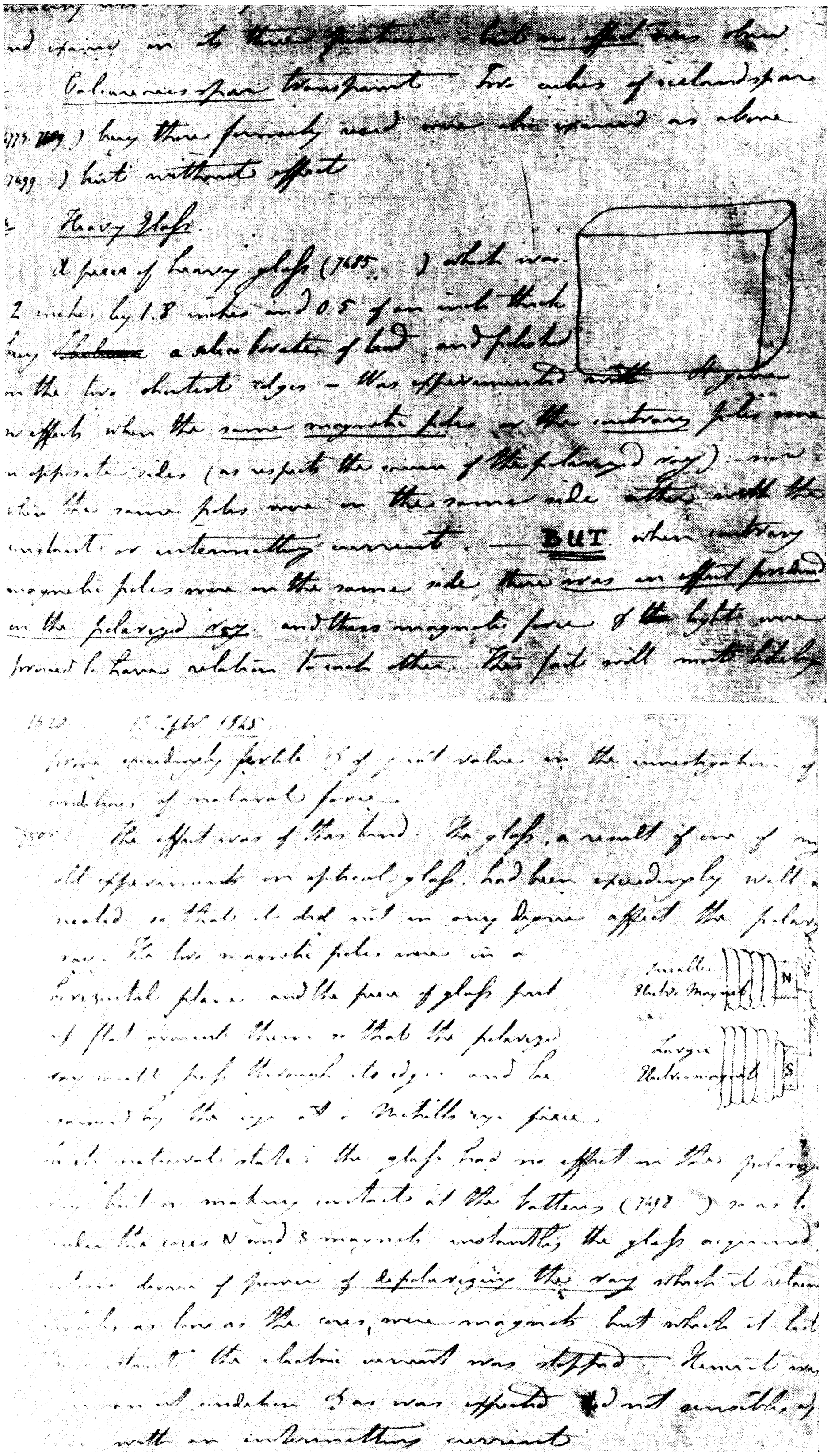
netism should have electric effects. The term 'moving magnetism' would cover such operations as moving a magnet near a conductor or using an electric current to produce magnetism where it did not exist before or to alter the amount that already existed. This principle, and that which Oersted first discovered were embodied by Maxwell in those two of his four equations or rules into which time entered.

An entry of extraordinary interest is that in which he describes his discovery of a relation between magnetism and light. He had been searching for some such effect for days. It is to be remembered that the course of his work was largely directed by a conviction that all the forces of nature were in some way connected with each other: light, heat, electricity, magnetism, chemical action, cohesion and the rest. The conviction gave him patience to try again and again where success at first was denied him, and inspired his choice of methods. He had linked together electricity and magnetism; he now sought to find some optical effect in which either of them might be concerned. His first efforts were made with electrical actions which might in some way give him what he wanted; but entry after entry ends up with the words "no effect." Then he tried magnetism. He would see whether some disposition of magnets might influence a ray of light; it would most likely, if there was such an influence, show itself in rotation of the plane of polarisation of a polarized beam since this is a delicate effect, easily disturbed. He was at first no more successful than in the days that had gone before, and the words "no effect" must still appear at the end of each paragraph. But at last he succeeded. He tried a particular disposition of the magnets in relation to a very special kind of glass through which the ray of light was travelling and there was a slight brightening and darkening of the field in the polariscope as the electromagnet was made active and inactive in turn. He was overjoyed. Consider the BUT in the following extract, and imagine the delight with which he printed it in capitals and underlined it.

Heavy glass

A piece of heavy glass (7485) which was 2 inches by 1.8 inches and 0.5 of an inch thick being silico borate of lead and polished on the two shortest edges—was experimented with. It gave no effects when *the same magnetic poles* or the *contrary* poles were on opposite sides (as respects the course of the polarised ray)—nor where the same poles were on the same side either with the constant or intermitting current—BUT when contrary magnetic poles were on the same side there *was an effect produced on the polarised ray*, and thus magnetic force and light were proved to have relation to each other. This fact will most likely prove exceedingly fertile and of great value in the investigation of conditions of natural force.

And so it has done. Magneto-optics has grown to be a very great and important subject. Curiously enough he thought that he had made another great discovery a month later, in October 1845, and was mistaken. A "new and striking result" appeared. Certain optical effects showed themselves in a piece of apparatus which he had contrived for the further study of his magnetism-light connection. He spent two days in eager examination and writes on October 12th "Singular and beautiful Phenomena there—no guessing what they will extend or lead to—an open door." Next day he finds that his new discovery has nothing to do with magnetism or electricity, but is merely a consequence of the casual heating of part of his apparatus. "Worked again on these phenomena and after much experiment and consideration made out the


...nd opened on to those positions – but no effect was shown.
Polarized spar transparent. Two cubes of Iceland spar
(7473 7499) being those formerly used were also examined as above
(7499) but without effect.
Heavy Glass.
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being silicated borate of lead, and polished
on the two shortest edges – Was experimented with. It gave
no effects when the same magnetic poles or the contrary poles were
on opposite sides (as respects the course of the polarized ray) – nor
when the same poles were on the same side either with the
constant or intermitting current. — BUT when contrary
magnetic poles were on the same side there was an effect produced
on the polarized ray and thus magnetic force & light were
proved to have relation to each other. This fact will most likely
7500 13 Sept. 1845
prove exceedingly fertile & of great value in the investigation of
conditions of natural force.
7505 The effect was of this kind. The glass, a result of one of my
old experiments on optical glass, had been exceedingly well annealed so that it did not in any degree affect the polarized
ray. The two magnetic poles were in a
horizontal plane and the piece of glass put
up against them so that the polarized
ray would pass through its edges and be
examined by the eye at a Nicholls eye piece.
In its natural state the glass had no effect on the polarized
ray but on making contacts at the battery (7498) so as to
make the cores N and S magnets instantly the glass acquired
a slight degree of power of depolarizing the ray which it retained
steadily as long as the cores were magnets but which it lost
instantly the electric current was stopped. Hence it was
a permanent condition & was affected and not sensibly affected
with an intermitting current.

Fig. 8. Page of Faraday's diary recording the discovery of the rotation of the plane of polarization of light which is passed through a heavy glass in a magnetic field.

cause of the second effect, that of the diffuse phosphorescent light, and so though I have lost an imagined discovery have removed a stumbling block."

Very interesting are the pages on which Faraday wrote out his proposals for a series of experiments with his reflections thereon and his anticipations.

Fig. 9. Faraday at work in old laboratory at the Royal Institution. From a contemporary water colour.

At the end of 1835 he saw that he must settle for himself the relations between the electricities produced in various known ways and he writes as follows:

3 Nov., 1835

2468. Have been thinking much lately of the relation of common and Voltaic electricity: of induction by the former and decomposition by the latter, and am quite convinced there must be the closest connection. Will be first needful to make out the true character of ordinary electrical phenomena. The following notes are for experiment and consideration.

2469. Does common electricity reside upon the surface of a conductor or upon the surface of the electric (N. B. dielectric is modern language) in contact with it. I think upon the electric and must work out the results on that view. It will make a great difference in the collation and connexion of the various electrical phenomena and also in their explication.

. . . .

2473. With relation to existence of electricity entirely upon the surface of conductors.

2474. Ascertain Coulomb's or Biot's fact with a globe about 6 inches or a foot in diameter—using a carrier that shall not disturb the form of the inside of the globe i.e. a flat plate—not a ball . . . .

2475. Make a part of the globe as thin as gold leaf and then try it upon the inside.
2476. Try the inside of a cylinder with straight or curved ends.
2477. Try the bottom of a cup—or inside of a hemisphere.
2478. Try both sides of a plane of large extent at different distances from the centre.
2479. As globe becomes larger and larger air being within, any part of it ought to approximate towards state of a plane in open air. Try therefore very large globe within. . . .

And so on to many more similar suggestions. These experiments led finally to the construction of the great cube of 12 foot edge, which was electrified until it sparked and brushed at every corner, while Faraday found no effect upon his most delicate instruments which he had taken inside.

His attempts to link up gravity with the other "natural forces" were persistent, and his record of them all the more interesting because he did not and could not succeed.

25 August, 1849

10061. I have been arranging certain experiments in reference to the notion that gravity itself may be practically and directly related by experiment to the other powers of matter (10018) and this morning proceeded to make them. It was almost with a feeling of awe that I went to work—for if the hope should prove well founded how great and mighty and sublime in its hitherto unchangeable character is the force I am trying to deal with and how large may be the new domain of knowledge that may be opened up to the mind of man. (10319)

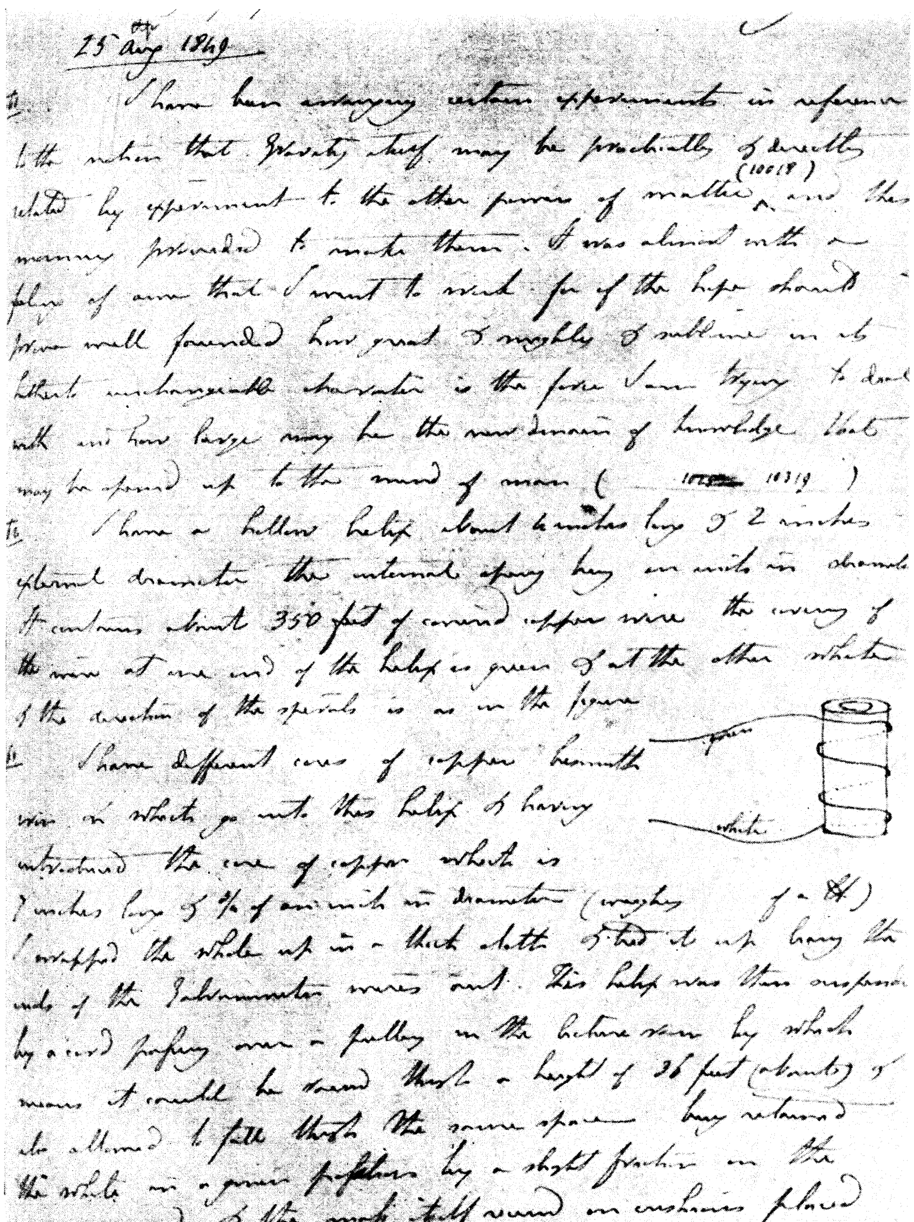
He proceeded to drop a helix, containing 350 feet of covered copper wire, from the roof of the Royal Institution theatre to the floor, hoping to see some indication on the galvanometer connected with the helix. At first he thought he had found something, but later discovered that the connecting wires between helix and galvanometer were not sufficiently intertwined and that the earth's field was in action. He tried also to find some effect upon a mass dropped from a great height, for which purpose he worked in the shot tower on the south of the Thames opposite to Charing Cross. He returned again to this subject towards the end of his life. A series of entries in the diary record a number of interesting imaginative and practical suggestions for experiment, winding up with the following more enthusiastic sentences.

15809. Let the imagination go guiding it by judgment and principle but holding it in and directing it by *experiment*.

15810. If any effect either electric or colorific—then consider the infinity of action in nature—a *planet* or a *comet* when nearer to or farther from the Sun. Dr. Winslow's observations on earthquakes. A falling river or cascade—the falls of Niagara—Evaporation vapor rising—rain falling—hail—Negative state of the upper regions—Condition of the inner and deeper parts of the earth—their heat—A falling stone or orolite heated—a volcano and the volcanic lightning. Smoke in a chimney perhaps goes out electrified.

"It might indeed have been anticipated" he writes on April 16, 1860, in respect to the failure of all his attempts on the gravity problem

. . . . from the very views I entertain, that we could hardly hope to lay hold by experiment of such an amount of gravitating force as would yield appreciable evidence of electric or heat force:—but if we were to stop the first institution of experiment in any new direction for such a reason, what progress or more, what discovery, could we hope to make by its means in any of the, as yet, undiscovered paths of science.



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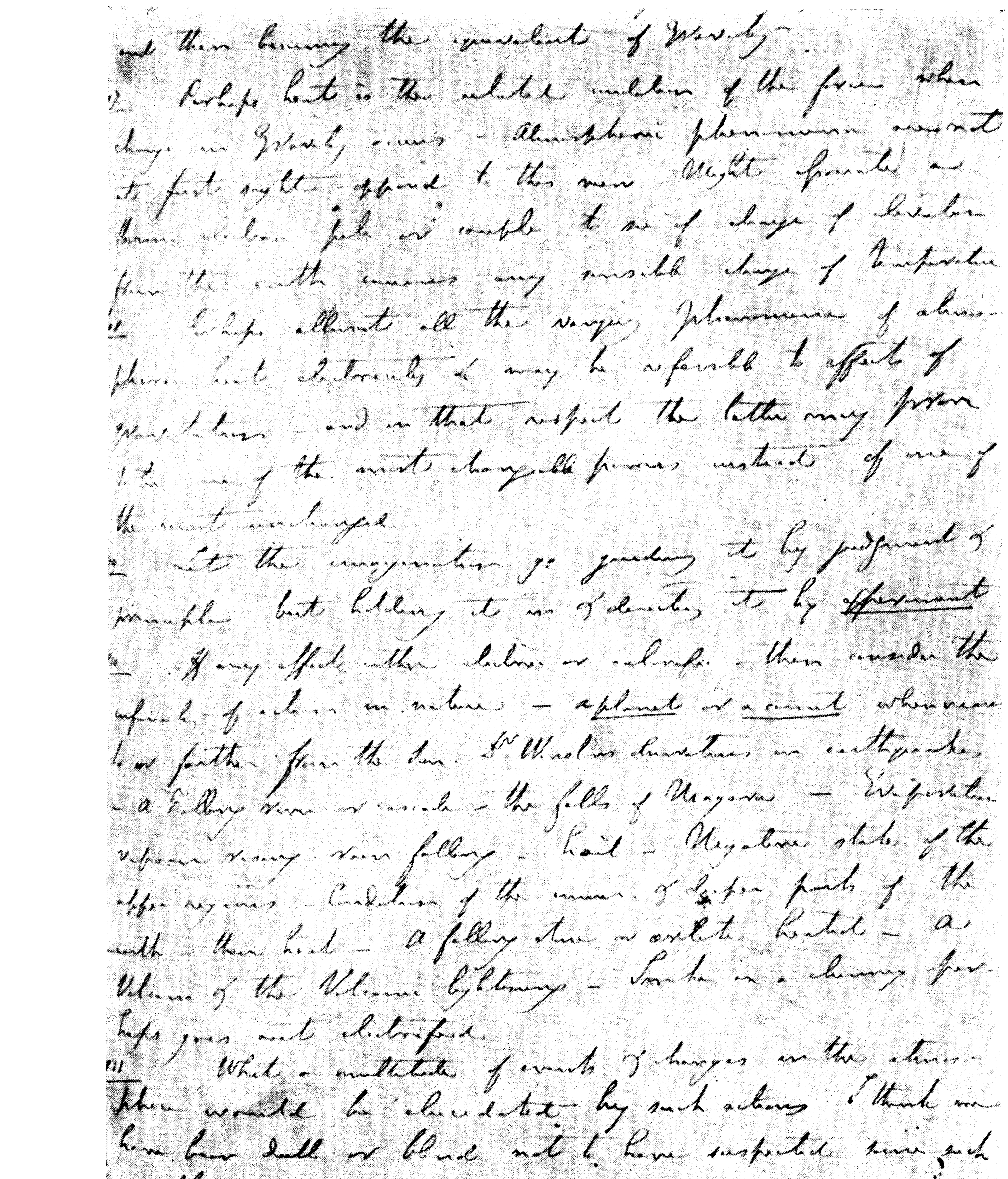
10 I have a hollow helix about 4 inches long & 2 inches external diameter the internal space being one inch in diameter It contains about 350 feet of covered copper wire the covering of the wire at one end of the helix is green & at the other white & the direction of the spirals is as in the figure

green

white

11 I have different cores of copper bismuth wire or sheets to go into this helix & having introduced the core of copper which is 7 inches long & 7/10 of an inch in diameter (weighs of a lb) I wrapped the whole up in a thick cloth & tied it up leaving the ends of the Galvanometer wires out. This helix was then suspended by a cord passing over a pulley in the lecture room by which means it could be raised through a height of 36 feet (about) & also allowed to fall through the same space being retained the whole in a proper position by a slight fracture on the running cord & the mass itself received on cushions placed on the lecture table (in the lecture room) beneath

Fig. 10. Page of Faraday's diary recording an unsuccessful attempt to discover a relationship between gravity and electricity.



and then becoming the equivalent of Gravity.

2 Perhaps heat is the related condition of the force when change in Gravity occurs - Atmospheric phenomena do not at first sight respond to this view. Might furnish a [illegible] [illegible] jet as unable to me of change of elevation from the earth causes any sensible change of Temperature

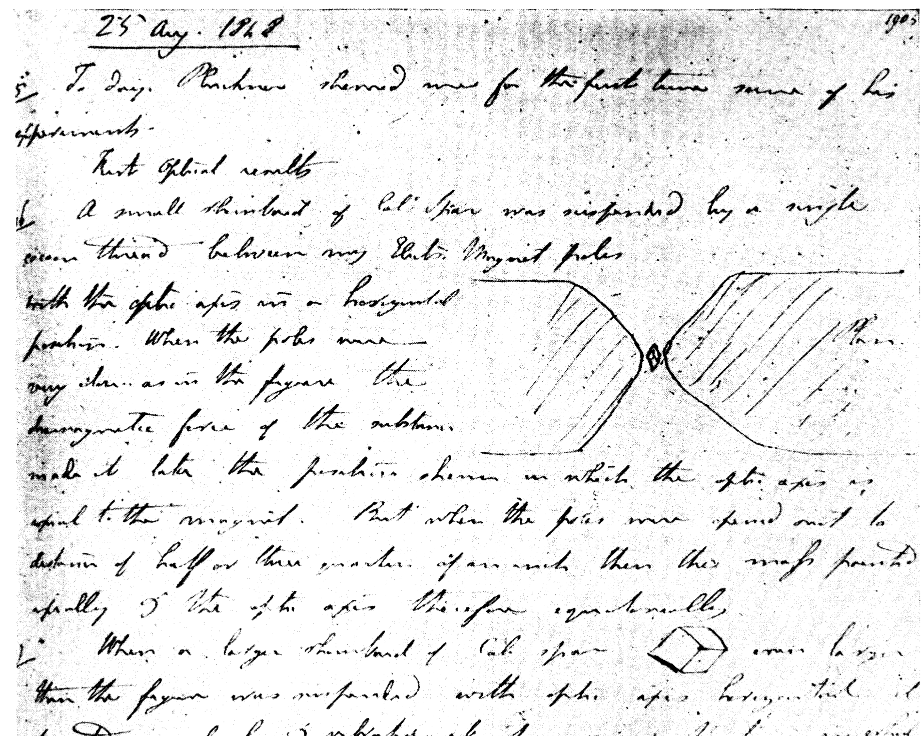
3 Perhaps almost all the varying phenomena of atmosphere heat electricity &c may be referrible to effects of gravitation - and in that respect the latter may prove to be one of the most changeable powers instead of one of the most unchanged.

4 Let the imagination go guiding it by judgement & principle but holding it in & directing it by experiment

5 If any effect then electric or otherwise - then consider the infinity of action in nature - a planet or a comet when nearer to or farther from the sun. Sir W. [illegible] [illegible] or earthquakes - a falling stone or avalanche - the falls of Niagara - Evaporation of vapour rising - rain falling - hail - Negative state of the upper regions - Condition of the inner & upper parts of the earth - their heat - a falling stream or cataract heated - a Volcano of the Volcanic lightning - Smoke in a chimney perhaps goes out electrified.

6 What a multitude of events & changes in the atmosphere would be elucidated by such actions. I think we have been dull or blind not to have suspected some such results.

Fig. 11. Page of Faraday's diary recording imaginative and practical suggestions for experiments.


25 Aug. 1848

5. To day Plücker shewed me for the first time some of his experiments.

First Optical results

6. A small rhomboid of Calc Spar was suspended by a single cocoon thread between my Electro Magnet poles with the optic axis in a horizontal position. When the poles were very close as in the figure the diamagnetic force of the substance made it take the position shewn in which the optic axis is equal to the magnet. But when the poles were opened out to distances of half or three quarters of an inch then the mass pointed equally by the optic axis therefore equatorially.

7. When a large rhomboid of Calc spar even larger than the figure was suspended with optic axis horizontal it pointed regularly and vibrated about a given position in which the optic axis was in the equatorial plane.

8. There is a given distance between the Mag. poles (parallel face) where a certain rhomboid or piece of Calc spar between them is so affected that the diamagnetic and the magneto optic force is balanced. At smaller distances the force points diamagnetic. At larger distances Magneto optic. So that on increasing the distance the magneto optic force diminishes less rapidly than the magnetic force and on diminishing the distance it increases less rapidly than the ~~optic force~~ magnetic force.

9. But increasing or diminishing the strength of the Magnet produces no alteration of the place of neutral action. Clearly increases or diminishes the strength of the actions on each side of it or rather the resultant of the two actions on each side of that neutral position. So Plücker at least has not found out on that point.

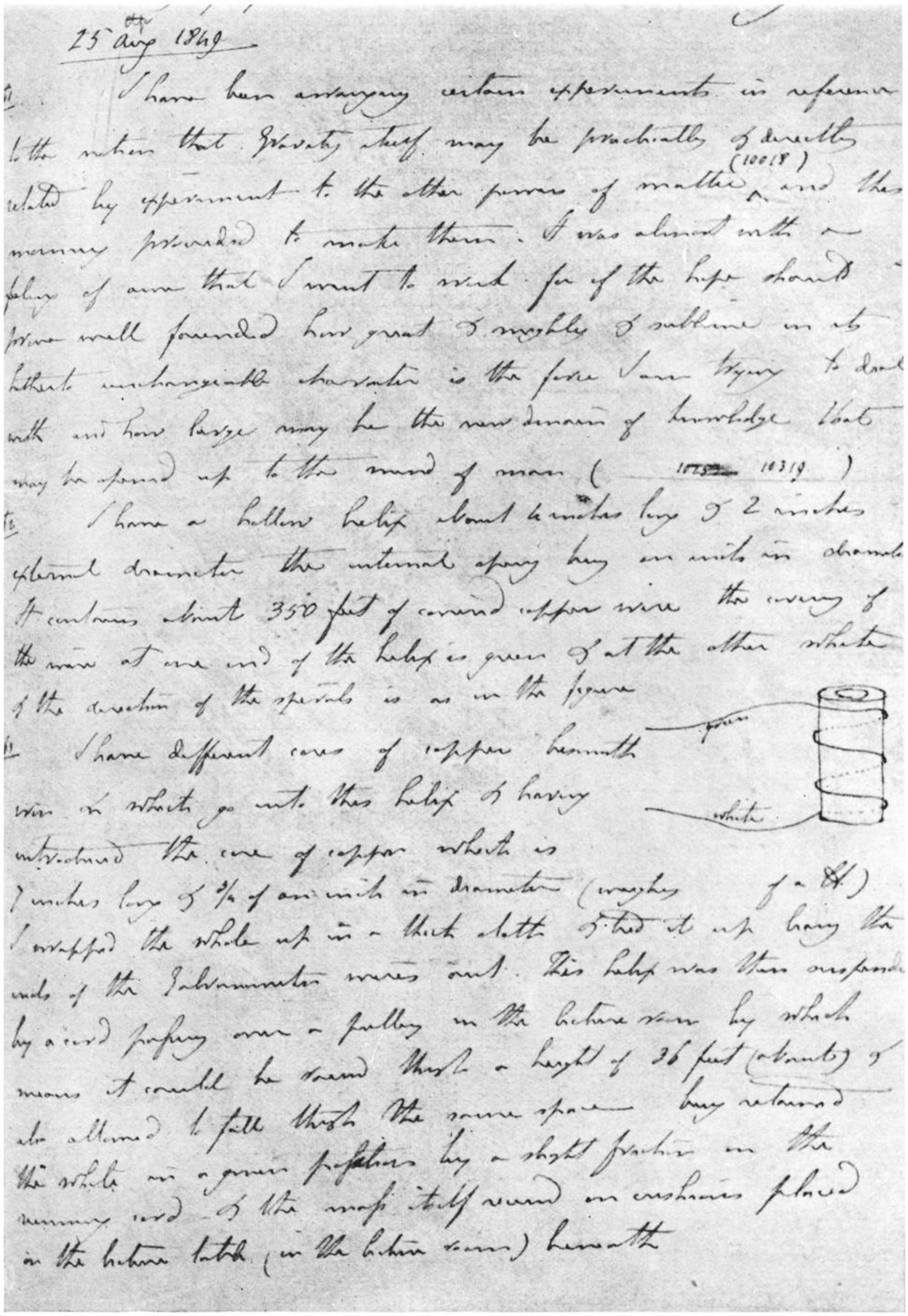
Fig. 12. Page of Faraday's diary recording some observations on the Plücker effect.

The connection between gravity and light is indeed difficult to make plain. It is to be found in the bending of a ray of light in a gravitational field as Einstein predicted and the astronomers have verified.

An interesting entry on August 25, 1848, reproduced here in facsimile refers to experiments which Plücker showed him when on a visit to England. They were Faraday's introduction to a pair of subjects which grew to importance in his hands, diamagnetism and magnecrystallic action. Faraday stated clearly the first principles of each, and disentangled their somewhat confusing effects.

Faraday's last entry is dated March 12, 1862, and describes an attempt to find some action between a magnet and the light emitted from a neighboring flame. But, though his intuition was correct, the apparatus at his disposal was not sensitive enough. Many years afterwards the effect he sought for was found by Zeeman.

These few extracts and notes may serve to give some idea of the character of the diary. They cannot of course indicate all its contents which range over the wide fields in which he worked. In his time, and to a remarkable extent in his laboratory, those first discoveries were made which were largely responsible for the progress of the succeeding century in thought and in the applications of thought. It is a wonderful piece of good fortune that the man who did so much should have been inspired to write this account of the part which he played.


25th Aug 1849

I have been arranging certain experiments in reference to the notion that Gravity itself may be practically & directly related by experiment to the other powers of matter (10018) and this morning proceeded to make them. It was almost with a feeling of awe that I went to work, for if the hope should prove well founded, how great & mighty & sublime in its hitherto unchangeable character is the force I am trying to deal with, and how large may be the new domain of knowledge that may be opened up to the mind of man (~~1025~~ 10319)

I have a hollow helix about 4 inches long & 2 inches external diameter the internal space being an inch in diameter It contains about 350 feet of covered copper wire the covering of the wire at one end of the helix is green & at the other white & the direction of the spirals is as in the figure

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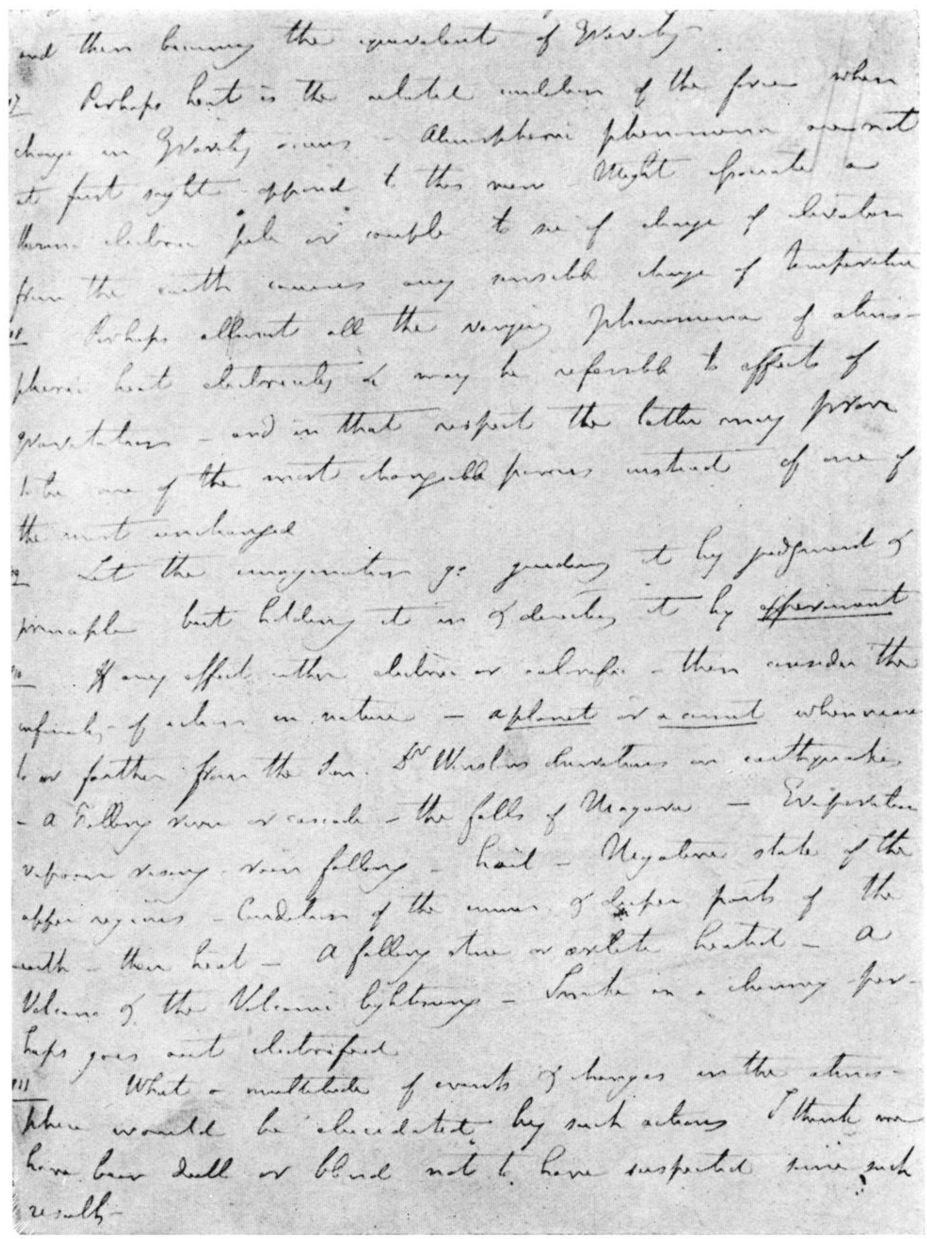

and then becoming the equivalent of Gravity.

7 Perhaps heat is the related condition of the force when change in Gravity occurs — Atmospheric phenomena are not at first sight opposed to this view. Might generate a thermo-electric [illegible] or [illegible] to [illegible] of change of elevation from the earth causes any sensible change of temperature

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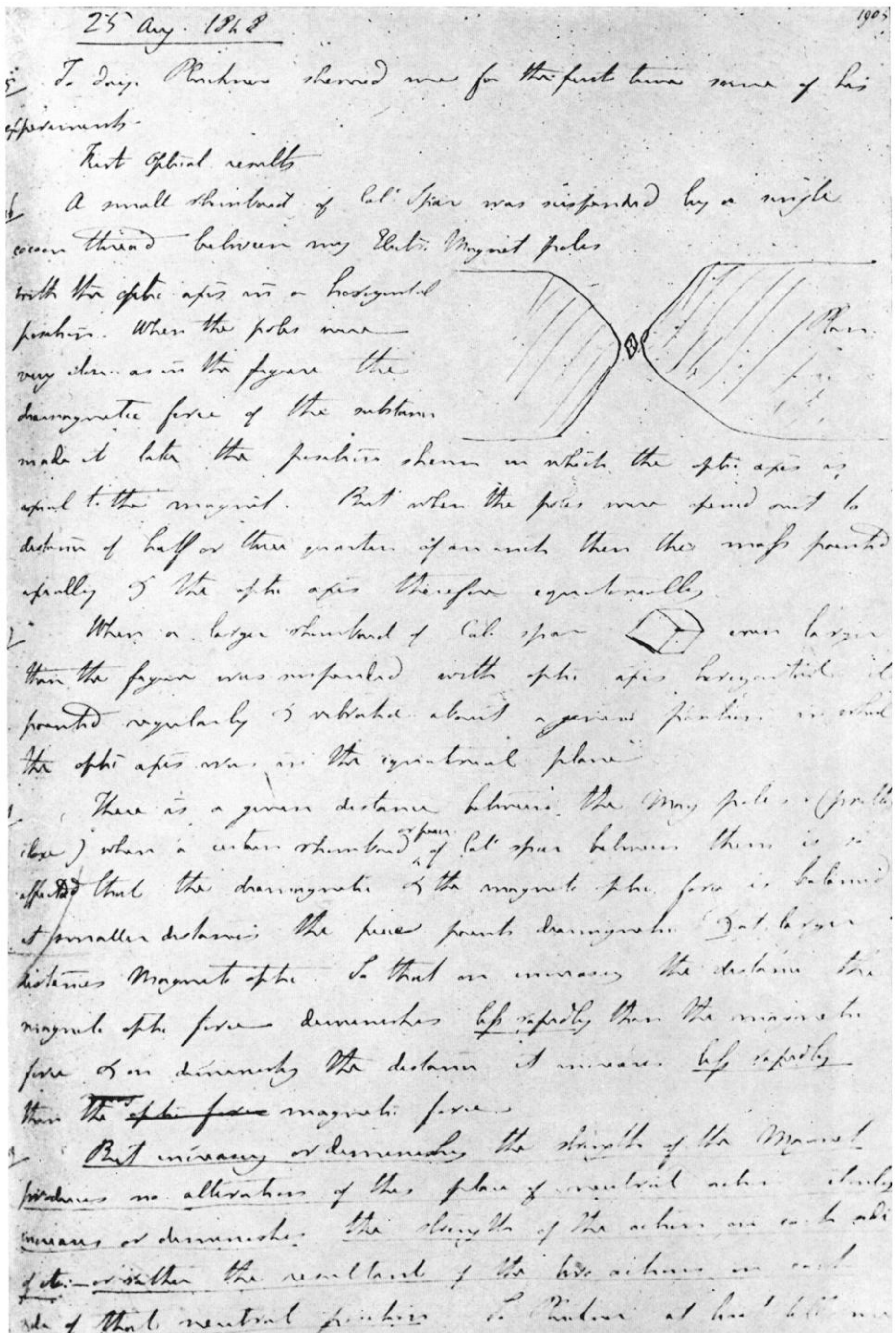


25 Aug. 1848

To day Plücker shewed me for the first time some of his experiments.

First Optical results

A small rhomboid of Calc Spar was suspended by a single cocoon thread between my Electro Magnet poles with the optic axis in a horizontal position. When the poles were very close as in the figure the diamagnetic force of the substance made it take the position shewn in which the optic axis is axial to the magnet. But when the poles were opened out to distance of half or three quarters of an inch then the mass pointed axially & the optic axes therefore equatorially.

When a larger rhomboid of Calc spar even larger than the figure was suspended with optic axis horizontal it pointed irregularly & vibrated about various positions in which the optic axis was in the equatorial plane.

There is a given distance between the Mag poles (possibly less) when a certain rhomboid of Calc spar between them is so affected that the diamagnetic & the magneto optic force is balanced. At smaller distances the piece points diamagnetic; at larger distances Magneto optic. So that on increasing the distance the magneto optic force diminishes less rapidly than the magnetic force or on diminishing the distance it increases less rapidly than the ~~optic force~~ magnetic force.

But increasing or diminishing the strength of the Magnet produces no alteration of the place of neutral action. Clearly increases or diminishes the strength of the actions on each side ~~of the~~ — or rather the resultants of the two actions on each side of that neutral position. So Plücker at first told me the likes and on that ground

Fig. 12. Page of Faraday's diary recording some observations on the Plücker effect.

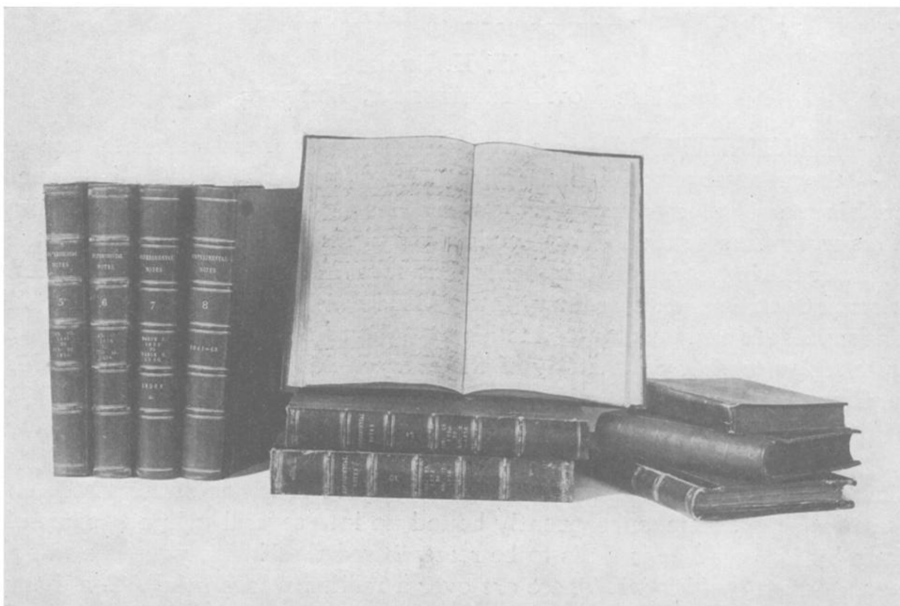


Fig. 2. The eight folio and two quarto MS. volumes of laboratory notes, commonly known as Faraday's Diary, in the possession of the Royal Institution. Open at the page illustrating his first dynamo.

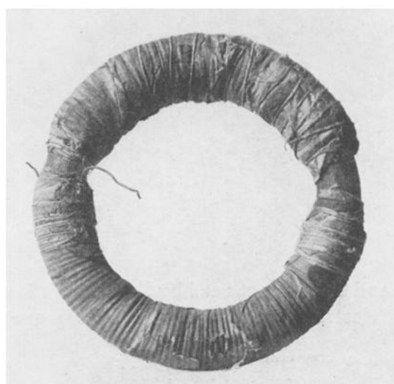


Fig. 3. Historic ring of soft iron, wound with separate coils of copper wire connected to battery and galvanometer respectively, used by Faraday in his first successful experiment in electromagnetics.

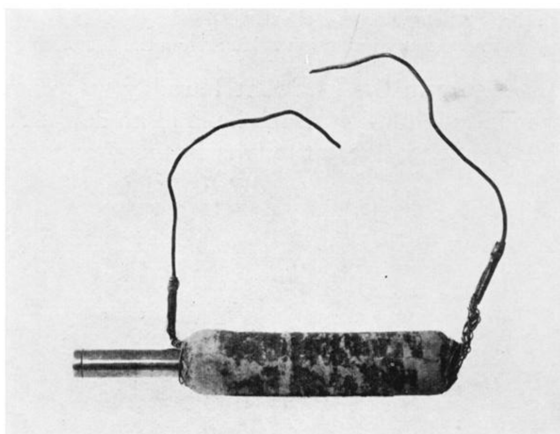
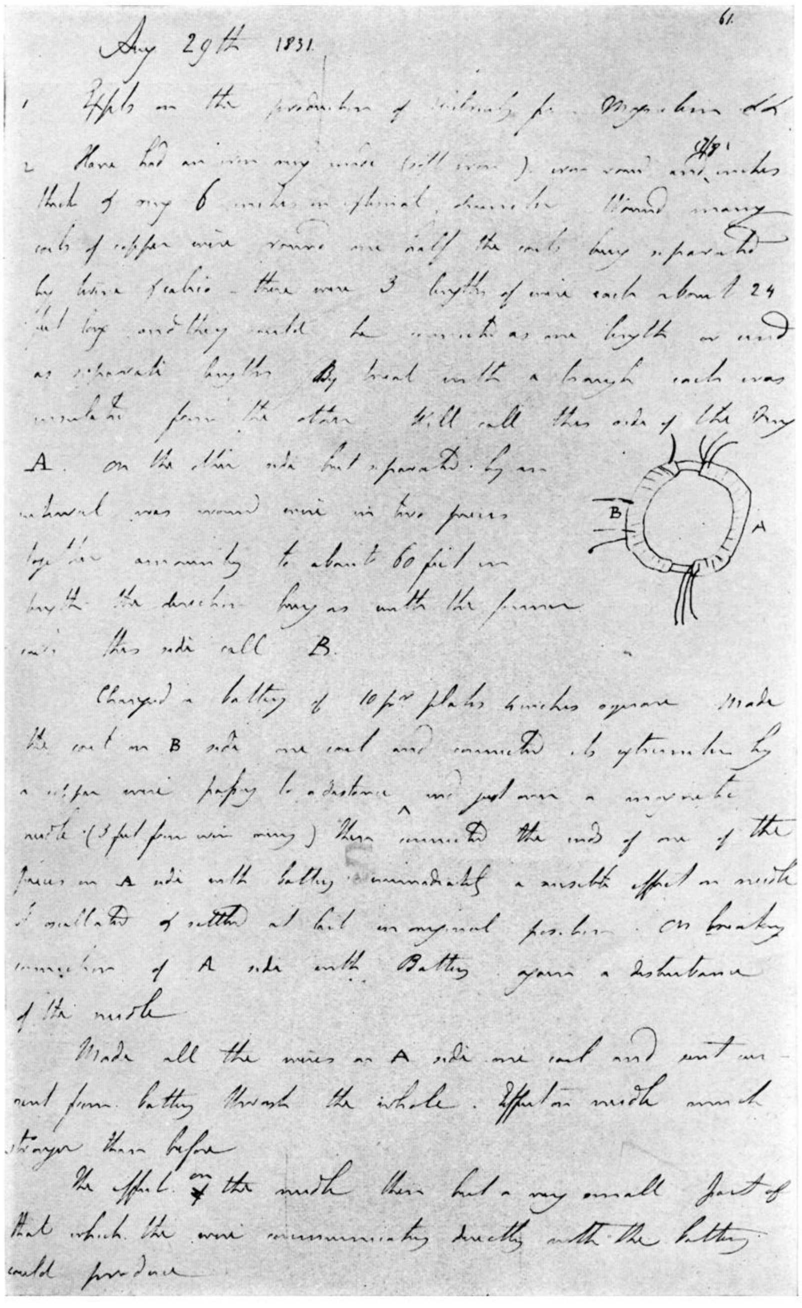


Fig. 4. Helix of copper wire and bar magnet used by Faraday. It is with this apparatus that he first induced an electric current by plunging the magnet into the coil.



Aug 29th 1831. 61.

1 Expts. on the production of Electricity from Magnetism, etc. etc.

2 Have had an iron ring made (soft iron), iron round and 7/8 inches thick and ring 6 inches in external diameter. Wound many coils of copper wire round one half, the coils being separated by twine and calico — there were 3 lengths of wire each about 24 feet long and they could be connected as one length or used as separate lengths. By trial with a trough each was insulated from the other. Will call this side of the ring A. On the other side but separated by an interval was wound wire in two pieces together amounting to about 60 feet in length, the direction being as with the former coils; this side call B.

Charged a battery of 10 pr. plates 4 inches square. Made the coil on B side one coil and connected its extremities by a copper wire passing to a distance and just over a magnetic needle (3 feet from iron ring). Then connected the ends of one of the pieces on A side with battery; immediately a sensible effect on needle. It oscillated & settled at last in original position. On breaking connection of A side with Battery again a disturbance of the needle.

Made all the wires on A side one coil and sent current from battery through the whole. Effect on needle much stronger than before.

The effect on the needle then but a very small part of that which the wire communicating directly with the battery could produce.

Fig. 5. Page of Faraday's Diary recording the discovery of electromagnetic induction.

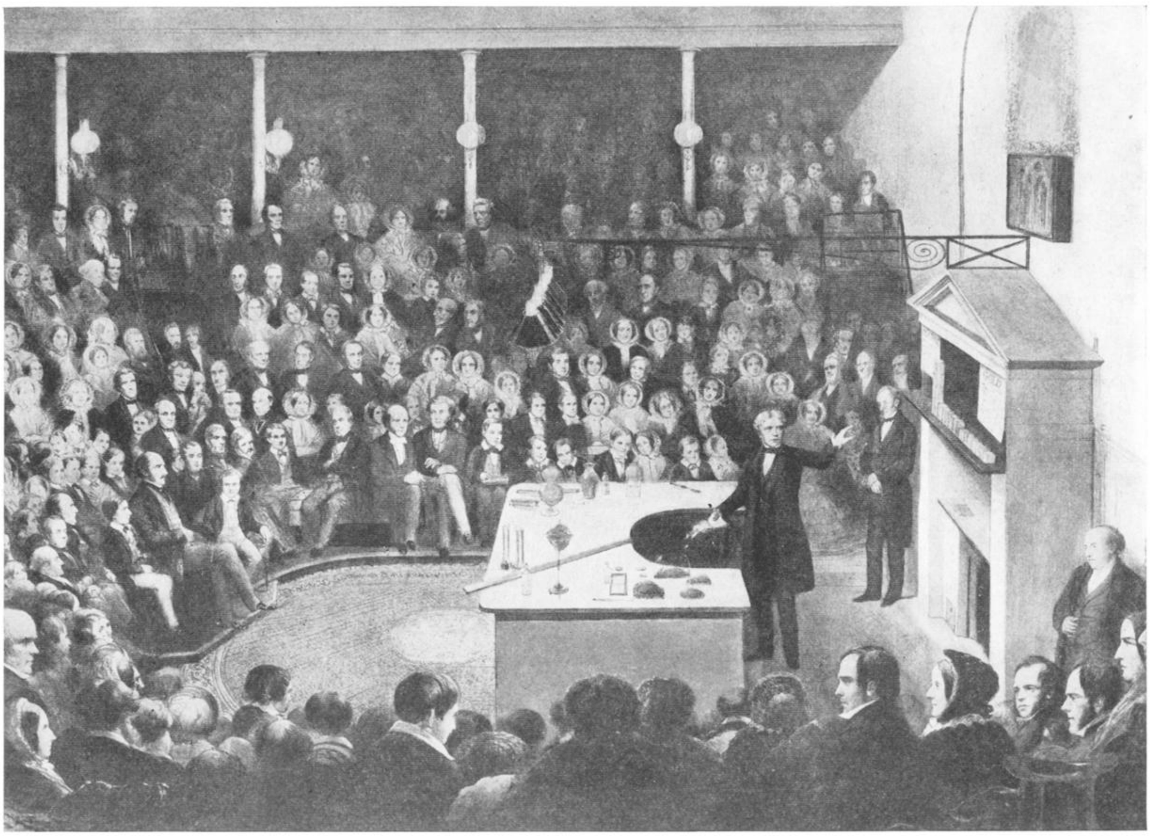


Fig. 6. Faraday in the Lecture Theatre of the Royal Institution. Christmas Juvenile Lectures on Metals, 1855–56.
The Prince Consort in the Chair.

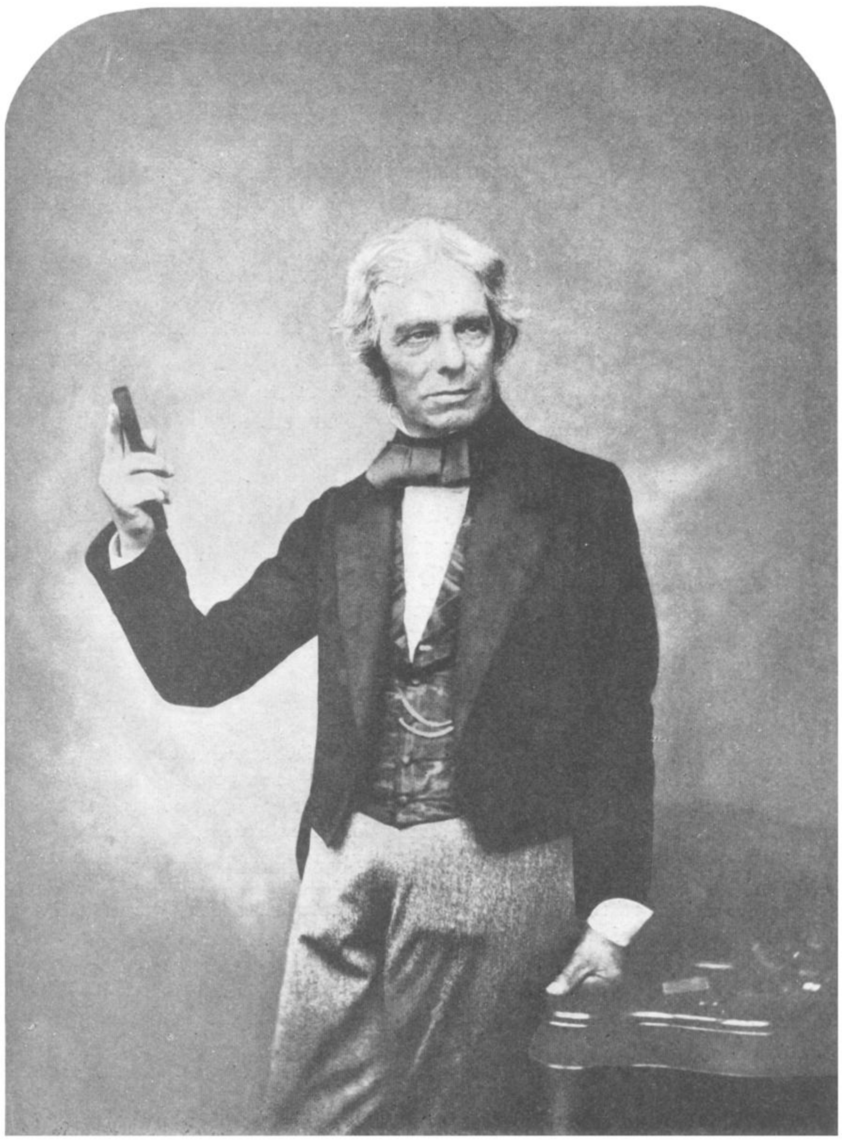
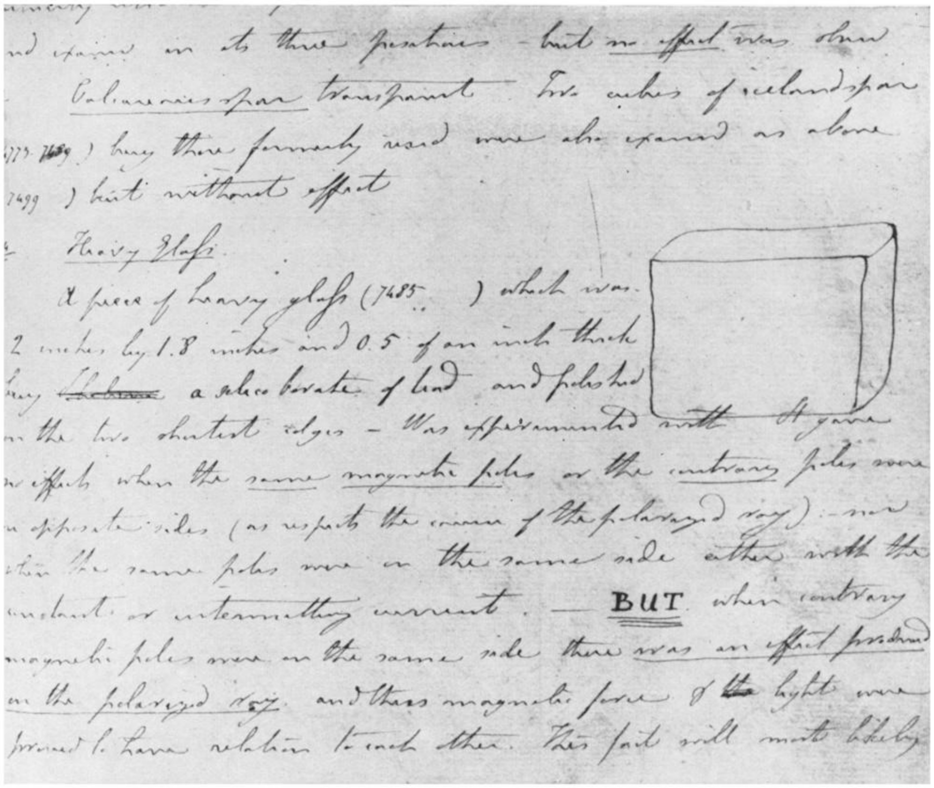
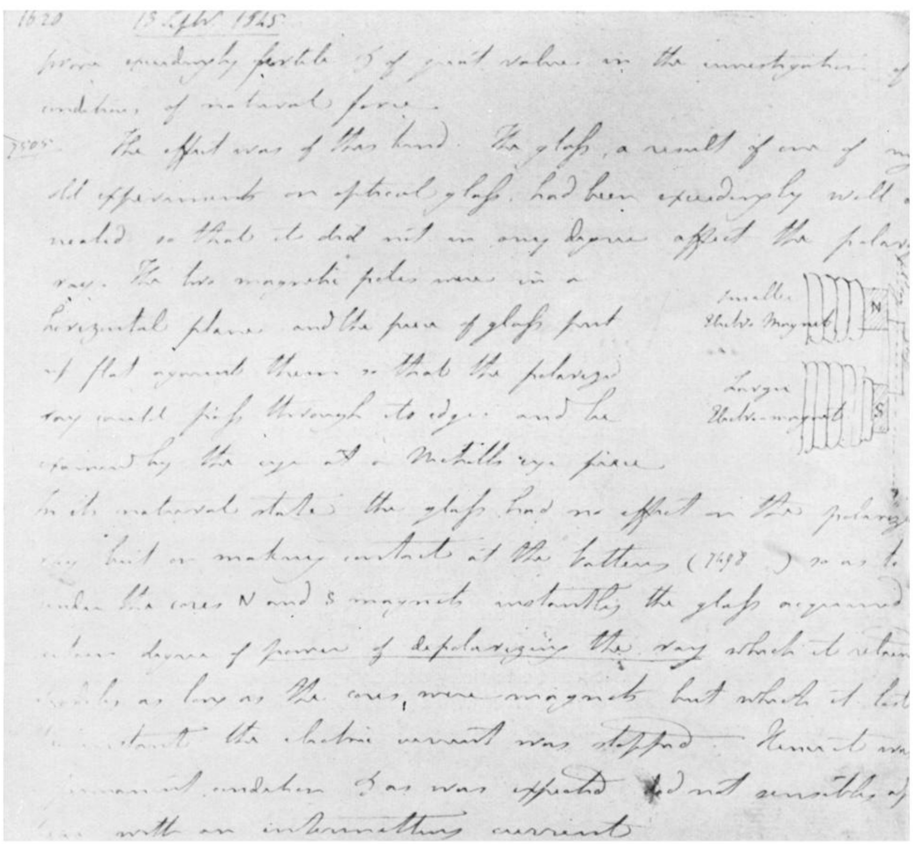


Fig. 7. Portrait of Faraday with bar of his heavy glass.



... examined in its three positions - but no effect was observed
Polarized spar transparent. Two cubes of Iceland spar
(7477, 7483) being those formerly used were also examined as above
(7499) but without effect
Heavy Glass.
A piece of heavy glass (7485) which was
2 inches by 1.8 inches and 0.5 of an inch thick
being ~~[illegible]~~ a silico borate of lead and polished
on the two shortest edges - Was experimented with. It gave
no effects when the same magnetic poles or the contrary poles were
on opposite sides (as respects the course of the polarized ray) - nor
when the same poles were on the same side either with the
constant or intermitting current. — BUT when contrary
magnetic poles were on the same side there was an effect produced
on the polarized ray, and thus magnetic force & ~~the~~ light were
proved to have relation to each other. This fact will most likely



1620 13 Sept. 1845
prove exceedingly fertile & of great value in the investigation of
conditions of natural force.
7505. The effect was of this kind. The glass, a result of one of my
old experiments on optical glass, had been exceedingly well an-
nealed so that it did not in any degree affect the polarized
ray. The two magnetic poles were in a
horizontal plane and the piece of glass put
up flat against them so that the polarized
ray would pass through its edges and be
examined by the eye at a Nichol's eye piece
In its natural state the glass had no effect on the polarized
ray but on making contact at the battery (7498) so as to
render the cores N and S magnets instantly the glass acquired
a low degree of power of depolarizing the ray which it retained
steadily as long as the cores were magnets but which it lost
the instant the electric current was stopped. Hence it was
a permanent condition & as was expected did not sensibly occur
... with an intermitting current

Fig. 8. Page of Faraday's diary recording the discovery of the rotation of the plane of polarization of light which is passed through a heavy glass in a magnetic field.

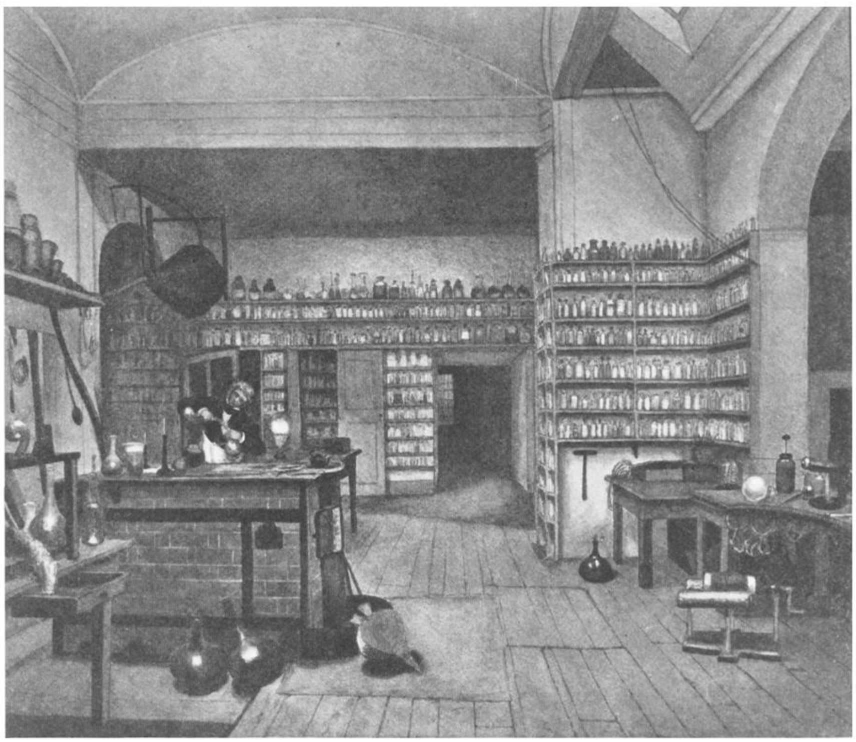


Fig. 9. Faraday at work in old laboratory at the Royal Institution. From a contemporary water colour.