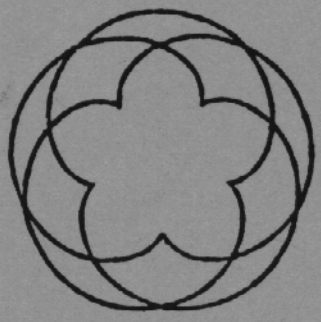
SCIENCE FORUM



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Science Forum is edited by Howard Smith and Hedley Gange and is the official organ of the Science Group of the Anthroposophical Society in Great Britain. It aims to publish lectures and other contributions from science conferences organised by the Group, as well as articles, reviews, correspondence and other items of interest.

The editors would be pleased to receive such items for consideration (preferably typed in double-spacing). Please address all communications to: Science Forum, c/o Rudolf Steiner House, 35 Park Road, London NW1 6XT

Anthroposophy is the name that Rudolf Steiner (1861-1925) gave to his Science of the Spirit. This has given birth to new perspectives and practical activities in the arts and sciences, in medicine, agriculture and education. Information on Anthroposophy and the Anthroposophical Society can be obtained from Rudolf Steiner House.

Copies of Science Forum can be obtained from Rudolf Steiner House: price per issue is £1.00 plus postage. Cheques should be made payable to 'Science Group of A.S. in G.B.'

Science Forum No.1 — Winter 1979

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Editorial

The formation of a Science Group

Several years ago, within English Anthroposophical circles, interest in scientific matters appeared at a low ebb. More recently, however, there has been an expansion of activity — sufficient indeed to justify the formation of a formal Group of the Anthroposophical Scoeity in Great Britain (AS in GB). The suggestion to form such a group was put to the 27 participants of a Science Conference held at Michael House School, Ilkeston, during Whitsuntide 1979, where it met with warm approval and enthusiasm. A committee was appointed to organise the Group, comprising:

Nick Thomas, Ron Jarman, Howard Smith, Alan Hall, Robert Kersey Green. A free-will collection to set up a fund for the Science Group resulted in nearly £100 — a healthy start.

Thus was born the nucleus of a professional group, at once the crystallisation of previous impulses, and the beginning of new activity. The Group was ratified by the Chairmanship Committee of the AS in GB on August 17th when, in accordance with the statutes, a letter of application bearing 7 signatures (the five members named above, plus John Davy and Michael Wilson) was presented.

Tasks

Now that we are in existence, what do we intend to do? The new scientific impulses which Rudolf Steiner gave during the first quarter of this century have taken firm root on the continent, where numerous groups have made steady progress over the years. Theories and concepts, initially present in vague outline only, have been developed and refined, and new discoveries have been made. In sharp contrast, there has been much less activity in Britain, although of course several notable individuals have done some very important work. Communication often leaves a lot to be desired, and the language problem has debarred all but a few English workers from sharing the results of their German-speaking colleagues. The Science Group wishes to tackle these problems and thereby encourage more research in Britain.

First, then, there is the whole question of *information.* The widely-scattered literature needs to be surveyed and reviewed, and important non-English items need translating and publishing in this country. The Group can act as a "clearing house", a central point of contact, to collect, co-ordinate and distribute not only information on formal, published work, but also quite informal ideas and fragments. We need to know

who is working on what, and what results have been obtained. Thereby we can serve our scientific interests more efficiently; anyone embarking upon new work will hopefully be able to obtain, through the Group, references and contacts which may save much wasted effort.

Closely allied to these tasks is the need, on a more personal level, for conferences and other meetings, including special working groups and study groups as appropriate. Three conferences have been held already (January 1977, January 1978 and May 1979), and this activity will continue on a roughly annual basis. Small specialist groups, e.g. in the fields of chemistry, electricity, aspects of technology etc., will be held on an *ad hoc* basis, depending on demand.

Research, whether theoretical or practical, is of course the life-blood of progress, and must lie at the heart of our endeavours. But here we meet a sticky problem: although research, above all other areas, is in need of expansion, it is also the most expensive area to support. It is nevertheless our sincere hope that, in the long term, a sound financial basis may be found for research.

The role of *Science Forum* as a medium of publication penetrating many of these activities is clear enough; its success will depend on the enthusiasm and co-operation of all who share our aims.

Aims

The Committee of the Science Group hopes that some of the activities outlined here will eventually reach well beyond the circles of those who are orientated towards Rudolf Steiner's path. For while it is probably true that many scientific insights within a given field have a rather limited audience that can receive and comprehend them, the consequences and applications of such insights are much more universal in character. Conversely, we may hope to benefit by interacting with the scientific community at large.

Summarising our intentions, then, we can express our aims as follows:

1. To promote a deeper understanding of scientific method and results in the light of Anthroposophy.
2. To share our insights and practical results by organising meetings and correspondence.
3. To publish important contributions.
4. Where relevant to provide a forum for collaboration between workers in similar fields.
5. In the longer term, to establish communication with the scientific community in general and contribute positively to it.

Membership

Since the Science Group is a group of the AS in GB, it follows that members of the Group must be members of the parent society. Membership is to be by invitation only, at the discretion of the Committee. However, it would be sad indeed if we were to exclude those colleagues who, while contributing greatly to conferences etc. and working in harmony with the Anthroposophical impulse, were nonetheless not members of the AS in GB. Such exceptional cases will be accommodated as Associate Members, again at the invitation of the Committee.

Apart from these necessary limitations, the work of the Science Group is not intended to be "restrictive". Quite the contrary. *Science Forum* will be available to anyone wishing to receive it. Any interested person is free to write to this journal, or the Science Group (both at Rudolf Steiner House – see inside front cover for address), for the sort of help and information mentioned earlier. And anyone who is in sympathy with the above tasks and aims can apply to attend conferences organised by the Group (though it may be necessary to hold occasional "members only" meetings). The general idea is to strive for the greatest possible co-operation, both within the Group and with other groups and individuals.

Publication of future issues.

Science Forum is not committed to appear at regular, fixed dates, as such a policy could compromise the contents. Rather, issue No. 2 will appear when there is sufficient material to justify it. As a very rough indication, however, we hope that something like two issues a year will prove to be feasible initially.

We strive to ensure that the main articles—many of which will be adapted from Science Conference lectures are of a good standard. However, more tentative material—ideas, suggestions, observations, questions etc.—may be accommodated in the correspondence section of the *Forum*, if appropriate.

In conclusion, we hope that all our readers will find *Science Forum* of interest. Any comments, letters, book reviews, articles etc. will be very welcome.

Goetheanism and Spencer Brown's Laws of Form

by Nick Thomas

Lecture given at the Science Conference at The New School, Kings Langley, January 1978

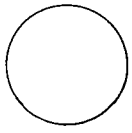
G. Spencer Brown studied at London Hospital Medical College and at Trinity College, Cambridge. He did post-graduate work with Russell and Wittgenstein, and then was a philosophy don at Oxford. Later he worked for Mullards, and did management consultancy work too. Besides this he is a trained psychotherapist, holds two gliding world records and is a chess half blue. Altogether a versatile character!

His views on knowledge versus ignorance, as expressed in his "Laws of Form", are interesting:

"Unfortunately we find systems of education today which have departed so far from the plain truth, that they now teach us to be proud of what we know and ashamed of ignorance. This is doubly corrupt. It is corrupt not only because pride is in itself a mortal sin, but also because to teach pride in knowledge is to put up an effective barrier against any advance upon what is already known, since it makes one ashamed to look beyond the bonds imposed by one's ignorance."

This seems to be a thoroughly healthy view, in case you should be suspicious in view of his diversity. He has produced in his "Laws of Form" what is possibly the most fundamental arithmetic and algebra imaginable, applicable alike to logic, electronics, mathematics, philosophy and other widely varied subjects.

The formal, simple, starting point is the notion of distinction. Consider a circle:



In a flat plane the circle forms a boundary, or distinction, between the points inside and those outside. Not only that, the distinction is complete; a point cannot be both inside and outside at once. Examples of distinctions might be between TRUE & FALSE in logic, ON & OFF in digital electronics, things that are horses and things that are not, light and darkness, and so on. Analytical thinking has the characteristic that it makes distinctions, and *divides* or *cleaves* the whole, conceptually that is, into distinct categories. These categories are given names so that they may be further thought about (this is the view of analytical nominalism, valid for mathematics, from which we begin). A distinction made for centuries in philosophy has been that between matter and spirit. Rudolf Steiner traces this to a one-sided development of Platonism. Goetheanism, on the other hand, denies the existence of any such division of the world, and starts from the view that the thing is a comprehensive whole. This means that the spirit, or the idea, of a thing is immanent in it – really – not just a shadowy abstraction, or an ideal element "in some other world" as it were. To find the reality of a plant we observe the plant itself rather than spin theories first and then endeavour to connect the two afterwards.

Coming back to Spencer Brown, I said that when with our intellect we draw a distinction we must *name* the entity thus distinguished. In his formal work Spencer Brown uses a symbol thus:

$$\urcorner$$

with which to name one half of the distinction. Thus a point inside the circle, say, is named and is said also to have the value of the *mark*, or *cross*, as it is called. Now, if I name something, and then name it again, I have still only named it. If I say that a point is inside the circle, then I say no more by repeating myself. To rename is the same as to name, which Spencer Brown symbolises as follows in his first axiom:

$$\urcorner\urcorner = \urcorner .$$

The implications of this are potentially very deep. Compare what Steiner says concerning the concept triangle, namely, that my concept of it is *the same concept* as yours, not a copy or likeless.

Besides naming, it is possible to carry out an operation: one may *cross* the boundary of the first distinction, say from inside the circle to the outside. The *same* symbol is used to denote this. The mark may be looked upon as a symbol dividing the page on which it is written into the space inside (or under) it and that outside. We must be careful to distinguish the mere symbol or name of the first distinction from that distinction itself: all manipulation of marks or crosses on paper is an activity in the realm of nominalism which is supposed to say something about the real distinction actually made in the world. When used as a *cross* the symbol denotes a crossing from inside to outside or vice versa. For the symbols themselves the crossing is always from inside to outside, but not necessarily for the first (i.e. real) distinction. Now although to rename is to name, to recross is not

to cross. If first I cross from inside to outside, then to recross I must go back inside again, ending up in a different place from that reached simply by crossing once. This is symbolised as:

$$\overline{\urcorner|} = .$$

where the right hand side is read as "blank". One state is the *marked* state, the other the *blank*. The above expression is the second axiom of Spencer Brown's arithmetic. The innermost space is blank, the first (inner) cross instructs us to make a crossing which must therefore be to the marked state, and the second instructs us to cross again, which can only be back to the blank state again. Hence the result. A complex statement about the world involving terms that may be individually valued in terms of the distinction, may then be simplified to see on which side of the distinction the entity referred to by the expression lies, e.g.

$$\overline{\urcorner\urcorner|\urcorner|} = \overline{\urcorner|\urcorner|} \textit{ (1st axiom)} = \overline{\urcorner|} = . \textit{ (2nd axiom)}$$

This is an example of Spencer Brown's *arithmetic.*

If these ideas are applied to logic then such an expression might arise after a complex proposition has been analysed and truth values substituted for each term.

There is an accompanying *algebra*. An expression may be symbolised by a letter, in time honoured fashion, thus:

$$\mathbf{a} .$$

It is easy to see intuitively that

$$\mathbf{a}\,\mathbf{a} = \mathbf{a} \textit{ since } \urcorner\urcorner = \urcorner$$

What about $\overline{\mathbf{a}|}$? This means that whatever value **a** has (i.e. mark or blank) then $\overline{\mathbf{a}|}$ has the opposite value. We cross the boundary from the value indicated by **a** to its opposite. If we applied these ideas to logic it would be rendered *'not a'*. It follows from the first axiom that the expression

$$\mathbf{a}\,\mathbf{b}$$

is also marked if either **a** or **b** is marked. Hence in the realm of logic it represents

$$\mathbf{a} \textit{ or } \mathbf{b}$$

This assumes that *'true'* is represented by the marked state, although one can just as well start with it represented by the blank state. Another fundamental expression in logic is

$$\mathbf{a} \textit{ and } \mathbf{b}$$

which is represented by

$$\overline{\mathbf{a}|\,\overline{\mathbf{b}|}}$$

You can test this by substituting various values for **a** and **b**, and you will find that the expression is only marked if both **a** and **b** are marked.

Suppose instead we consider numbers, and distinguish positive from negative, letting negative numbers take the value of the mark. Thus any expression which evaluates to a negative number is valued "mark" while any that evaluates to a positive number (or zero) is "blank". Then

$$\overline{\mathbf{a}|} \textit{ means } -\mathbf{a}.$$

What do we make of

$$\mathbf{a}\mathbf{b}$$

in this case? The operations of multiplication and addition are clearly inappropriate. The function

$$min\ (\mathbf{a},\mathbf{b})$$

works, for this selects the smaller of **a** and **b** (standing for "Minimum of **a** and **b**"), and thus is necessarily negative if either **a** or **b** is. On the other hand

$$max\ (\mathbf{a},\mathbf{b})$$

is only negative if both **a** and **b** are negative. These interpretations may be summarised in the following table:

$\overline{\mathbf{a}|}$	*not* **a**	$-\mathbf{a}$
ab	**a** *or* **b**	$min(\mathbf{a},\mathbf{b})$
$\overline{\mathbf{a}|\,\overline{\mathbf{b}|}}$	**a** *and* **b**	$max(\mathbf{a},\mathbf{b})$
$\urcorner$	*true*	*negative*

This has been intended to give you a brief and abbreviated introduction to Spencer Brown's ideas and his calculus. One can hardly imagine a simpler calculus: it has only two values (mark and blank) and one operation (crossing). It is evidently dualistic and epitomises analytical thinking in one way. However, it thereby lays bare our fundamental assumptions, and it also leads inevitably to exciting things. It gains its power from the deliberate double-meaning of the mark, which stands both for a value *and* an operation.

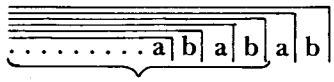
Unfortunately I do not have the time to show in detail what I am now about to say. Once we are secure in our use of the algebra we learn a number of operations which enable expressions to be transformed, usually to simplify them. One can also ***complicate*** them. To be perverse we may wish to say something in a *more* complicated way! However, this can sometimes actually make them *clearer*. Goethe found this when he studied more complicated organisms first, and only later the simpler ones. This he did because he thought that the *idea* was more fully manifest to sense perception in the complicated plant, and so was easier to grasp. Once grasped, its role in the simple plant was then easier to see.

Spencer Brown found that by systematically complicating an expression he could arrive at one which referred to itself; for

$$\overline{\mathbf{a}|\,\mathbf{b}|} = \overline{\overline{\mathbf{a}|\,\mathbf{b}|\,\mathbf{a}|\,\mathbf{b}|}}$$

as is easily proved arithmetically i.e. by systematic substitution to exhaust all possibilities. This is opposed to "demonstrating" it algebraically which we have not time for. The expression may be compli-

cated in this repetitive way as often as we please. If, however, we allow such a process to be repeated ad infinitum we obtain the expression:



A little thought shows that the inner part of this expression is the same as the whole. Thus if we designate the whole expression as "f", then:

$$\overline{f\ a\ |\ b\ |} = f$$

which may also be written

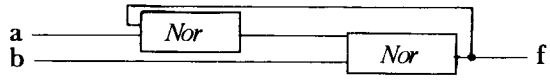
$$\overline{a\ |\ b\ |}$$

This notation is handy for expressions involving several of these so-called *subversions*. Such an expression is *second order*, since the value of *f* is ambiguous when both *a* and *b* are blank. We see that we have an expression that is re-entered into itself. It is reminiscent of a number of problems raised from time to time such as the perfect map that contains itself.

When applied to the realm of logic, a second order logic expression would be obtained. Boole thought that such equations did not exist. This particular equation is well behaved because it is like a second order equation with *real roots*; it may have the value *mark* or *blank* in a non self-contradictory manner.

A linguistic example (not of the above equation, though) could be:

"This sentence was true, or, it is raining". Highly likely to be true in England! If instead we apply the laws of form to electronics, from which it all began in fact, then one circuit realising the above equation is:



Some years ago I was concerned with logic circuits involving feedback and was most pleased to find later an algebra that can handle such problems elegantly.

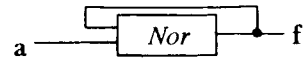
I realise that I'm having to take you through all this very fast! Consider now a sentence like:

"This sentence is false".

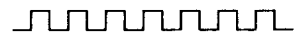
If it is true, it is false, and vice versa. The great temptation at this point is to dismiss it as self-contradictory and so of no significance. In the realm of language that is reasonable, but not for the analogous state of affairs in electrical engineering. It would be represented by the *oddly subverted* expression

or, more generally

in which there is a controlling variable. The corresponding electronic circuit is:



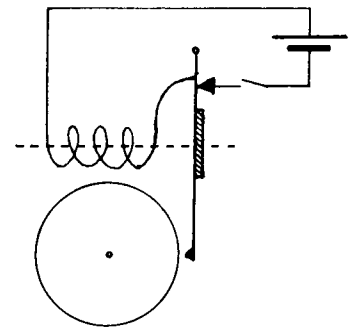
When a is "off" this simply oscillates thus:



Spencer Brown likens such an expression to a second order equation with *imaginary roots*. This type of expression, perhaps more complicated, is what describes the nature of the Cretan who said that all Cretans are liars, and of the barber beloved by Bertrand Russell who shaves all those in the village who do not shave themselves. Boole avoided, he thought, the existence of such equations, and as a result all manner of philosophical difficulties arose. Bertrand Russell found a now famous paradox in set theory which may be described by an oddly subverted expression. Because he was only aware of Boole's interpretation he had to formulate his ad hoc theory of logical types to get round it.

Later Kurt Gödel proved that there are infinitely many true theorems in arithmetic that are unprovable from the axioms. There have been several famous problems that have defied mathematicians for a very long time, such as Goldbach's proposition that every even number is the sum of two primes, and Gödel implied that we should expect this sort of thing to happen. Spencer Brown's results alter all this, for the possibility of reasoning using second or higher order logic may allow such theorems to be proved after all. Bertrand Russell was even pleased that his theory of logical types was no longer needed. Spencer Brown claimed that such a problem had been solved by him about 18 months ago, namely, the four-colour map problem.

As far as second order logic equations are concerned, they have been in use in electrical engineering for many years, without being recognised as such. The common electric bell (an awakener of consciousness!) is based on an equation with imaginary roots:



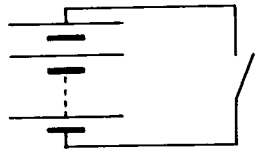
As soon as it is switched on, it switches itself off, and when that has happened it switches itself on again, and so on!

Going back to basics, what happens is that the entity described by the expression keeps crossing and

re-crossing the boundary of the first distinction (in this case between ON and OFF).

One of the fundamental motive forces in Nature which features prominently in Goetheanism is the principle of POLARITY. On thinking about Spencer Brown's oddly subverted forms I came to realise that they have a most interesting and fundamental significance in relation to this concept of polarity.

Let us start with a simple example. I am sure you are all familiar with the humble car battery:



A battery is polarised for electricity. Now what happens if I connect the positive terminal to the negative? Well we all know the result! But what am I *doing* in performing such a misdeed? *I am subverting the polarity.* I am equating positive and negative by connecting them together by a piece of wire, because that is what a piece of wire does: it equalises the potential (ideally) along its whole length. This is a catastrophic example of odd subversion. If instead I connect a load across the battery, the subversion is present but less acute, and I get useful work as a result.

If the polarities of light and dark are caused to interact by means of a prism, colours arise ...

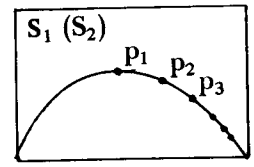
In such cases we must be *given* a polarity to start with, and then the poles must be made to interact in some way. In what way? By causing each pole to *contradict* the other in some way after the manner of an odd subversion. The electric bell shows this: the polarity is between ON and OFF (a very simple polarity but the arrangement of the bell is such that when it is on it must cross the boundary of that distinction to the off state, and vice versa). The result is a *continuous activity*; the bell consequently *rings.* In the case of the battery, and electro-CHEMICAL processes in general, that activity is the flow of current. In the case of light it is the production of colour. The colour example shows clearly that the interaction may be *graded*. This happens, too, in electronic applications where instead we get varying mark-to-space ratio (or mark-to-blank ratio!), depending on the timing of the components used. A subverted circuit oscillates thus:

but it may do so in this manner:

or in this:

I should now like to make a connection with what Lawrence Edwards discussed last year. You may recall that he showed us how the study of *path curves* in projective geometry has led to the insight that growth processes in plants may be described by them. The question has lived with me now for quite a while as to *why* path curves should be so apt. I have no doubt that there are many answers to this question, but I believe I can throw a little light on this.

May I remind you, in simple terms, what a path curve is? If I have a space S1, and a point P1 in it (in the plane), I may then suppose that another space S2 pervades S1 such that a definite transformation will carry every point in S1 to some definite corresponding point in S2.



Thus P1 may be carried to P2. P2 is in S2, which is important. *Now* I suppose P2 to lie in S1, and repeat the process, which will lead to point P3, and so on. The result is a path curve through these points. I can describe this in Spencer Brown terms by saying that there is a distinction between spaces S1 and S2. Then I *cross* the boundary in passing from P1 to P2, for P1 lies in S1, but P2 initially lies in S2.

Now I *recross the boundary* when I suppose P2 to lie in S1 after all. I then repeat the process. We thus have an oscillating process like an odd subversion, in which I keep crossing and recrossing the boundary of the distinction. Ideally the steps should be infinitely small if a continuous process is to be approached. An interesting aspect is that the path curve is seen to be a self-perpetuating process once started off, as is an oddly subverted form. The essential element of comparison here lies in the fact that the process involves a continuous crossing and recrossing of the boundary of the first distinction, prompted by the process itself.

This can also be seen in another example from botany. Goethe was very interested in the two types of movement of growth in a plant, namely the vertical and spiral tendencies. One may draw a distinction between the two. But now growth progresses upward with these two tendencies working hand-in-hand. In contemplating this I came to realise that again we have a case where the process consists in a continual crossing and recrossing of the boundary of the distinction between vertical and spiral growth, after the fashion of the odd subversion. Indeed it was from this example that I first perceived the significance of oddly subverted forms in the way I am now trying to convey to you. Goethe himself says:

> "Let us in Summer look at a stake planted in the soil up which a bindweed (convolvulus) climbs from below, winding its way to the heights and —

clinging closely – maintains its living growth. Let us think now of the bindweed and stake as both equally living and ascending upwards from one root, producing each other alternately and so progressing unchecked."

Note the word *alternately*. If you look at the trunk of a beech tree you can often see the spiral growth involved, where it is clearer that both vertical and spiral aspects work together than it is in plants where the two manifest in stalk and leaf arrangement. Goethe was struck by the fact that in some plants these two tendencies become separated in the flower. This is very clear to see in marigolds for example. The vertical gesture, evident in the pistil, then awaits revitalisation by the spiral gesture introduced by the pollen. Once separated the autonomous upward activity of growth ceases, but when rejoined in what Goethe described as a spiritual anastomosis the whole process is requickened and a seed is produced for a whole new plant.

My theme in the last few minutes has centred upon the idea of polarity. What I believe Spencer Brown's oddly subverted forms can indicate is *how* the opposite poles of a polarity can be caused to interact. This is achieved by arranging for *each pole to subvert the other*, just as the short circuited battery was placed in a condition where positive and negative were implicitly confused by the short-circuiting wire. However, the battery example shows too radical a version of this. A more elaborate subversion, expressed perhaps by a more complex form, is at once gentler in action and more likely to yield useful results. The richness possible is well exemplified in the case of colour, and its usefulness in the electric bell or a tuned circuit in a radio.

As we saw earlier, oddly subverted forms appear in logic as contradictions. Rudolf Steiner often referred to the fact that genuine spiritual facts give rise to contradictions when expressed in ordinary language, or if judged by means of logic applicable to the sense world. Through the considerations I have set forth I believe we can see this even more clearly and in a practical way. Duality is the hall mark of the created and the manifest. Where a distinction can be drawn clearly, in some sense the life has gone out of the form concerned. Hence such things are accessible to our analytical intellect which seeks for and names distinctions as Spencer Brown describes. In more living situations *perfect* distinctions are hard to draw, and are more usually discernible in an oddly subverted activity such as that of vertical and spiral growth. This is why they are sometimes much harder to grasp: a living form has a life of its own! The same is true of living thoughts.

The power of thinking plays a decisive role in all this. Steiner pointed out that it is thinking that distinguishes between the self and the world, and hence must itself supersede that distinction. We see the same logic again in considering Spencer Brown's work, for any perfect distinction we care to choose can only be made by thinking. Thinking thus transcends any distinction. In particular it enables that distinction traditionally made between matter and spirit to be overcome. Steiner characterises this as an offshoot of a one-sidedly developed Platonism, to which Goethe was vigorously opposed. Goethe saw the world as a comprehensive whole, which entails the notion that ideas are active in the world, not above or behind or beyond it, but *in* it. As you probably know, Schiller was surprised at this for he did not think that an *idea* could be *experienced*. Goethe knew firsthand that it could, however. It is interesting that Spencer Brown algebra entails that any distinction is self-superseding ultimately, for an oddly subverted form inevitably arises from it which points beyond it. It is interesting to compare this with Hegel's views, and Steiner's. Hegel's *thesis, antithesis* and *synthesis* point to the overcoming of dualism, and Steiner indicated that duality is characteristic of the sense world, but *threefoldness* of the spiritual world. How intriguing that duality is in a sense "unstable" mathematically! This overcoming is no easygoing affair, as Steiner often pointed out. One of Piet Hein's "Grooks" illustrates this rather well:

"I concentrate on the concentric rings
Produced by my pen in the ink.
The thing that distinguishes thoughts from things
Is that thoughts are harder to think!"

Another quotation from the "Laws of Form" is significant in this respect:

"Thus we cannot escape the fact that the world we know is constructed in order (and thus in such a way as to be able) to see itself.

This is indeed amazing.

Not so much in view of what it sees, although this may appear fantastic enough, but in respect of the fact that it *can* see *at all*."

And a little further on:

"... the universe *must* expand to escape the telescopes through which we, who are it, are trying to capture it, which is us. The snake eats itself, the dog chases its tail."

Such are the philosophical consequences which seem to follow from the "Laws of Form".

We have been concerned on the one hand with extreme abstraction, and on the other with Goetheanism. I hope I have shown that they may, perhaps, be mutually oddly subverted to the benefit of both!

Productions like the "Laws of Form" are quite capable of both a positive and a negative application, and I believe I have seen a serious possibility of the latter. In the realm of freedom it matters *who* discovers a thing. The thing is not new, for it is known to the Hierarchies and to Initiates, but it has to be discovered eventually in the realm of freedom. Therefore it is our business to be concerned, as anthroposophists.

The Place of Chemistry Among the Sciences

by Stephen Moore-Bridger

Given as a Short Contribution at the Science Conference at Kings Langley, January 1978

The content of this talk arises out of certain basic questions which occur to me as a teacher in a Waldorf School. A Waldorf science teacher is in the rather fortunate position that there cannot be a conflict, for him, between Goethean principles and his everyday work, in that he wishes to teach his science according to Goethe's methodology. He does this because he believes that this methodology is adapted to a healthy working of the awakening human intelligence; that Goethe's method is the correct and natural way for human intelligence to function. This activity can then be the source, for a maturing human being, of confidence in his thinking and hence freedom in his actions.

This method is especially clearly exemplified in physics. Here, simple phenomena can be placed before children without explanation but simply presented as percepts. This takes place on one day. Only on subsequent days are children led to form representations linking up phenomena pictorially and, later, conceptually.

Obviously of great importance, if children are to be able to witness the clear build up of a physical realm of phenomena, is to isolate the *primal* phenomena in a realm. I feel unsure, however, whether a primal phenomenon is actually a percept or a concept. For example, a body dropped falls to the ground. Have my eyes seen a primal phenomenon, or has my thinking 'seen' it? Does my thinking see the concepts 'body' and 'ground' (centre of earth) necessarily related by the concept 'falling' and is this the primal phenomenon? I would appreciate help here!*

Personally, I work in chemistry, and, challenged by the approach of experienced teachers to physics, I tried to seek primal phenomena in chemistry. Here one meets a difficult realm.

Perhaps there are primal phenomena connected with *combustion*: e.g. formation of ash, smoke, light, heat, acidity of smoke, alkalinity of ash, using up of oxygen. Then with acidity and alkalinity in relation to *indicators*: virtually all natural indicators (red cabbage juice, elderberry juice, litmus etc.) experience 'spectrum shifts' from the blue to red end with acids and red to blue end with alkalis. But the definition of acids as turning litmus red will not hold universally, as other solutions will also do this e.g. ammonium chloride solution. Many non-bases will have a blue effect. Primal phenomena with exceptions?! Dissolving, or dissolving power of water, cannot, in my view, be seen as a simple primal phenomenon in the way that its physical dropwise and planar tendencies can.**

Again, if one takes one substance such as iron, one seems to find literally dozens of 'primal phenomena' equivalent to those in physics, e.g. iron and sulphur when brought together and heated react to give iron (II) sulphide. This will always happen with any iron and sulphur at any time or place, when the basic conditions are satisfied. But now we need another primal phenomenon for iron reacting with chlorine, or sulphuric acid or whatever. In other words, the primal phenomena become only *descriptions* of events, and, whereas in physics they can be led to explain more complex phenomena, here they rarely can; they become actually trivial at this level. Hence a chemist cannot rest satisfied with this, and looks beyond for another *explanation* of *complex* phenomena, either in his atoms or by trying to estimate what entities play as fruitful a role for chemistry as primal phenomena do in physics.

My own thinking led me to wonder if primal phenomena in all organic realms are qualitatively identical. Goethe wrote to Hegel of his hope of establishing a system of science. This is a philosophical task which Hegel attempted in his 'Philosophy of Nature.' This rests on the presupposition of an objective 'Idea' in Nature. Hegel attempts, in his own way, to build up the content of this 'Idea' purely as an ideal process which he calls 'logic' (in a very unusual sense of the word). The logic develops in a purely inward ideal phase by the continual overcoming of polarities (i.e. Being and Nothing lead to Becoming) until the Idea is complete. Then it enters on its outward phase (nature). In its outward phase, there are forms which either are not directly penetrated by the Idea or forms which are penetrated to different extents by the Idea. Some forms are very distant from it, some much nearer: only in man does the Idea appear as Idea. In the animal it appears as Consciousness, in the plant as Type, in the inorganic

as primal phenomena (or governing these, depending on how one defines them). Adapting this way of thinking one sees an ascending scale of realms which are progressively more ideal and less infected by 'otherness' and 'asunderness'. They are (much simplified):–

Mechanics (Space, time, motion, matter, gravity, up to the celestial mechanics of Kepler)

Physics (Light, meteorology of the elements, particular bodies and their individual qualities, shape, magnetism, electricity, chemistry, geology)

Life of Plants (Types, one organ in metamorphosis)

Life of Animals (Organs adapted to a whole present in consciousness)

The further realm of the specifically human development towards 'Idea conscious of itself as Idea' through psychological phases is reserved for the 'Philosophy of Mind'.

This led me to try and apply this system but backwards. The higher the realm the more 'real' , in a sense, it is. Evolution has led to a casting off of life into matter, to a less real phase, the realm of chemistry. I feel we, as teachers, can develop our subject by always asking of a substance, 'What is its origin? What living process has led to it?' These processes may be recent (organic substances like carbohydrates and proteins) or ancient (geology of rocks, etc.) assuming the earth once to have been entirely alive.

I see a plant type as expressing itself in the relations and interchanges of many substances. Remove one substance from its living source, and it now becomes only a fragmentary static expression of a type. Reintroduced into an organism it might again take up its rightful place in a whole, but the more it is removed from its source the less 'real', in this sense, it becomes. This thought can raise many questions!

NOTES

* See 'The Philosophy of Freedom' by R. Steiner for a description of 'concept' and 'percept', and 'Goethe the Scientist' by R. Steiner (e,g, Chapter 17) for a description of 'primal phenomena' (Ed.)

** This refers to an earlier lecture at the conference, by H.J. Smith, in which the dual tendency of water to form spherical drops and planar surfaces was presented as polar primal phenomena. This lecture will be published in a future issue of Science Forum. (Ed.)

News and Comment

Alternative Energy Sources

Science and technology have significantly changed our way of life during the last half century. Great progress has been made, but a point seems now to have been reached where it is reasonable to ask whether, on balance, further technological progress will be to the benefit or detriment of mankind. Co-ordination has been lacking between the spheres of technology and human need. There have been deficiencies in communication and common experience between scientists and technologists on the one hand and politicians and sociologists on the other. This is only part of a comprehensive problem, but it is worthy of consideration. It is also an aspect of modern life where we, as scientists and technologists with an interest in anthroposophy, should be able to make a positive contribution. To do this we shall require, not only basic anthroposophical understanding and social insight, but a realistic knowledge of what is currently going on in the scientific and technological spheres — concerning new processes, production techniques, theoretical developments, sectional interests and commercial pressures.

This comprehensive approach could be applied, with advantage, to, for example, the problem of world energy resources, and, in particular, to the question of developing alternatives to fossil fuels and nuclear power.

There are today more than 70 manufacturers, in the UK, in the field of solar water and space heating. Solar water heating is beginning to be competitive with on-peak electricity. Space heating requires large collectors and is best combined with energy effective architectural design, good insulation and large, south-facing windows. Expenditure on research is small, compared to that on, for example, nuclear power, and large scale, low cost production methods have not yet been introduced. With further encouragement, these forms of solar heating could make a valuable contribution to the national economy.

In hot countries, utilization of solar energy for purposes of refrigeration is likely to be economically attractive.

Work is in progress on the development of solar cells. A single-crystal silicon photovoltaic cell produces a voltage of about 0.5V. Arrays of these cells, in conjunction with battery storage, are being used to provide power to floating buoys and to operate small water pumps in remote locations. Current efforts are directed towards devising cheaper methods of producing silicon cells. Alternatives to silicon are also being investigated: these include gallium-arsenide and thin film cuprous sulphide/cadmium sulphide cells. If mass production of these cells can be achieved, there should be a dramatic fall in costs. Installations employing these cells could be used to provide electric power in remote locations, for example on islands, or to supplement peak output on utility supplied systems, so allowing centralised generating capacity to be reduced.

Another method of generating electricity from solar energy employs flat plate collectors, reflectors, concentrators and solar boilers. These systems are being developed in France, Germany and Italy. The heat obtained is used to drive a Rankine-cycle engine associated with an electrical generator.

Research is proceeding on biological solar energy conversion. Plants suited to any particular climate are grown in large quantities, and heat is generated by burning, or chemical/biological methods are used to produce fuels such as methane or ethanol. Algae cultivation is also being studied. Algae can be grown in liquid wastes and used to produce methane from matter that would otherwise be polluting. The possibilities of photo-synthesis in cell-free systems and of photoelectrolysis are being investigated.

Britain is favourably placed from the standpoint of wind power, and a national programme of R&D in this field is now underway. Questions of design, materials and wind behaviour are being studied. The siting of wind machines in prominent positions is likely to arouse environmental objections (although many people would prefer to live in proximity to a windmill than to a nuclear power station). These objections could be overcome by choosing off-shore sites for the machines. Experience gained in developing North Sea oil and gas could be helpful in this direction. One possibility being considered is the building of wind-powered electrical generators in off-shore clusters comprising about 200 machines in an area of around 70 sq. km.

Both solar and wind power sources are intermittent, and the question of energy storage is receiving attention. Two possibilities are: pumped water storage and utilization of energy to produce

hydrogen and methane.

Britain is surrounded by natural reserves of energy, in the sea. Several methods of harnessing this energy are under consideration. It is estimated that a Severn Estuary barrage scheme could meet up to 10% of the present UK energy demand. Utilisation of wave-power is at the experimental stage: proposed devices include rafts, air-buoys and 'nodding ducks'. Ocean currents could be used to drive turbines located on the sea-bed. The chemical energy contained in the salinity gradients that exist where fresh water at a river mouth meets the salt water of the sea could be exploited. Marine organisms, which exist in large quantities, could be used for the manufacture of hydro-carbon fuels.

From an anthroposophical standpoint, it is important that our attitude towards the energy problem should be based upon a knowledge of all the relevant factors, including those unquantifiable elements which are often left out of account. This wider approach embraces such questions as: the qualitative differences between sunlight and nuclear energy, responsibility for the future of the earth (not just to the year 2000 but well beyond), the achievement of an equilibrium economy with satisfying work for all, and the minimising of tensions between the developed and developing countries. The same basic approach can be applied to other problems facing the modern world.

HEDLEY GANGE.

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Magnetic Fields and Living Organisms

Within some scientific circles there has been concern – evidently emanating from remarks by Rudolf Steiner – that electromagnetic radiation (e.g. radio waves) may have undesirable effects on living things, including Man. (See, for example, the discussion following Lecture 8 in the Agriculture Course). May I draw the attention of those interested in such matters to a new book by a Russian Biologist, A.P. Dubrov, entitled "The Geomagnetic Field and Life – Geomagnetobiology", which was reviewed in New Scientist, 22nd February, 1979. I must confess to only getting as far as the review myself, not feeling sufficiently dedicated to spend £30 on a 318 page book. However, the review mentions the main findings of Dubrov, and for the benefit of readers I will summarise these here.

The day-to-day variation of the earth's magnetic field component is correlated with many biological rhythms in plants, e.g. root secretions, respiration, variation in cell sap concentration etc. Perhaps the most significant conclusion of this is that the circadian rhythm is controlled by the geomagnetic field (GMF). Further, the GMF is thought to interact with brain and muscle activity in man, and Dubrov even wonders whether the large changes in the GMF which occur every 10,000 years could be linked with genetic changes.

The book gives many references, including work by NASA, which point to biological effects of magnetic fields, including experiments in which animals develop abnormalities in their natural rhythms when shielded from the GMF. The underlying mechanism proposed for these effects involves a link between membrane permeability and magnetic fields; time will tell whether this is sufficient.

Is the GMF an important causal link between cosmic influences and earthly events? Is it the *magnetic* component of our electromagnetic technology which we need to keep an eye on, and which may already be disrupting subtle, natural magnetic processes? These and other questions must be tackled by a truly human science.

HOWARD SMITH

A Comprehensive Approach to Electricity

by Hedley Gange

Lecture given at the Science Conference at The New School Kings Langley, January 1978

1. Introduction

We sometimes hear the expression 'the electrification of civilization', and it is, perhaps, true to say that modern civilization is, in many respects, founded on electricity. This situation is the result not only of the widespread practical applications of electricity: discoveries in the realm of electricity during the last 100 years have influenced all branches of science and the characteristics of the way of thinking associated with electricity have set the tone throughout science. There also seems to be something about this logical, objective and purposeful way of thinking that has captured the popular imagination. Terms and concepts taken from the fields of radio communication, space research and the atom are in everyday use; it is electricity more than anything else that has allowed the whole world to participate in the venture of setting foot on the moon.

In fact, electricity has become such an accepted part of life that the question may be asked 'Why, at this late stage in the development of electrical science, is there any point in seeking a fundamentally new understanding of electricity?' Well, as we know, the benefits of modern technology have not been without their accompanying problems, and some of these, such as environmental pollution and the depletion of world natural resources, are now becoming acute. There is also some disquiet about the division of society into the two cultures, scientific and humanist, about the integrity and moral responsibility of scientists, and about the apparent lack of interest, among the younger generation, in science and technology. All these point to the need for a closer relationship of science to human values and human needs. If we can develop a humanly orientated approach in the realm of electricity it will be a useful beginning.

From the standpoint of anthroposophy, the need for a comprehensive understanding of electricity is even more compelling. In 1923, Rudolf Steiner referred to the way Lucifer and Ahriman gain the upper hand when they are able to influence man without him being aware of it. He stressed that the important thing is to understand how man is being influenced by electricity and to bring this sphere of activity into full consciousness. He said that the mere act of riding in a tramcar rendered a person more susceptible to the influence of Ahriman. When we consider the plunge into sub-nature that mankind has taken, since 1923, it is almost certain that, were Steiner alive today, he would attach the greatest importance to coming to grips with this sphere of activity and with its associated problems. It is clear from what is written in the Leading Thoughts that this is to be regarded as an essential stage in evolution.

Dr. Lehrs' book 'Man or Matter', which was published in 1951 and addressed to the general public, gave a clear indication that a new approach to the study of electricity was possible. However, little progress seems to have been made since that date. This may be attributable to the absence of any persistent attempt to pursue investigations in this field or of any clear statement of the form which such an investigation should take. I feel, therefore, that it may serve a useful purpose if I attempt to outline a plan which might serve as a basis for the development

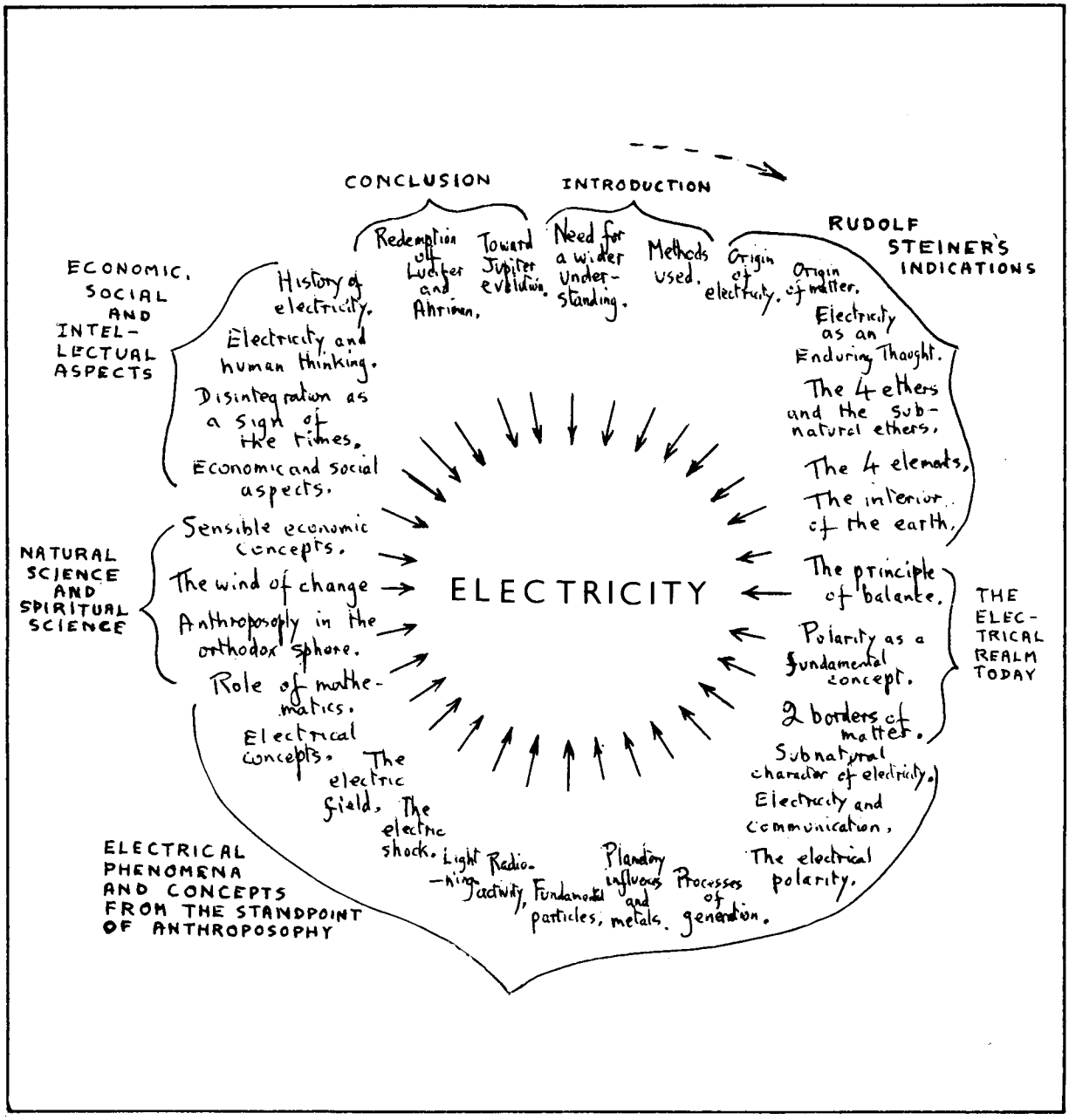

fig. 1

of a comprehensive approach to the study of electricity.

I envisage this plan as taking the form of a circle as shown in Fig. 1. The subject of electricity is approached from many different sides, comparable to points on the circumference of a circle, each approach towards the centre making its own contribution towards a full understanding. Within this general scheme, different methods of thinking and observation can be employed, as in other branches of anthroposophical science. These take three main forms; firstly there is the way of thinking appropriate to the knowledge which Rudolf Steiner was able to impart, from his own spiritual researches, including that concerning the etheric formative forces and the interior of the earth. Secondly we may make our own observations of man and Nature, to verify or augment the descriptions given by Rudolf Steiner. Thirdly

there is the mode of thought employed in orthodox science: both as it is to-day and, for some purposes, as it has developed historically.

Regarding the relationship between natural science and spiritual science, in the words of Herr Schiller, 'Out of spiritual science can come a new development of natural science. Rudolf Steiner advised scientists to enlarge the scope of their science, so that it could be a preparation for spiritual science.' To that we may, perhaps, add that, where electricity is concerned, as well as enlarging the scope of orthodox science, it will be necessary to review and modify many of the existing theories and concepts. These theories are, of course, of great value in many ways, and at present they are indispensible for many purposes, but they do suffer from the limitations which are inherent in the present scientific method. In fact, in developing a new approach, it will be desirable to forget, temporarily, some of the existing theories, such as those concerning the structure of matter, involving atoms, electrons, waves, etc., at least so far as fundamentals are concerned. This will allow a genuinely new start to be made free of pre-conceived ideas. In present day science, no clear distinction is made between observed fact, convention and pure hypothesis, but from an anthroposophical standpoint these distinctions are important.

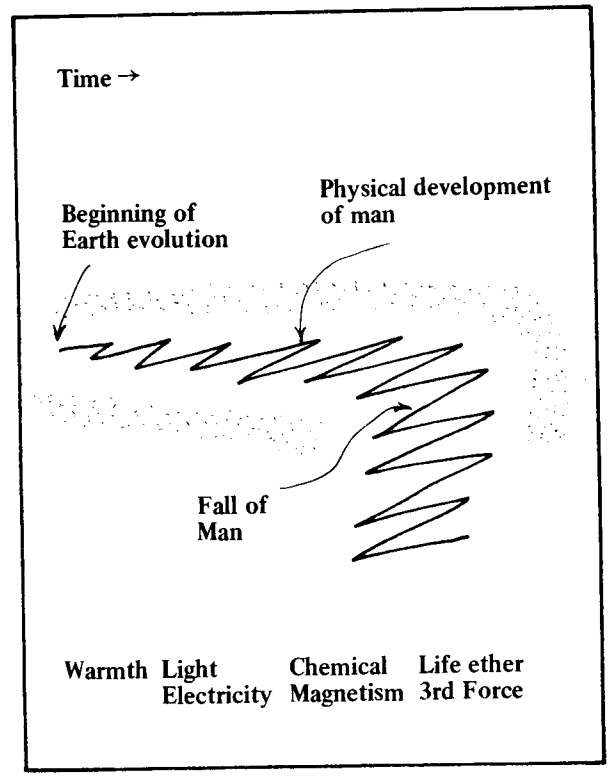

fig. 2

2. Rudolf Steiner's indications relating to Electricity

In a lecture in 1916, Rudolf Steiner said 'It was in that ancient time after the old Saturn period and during the old Sun period, when Sun and Earth were one, that the foundation was laid for the existence of electricity on Earth. There was a short repetition of this state during the Earth period. In electricity we have a force connected with the earth from of old, a Sun force, a Sun force hidden in the earth.' In this lecture he was commenting on contemporary experiments to make beech trees grow independently of the seasons, using electric light, and he went on to say: 'The beech tree does *not* grow without the sun. Only we must know where to look for the sun. But then we must also be clear that there *is* a difference. Seen with a wider vision it does appear one thing to let the beech thrive in the light of the cosmic sun, and another to give it the light which has become Ahrimanic, the light which originated in very ancient times.' This seems to indicate that a part of the original cosmic sunlight has grown old and de-vitalised, and has become a prey to Ahriman.

On another occasion he referred to electricity as 'the decayed sunlight of the old Moon evolution.'

In a lecture in 1962, based on Steiner's descriptions, the anthroposophical physicist Herr Schiller drew the diagram shown at Fig. 2, relating the origin of electricity to the event in early earth evolution when the Sun separated from the Earth. This event left a sort of vacuum on the Earth, which gave Lucifer and Ahriman the opportunity to step in and secure a sphere of influence for themselves. In a comparable way, the origin of magnetism is associated with the event in the Lemurian epoch when the Moon separated from the earth. The fact that the earth had by then assumed a denser state is reflected in what Dr. Lehrs describes as the 'gravitational' character of magnetism as compared to electricity. Herr Schiller said that electricity entered man's body at the Fall of Man, which occurred in the Lemurian epoch.

Rudolf Steiner referred to this time in his lecture of October 1916, from which I have already quoted. He said: 'There was a moment in evolution when what we today call magnetic and electric forces established themselves within man. For magnetic and electric forces live in us in a mysterious manner. Before this time, man lived on earth without the magnetic and electric forces that have developed ever since spiritually between the working of the nerves and the blood. The forces of magnetism we will leave out of consideration, also a portion of the forces of electricity. But the forces, which I will distinguish as the electrical forces in galvanism, voltaism, etc., forces that have taken deep hold in the culture and civilization of our time – these forces found entry in

that far off time into the human organism and united themselves with human life; and this very fact made it possible for them to remain for a long time unknown to human consciousness. Man carried them within him, and for that very reason they remained unknown to him externally. The forces of magnetism and the other electrical forces we learned to know earlier. Galvanism, the electricity of contact, which has a much deeper determining influence on the Karma of our age than is generally realised, was, as you know, only discovered at the turn of the 18th and 19th centuries, by Galvani and Volta.'

He then went on to describe how evolution in time does not proceed in a straight line but turns back on itself. As evolution continued on its lemniscatic course through time, it reached, about the turn of the 18th and 19th centuries, the same point, but at a higher level, which it had occupied in that earlier Lemurian time when electricity had entered man's body. As a consequence, mankind as a whole remembered that earlier event and allowed electricity to break into his consciousness. So it came about that Galvani was able to discover electricity at that time. The actual date was 1785.

In other places we are told that electricity was known in the ancient Egyptian and Greek mystery centres, but it was kept strictly secret and treated with awe and reverence.

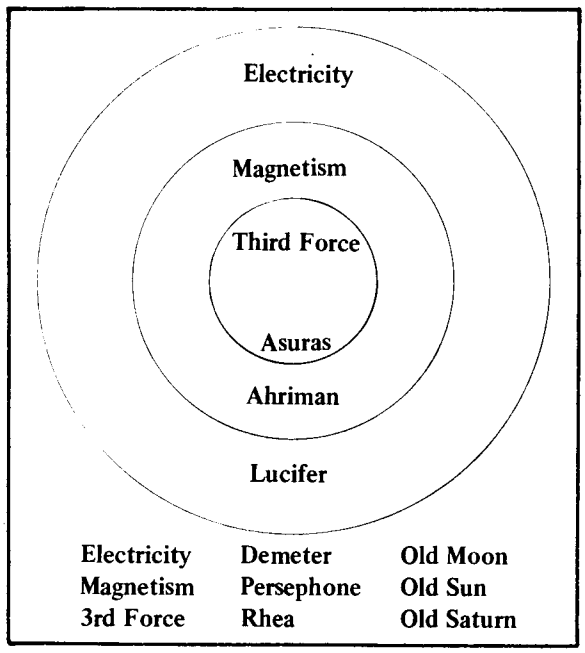

fig. 3

In other lectures, Steiner connects electricity and magnetism with the interior of the earth. The three strata of the earth are designated: electricity, which is the realm of Lucifer, nearest the surface (as shown in Fig. 3), next magnetism, the realm of Ahriman, and at the centre of the earth, the as yet unknown Third Force, which is associated with the negative Asuras. Some people identify the Third Force with atomic energy but this is still unresolved. These three strata are also described respectively as the relics left within the earth of the old Moon, old Sun and old Saturn evolutions. These regions were known to the ancients as the realm of the Mothers, the goddesses Demeter, Persephone and Rhea, which are spoken of by Mephistopheles in the Faust mystery.

In a moral sense, the interior of the earth is connected with evil, and it is part of mankind's task ultimately to spiritualise and redeem these lower regions. Rudolf Steiner describes how the nine Beatitudes given in the Sermon on the Mount, in the Gospel of St. Matthew, refer to this process.

Dr. Steiner also speaks of electricity as one of the 'Enduring Thoughts' through which the Archangels are to accomplish their mission for humanity. This 'thought that shall endure' appears in the words spoken by the Lord to the Archangels in the 'Prologue in Heaven', in the first part of Göethe's Faust.

In the First Scientific Lecture-Course, Steiner says: 'We have no direct experience of the electrical phenomena of Nature. We only experience what they send upward, so to speak, into the realms of light and sound and warmth, etc. For we are here crossing the same boundary as to the outer world, which we are crossing in ourselves when we descend from our thinking and idea-forming, conscious life into our life of Will. All that is light, and sound, and warmth, is then akin to our conscious life, while all that goes on in the realms of electricity and magnetism is akin – intimately akin – to our unconscious life of Will.'

It is, however, a feature of life to-day that the more hidden aspects, in Nature and in man, are coming to the surface, in one form or another. In studying electricity, and other forces associated with it, we are bringing the sphere of the will into full consciousness.

Steiner also referred to the descent from the phenomenal world to the sub-natural domain of electricity and magnetism as a descent from the realm of the etheric formative forces to the realm of the sub-natural ethers. The diagram, Fig. 4, shows the states of matter encountered in the phenomenal world, solid, liquid and gaseous, extended between the etheric formative forces above and the sub-natural forces below. This scheme is sometimes referred to as the 'Spectrum of Nature'. The realm of sub-nature is divided into sub-natural light ether, which is electricity, sub-natural chemical ether, which is magnetism, and sub-natural life ether, which corresponds to the Third Force, which is to emerge in the future. The element warmth mediates between the physical and the etheric. The concept of electricity as sub-natural light ether is similar to the description given earlier as 'light that has become Ahrimanic'. On another occasion, Steiner described how the Atlanteans worked with forces of growth but today we are working with forces of decay. Light, which previously built up the

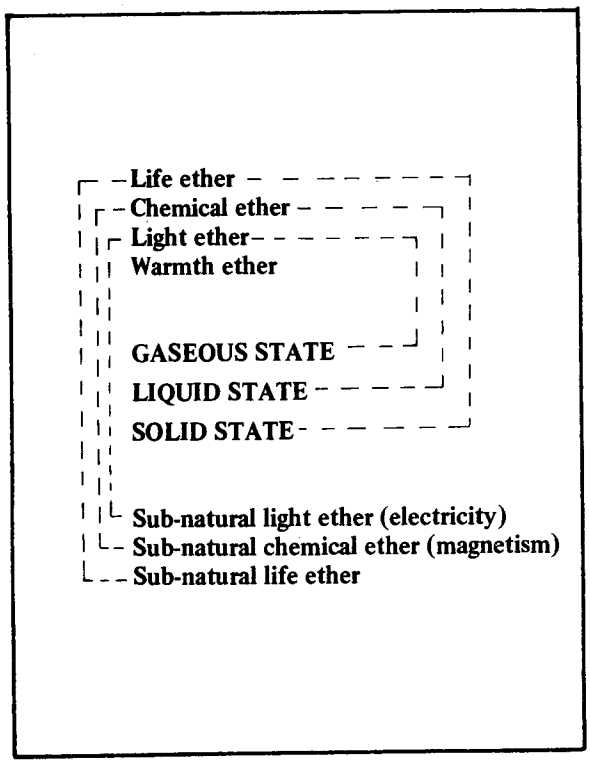

fig. 4

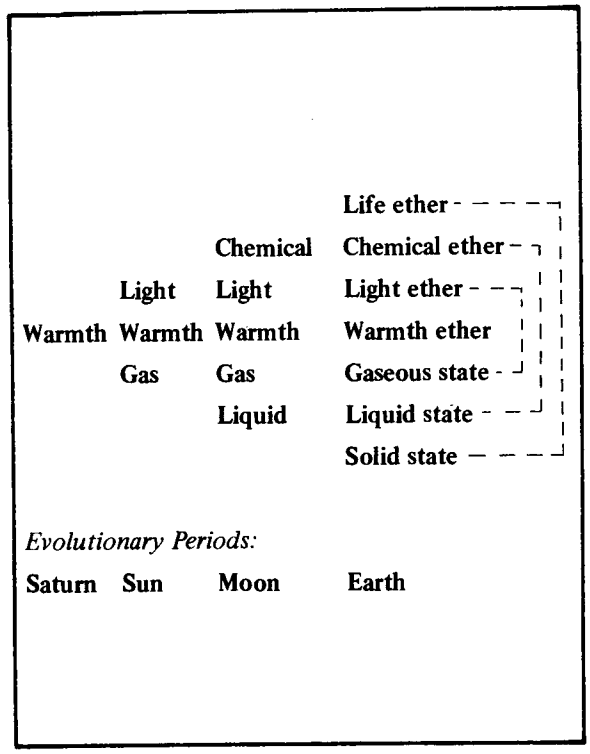

fig. 5

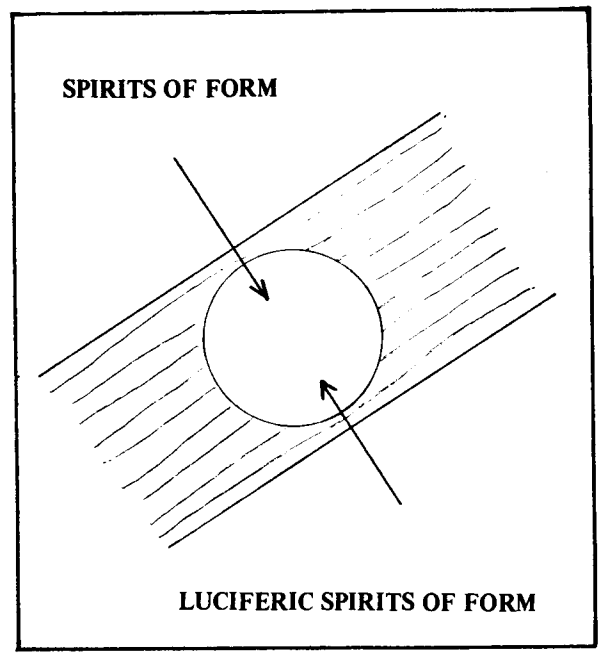

fig. 6

body of man, has been destroying itself since Atlantis; and 'as it perishes within matter it becomes electricity.'

The diagram, Fig. 5, depicts the relationship between the evolution of the etheric forces and the progressive densification of matter, through the planetary evolutions of Saturn, Sun, Moon and finally as existing on earth today. Each stage in the refinement of ether has been accompanied by the emergence of a denser physical condition.

I will conclude these indications given by Rudolf Steiner with some of his references to the nature of matter, as this has some bearing on the study of electrical phenomena.

In studying matter, the natural scientist is trying to break through Maya. He must learn to grasp the Beings behind the phenomena. Speaking of the origin of the planets, Steiner said that all physical matter comes into existence through the meeting together of forces coming from the Spirits of Form. There are the normal and the abnormal (or Luciferic) Spririts of Form. The abnormal Spirits of Form have refused the influence of the higher Powers: they have stolen a part of this influence and enclosed it in themselves. 'The forces from the normal and abnormal Spirits of Form collide with one another and an indentation in the etheric space is produced, and consequently at this point there is a simultaneous breaking up of the form, but only of the form. The form breaks up and a hollow space is bored, as shown in the diagram (Fig. 6). Broken spiritual form, crushed form, is in reality matter. In a physical sense matter only exists when spiritual forms are broken up.'

Other Powers besides the Spirits of Form are concerned in the creation of matter. Matter has been described as the body of the Thrones. Ponderable matter arises when the living idea of the Hierarchies meets the opposition of the Luciferic and Ahrimanic Powers.

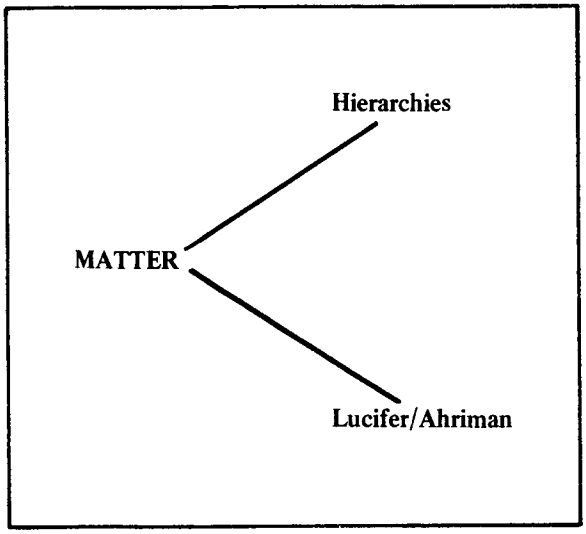

fig. 7

Matter thus has two aspects, which may be termed the upper and lower aspects, as depicted in Fig. 7. This concept is complementary to that of the 'Spectrum of Nature'. The Upper and Lower spiritual forces work into matter through the medium of the natural and sub-natural ethers, respectively.

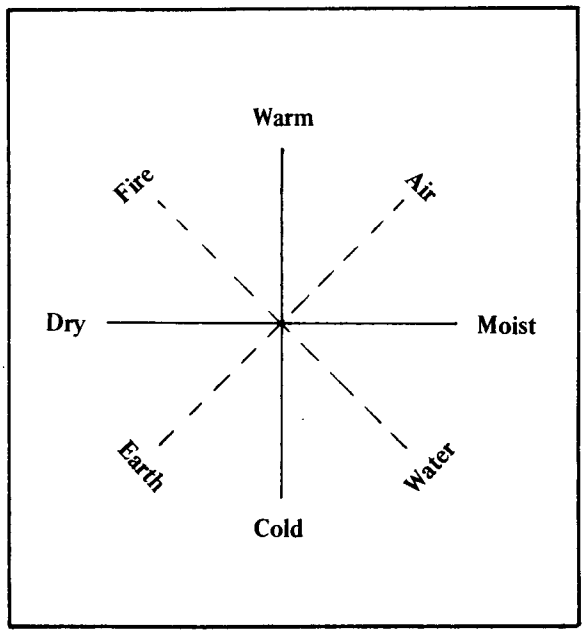

fig. 8

Rudolf Steiner also referred to the Aristotelian doctrine of the Four Elements in relation to the study of natural phenomena. Dr. Lehrs has shown how the principles underlying this doctrine are applicable in the world of to-day, providing allowance is made for the evolutionary changes that have occurred since they were first formulated. In this scheme, shown in Fig. 8, the two opposing tendencies, to which matter is subjected, are the upwardly directed forces associated with Warmth and expansion and the downwardly directed forces associated with Cold and contraction. This is referred to by Dr. Lehrs as the primary Levity/Gravity polarity. Here the term Gravity is used in a wide sense to embrace the condensing, materialising tendency which plays an essential role in the anthroposophical concept of evolution. The poles of this primary polarity are considered to have the property of interacting in two opposite ways. In what is termed the 'moist' condition they interpenetrate, each surrendering something of its own character in a stable relationship: in the 'dry' condition each component tends to retain its own character in a looser relationship. The terms 'warm', 'cold', 'moist', 'dry' had a much wider meaning for the Ancient Greeks than they have to-day: they applied to feelings and the principles underlying natural processes, as well as to physically perceptible phenomena. The four qualities, warm, cold, moist, dry give rise to the Four Elements. The element Earth arises from a combination of the qualities 'cold' and 'dry', and the element Water from the qualities 'cold' and 'moist'. The qualities 'warm' and 'dry' combine to produce the element Fire, and 'warm' and 'moist' the element Air. The Ancient Greeks did not experience air as a physical substance as we do today.

These different approaches to the concept of matter, to which Steiner referred on different occastions, evidently have some features in common. There is the idea of an equilibrium state between opposing forces, and there is some relationship between the Four Elements and the four differentiations of ether as given in the Spectrum of Nature. These various indications suggest that it should be possible to develop a concept of matter capable of being integrated into a comprehensive world-outlook. This is not so with the modern scientific view of matter: this is, in a sense, a polaric view, but the countergravitational element is not rooted in experience, but takes the form of forces assumed to operate between hypothetical sub-atomic particles or equivalent entities. Its value is, therefore, limited, so far as a comprehensive understanding is concerned.

The use of the names of both Lucifer and Ahriman, in connection with electricity, may be confusing. It seems that Lucifer is connected with the origin of electricity and Ahriman with the origin of magnetism. It was, however, the power to work within matter, that magnetism gives to electricity, that made the electrification of civilisation possible. To-day electricity is used, mainly, in association with magnetism. By

simply rotating an armature, electricity can be made available in large quantities. In modern technology, the Ahrimanic element probably predominates over the Luciferic. The conduction of electricity, continuously, along wires became possible through the work of Galvani and Volta. This was the essential step which allowed Michael Faraday, later, to discover the principles of electro-magnetism.

3. Electricity in the world today

Perhaps we may now take a general look at the role of electro-magnetism in the world of to-day in the light of the indications given by Rudolf Steiner. It is apparent that there are two sides to this role. On the one hand, electricity has brought great benefits to mankind; in, for example, reducing drudgery, saving life, reducing pain, providing the possibility of a fuller life. For these, we should, I think, have a feeling of indebtedness for the availability of this agency as part of our heritage and for the human endeavour associated with its development. On the other hand, some of the dangers, actual and potential, associated with the exploitation of electricity, are now becoming apparent: I will refer to these later.

Electricity is closely woven into the life of humanity as an 'enduring thought' and it is likely to remain so far into the future, so the way in which we think about electricity, in all its aspects, is important. The 'commodity' of electricity contains a thought element: electricity is hidden in Nature, and it is only by exercising his ingenuity that man has been able, first to extract it, and then to make use of it. If the scientists and technologists do not have a spiritually orientated outlook, there is clearly a danger that the way of thinking about electricity may assume an Ahrimanic form, and, as we know, the theories of to-day may determine the practical realities of to-morrow. From anthroposophical considerations, we would expect the realm of sub-nature to be logical and impersonal, with a tendency to create its own thought-forms and to pursue its own autonomous development regardless of wider human interests. These are, in fact, the trends in modern technology which are giving concern in many quarters to-day.

If the anthroposophical way of looking at Nature is realistic, it seems to me that it should point to the existence of the electrical force-realm even if electricity had not yet been discovered. Rudolf Steiner always stressed the importance of Balance. Man stands firmly on the earth and looks at the phenomena of Nature; he is drawn towards the Sun, the sky, the stars and the spiritual powers beyond. This picture is unbalanced, however; reality demands that man considers what is below, physically and spiritually, as well as what is above, with he, himself, occupying the point of balance. I have shown this diagrammatically, in a spatial sense, in Fig. 9; there is a tendency towards utmost expansion above and towards utmost contraction below, that is, the infinitely distant plane above

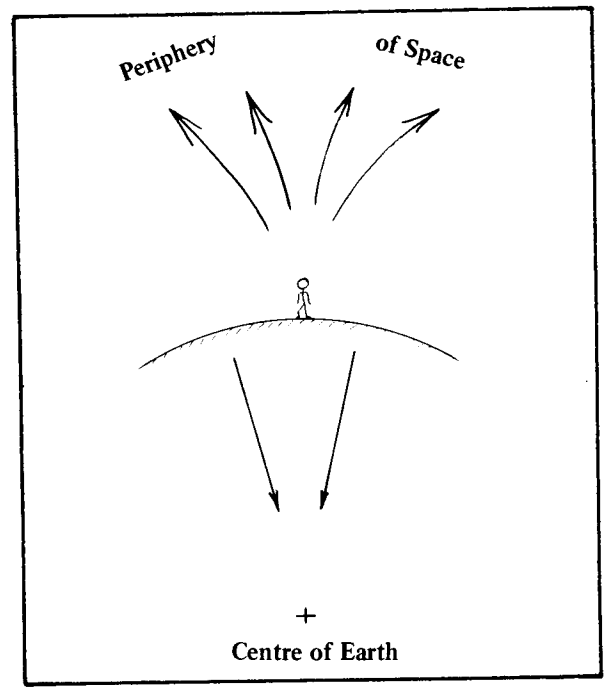

fig. 9

and the point at the centre of the earth below, with man in the middle. In, for example, Dante's Divine Comedy, almost as much consideration is given to the lower regions as to the heavenly realms. The phenomenal world is extended between the gravitational and levitational forces. In the course of evolution, various subsidiary forces have developed, producing all the wide variety of living and inanimate phenomena. According to the principle of balance, we would expect these forces, working directly into matter, to fall into two categories exhibiting polarically opposite qualities, as indicated in the diagram, Fig. 10. Through light, colour, form, organic activity we have learned

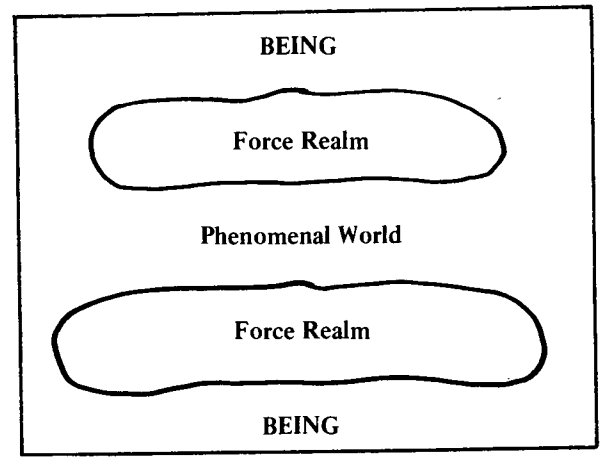

fig. 10

to recognize the influence of the etheric forces, in their several differentiations. For a number of reasons, it seems right to place these forces at Nature's upper border. To complete the picture, we would expect to find, somewhere, a realm of forces opposite in character to those pertaining to the upper border. Such a realm might be characterised as: lifeless, rigid, self-contained, pointwise, hidden, in contrast to the etheric realm which is living, plastic, receptive to cosmic forces, planar (rather than pointwise) and directly experienced (rather than having to be drawn out by man). These qualities which we would expect to find in the lower force-realm are similar to those which we encounter in the realm of electromagnetism, to-day. Our experience of this realm thus confirms the completeness of the anthroposophical view of the world, providing the principle of balance is kept always in mind.

The place of sub-nature in the anthroposophical world-view may be approached from another angle. As ether has evolved through the stages of warmth, light, chemical and life ether, it has become progressively more successful in grasping the condensing, materialising force, so that to-day living processes may take place even in solid matter. Applying a balanced approach, as before, we would expect that, at the same time, the opposite condition has also arisen, that is, the materialising force has also had some success in capturing a portion of the etheric forces, resulting in the appearance of *sub-natural* light, chemical and life ethers. The description of electricity as light that has been caught in the web of Ahriman seems to agree well with observation. This ether has evidently been robbed of much of its vitality, but has retained sufficient etheric quality to be able to produce a whole new world, based on technology, – a copy of the natural world, within certain limits, but independent of Nature and of wider cosmic influences.

One of the first things we notice about electricity is that it is a polarised force, manifesting in the form of the complementary positive and negative poles. From the standpoint of orthodox science, this simply has to be accepted as an observed fact. Polarity is, however, fundamental in the anthroposophical world-view and it should be possible to trace a connection between polarity as a fundamental principle and polarity as encountered in electricity.

Our familiar world is full of polarities; almost everything has its opposite:- bright, dull; sharp, blunt; strong, weak; rough, smooth; deep, shallow; reduced, oxydised; cool colours, warm colours, and so on. These polarities and tensions figured prominently in earlier views of Nature, not only in the Aristotelian doctrine of the Four Elements but in many other cultures. Polaric concepts were fundamental in, for example, Chinese philosophy a few centuries before Christ, and in the well known symbol taken from the book I CHING, (Fig. 11). I have already referred to the way the secondary polarities in the phenomenal

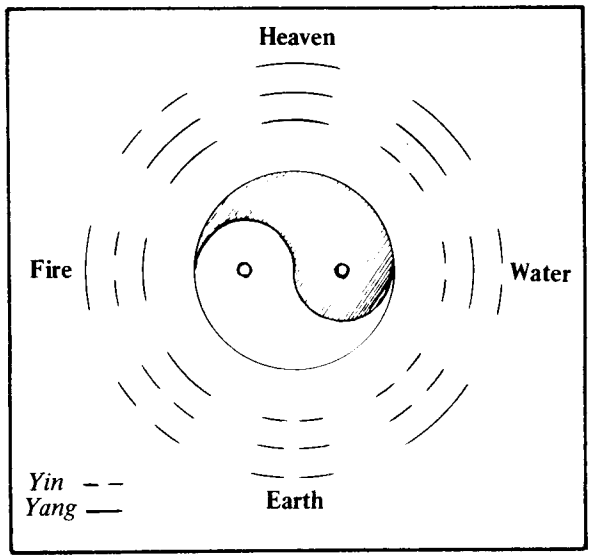

fig. 11

world may be considered to arise from the primary Levity/Gravity polarity. This is shown in a schematic way in Fig. 12. The primary polarity is, here, shown simply as expansive and contractive tendencies, although it is, of course, a fully qualitative polarity. A wide variety of forms may arise through the interplay of the poles of the primary polarity in different ways and to different degrees, as indicated here. Some of these, where matter is contracted into a very small space or expanded into a plane, constitute a secondary polarity, with various other intermediate conditions.

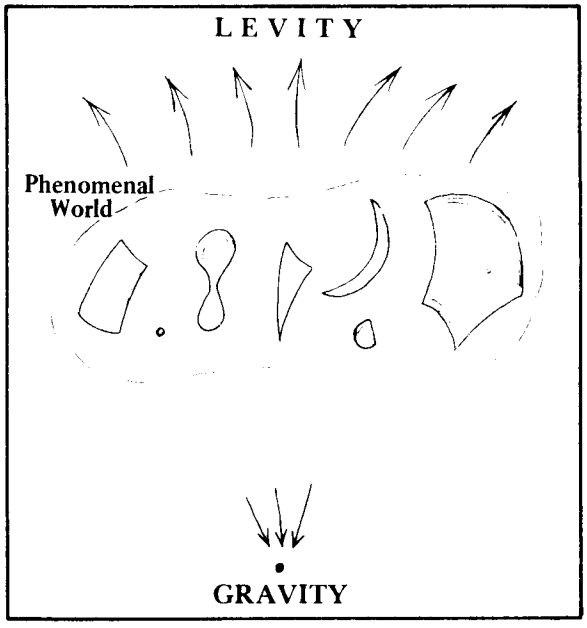

fig. 12

In the course of evolution ether and gravity have been brought into closer and closer association, and ether has been drawn deeper into the dark realm of matter. It is not surprising that the forces released at Nature's lower border still retain the ether/gravity relation which they had within matter. It is as though the Luciferic and Ahrimanic forces have taken advantage of the relationship with ether that they have formed within matter, to enable them to create a domain of their own, independent of Nature. There seems to be a parallel between the way these forces have bound ether in a state of mutual polarisation and the way in which the Luciferic powers have, long ago, caught a part of the cosmic light and enclosed it within themselves, as described by Rudolf Steiner in connection with the origin of matter.

The appearance of polarities in Nature may be approached from another angle. In studying the etheric formative forces, we are advised to practise observing natural phenomena, organic and inanimate, as though we were looking through one of the elements, first warmth, experiencing the warmth aspects of Nature, in their relation to us, then similarly with the elements of Air, Water and Earth. There is a form of understanding appropriate to each element. Taking this a stage further, we could try to observe the world from the standpoint of sub-nature. What are the characteristics of sub-nature? First, there is an absence of qualities, such as colour, texture, lustre: in this realm, the quantitative aspects of matter are most prominent and the forces acting on matter, associated with weight, acceleration etc., which can be readily expressed numerically; there is also a close correspondence between observation and mathematical logic. Viewed from this angle the natural world appears as a

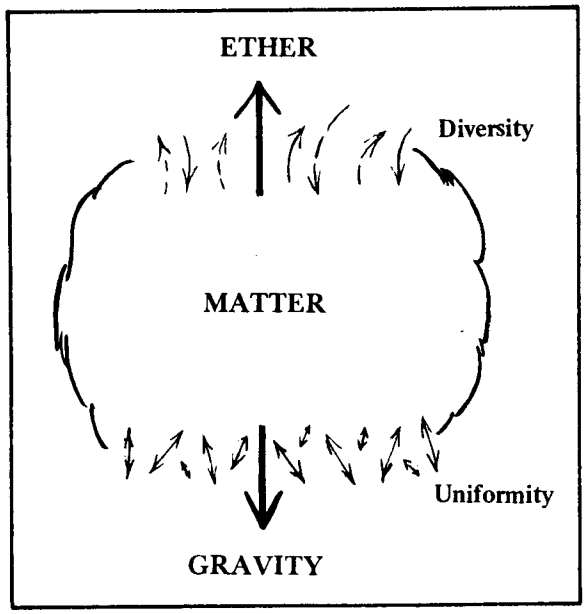

fig. 13

colourless skeleton of reality, but there is a new content of forces and energies, with a certain sense of power. We notice that electrical potentials, small or large, are arising almost everywhere, wherever the states of matter are changing, or interacting, in meteorological processes, in industry, in living organisms, in the home. The potentials are particularly pronounced in processes involving substances of contrasting natures, such as friction between resinous and vitreous materials, chemical action involving noble and corrosive metals or volitional activity in animal organisms in which muscle and nerve participate. All these pairs of substances seem to represent polarities of the Moist/Dry type, in the language of the four elements.

There is evidently some correlation between the polarities and contrasts in the phenomenal world and the appearance of the electrical polarities. We are here concerned with the two borders of matter; in the diagrem, Fig. 13, the borders are necessarily shown some distance apart, but in reality they exist together throughout matter, since the two aspects, quality and mass, are always present. This diagram is intended to represent an aggregate of matter of different sorts. The state of the material world to-day is the result of the long evolutionary process in which two different activities have been going on simultaneously: ether has taken the lead in the development of the varied and increasingly complex forms of life, whilst, at the same time, gravity has been progressively increasing its grasp on a portion of the etheric realm. The resulting de-vitalised ether can readily be 'bound' by gravity in a state of mutual polarisation, manifesting as electricity, whenever conditions are suitable. As a result of physical, chemical, organic and other activities, all manner of tensions are continually arising and disappearing within the realm of matter. Both upper and lower borders are simultaneously involved in these processes, but activities at the two borders become manifest in different ways. Happenings at the upper border include physical and chemical changes in the states of matter and the appearance of heat or light. The corresponding activity at the lower border is much more restricted. The great diversity of activity at the upper border is accompanied at the lower border by the appearance of the uniform, stereotyped positive and negative electrical polarities. (The etheric component in a particular substance gives it its characteristic qualities such as colour, texture, taste, healing properties; the gravitational component is responsible for those properties which all matter has in common such as volume, density, conductivity.)

There is a further way in which the appearance of electricity in Nature may be regarded. The tendency of the gravitational, condensing force, in evolution, is to make all matter the same, and the earth into one uniform, dense mass. All the variety of substance, texture and form in Nature is attributable to the activity of the etheric forces. The condensing force must

have participated unwillingly in the creation of all this variety, with the result that localised tensions have been set up within the sphere of the condensing force. In the course of the interactions of matter, these tensions may become observable as electric forces acting between one substance and another. The simple diagram in Fig. 14, is intended to illustrate this point.

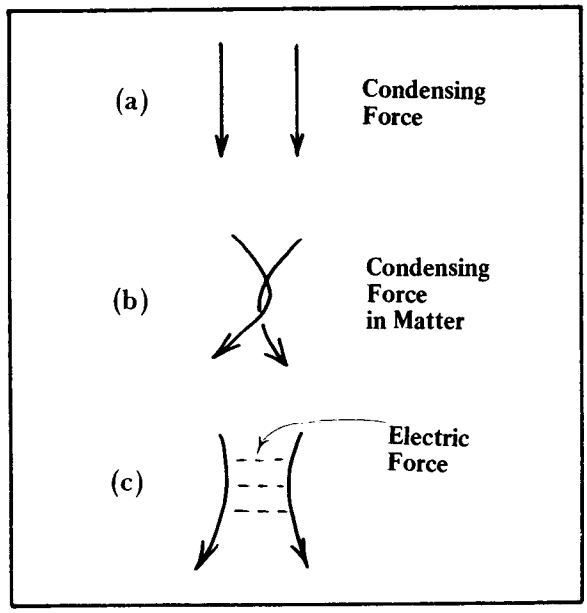

fig. 14

4. Electrical and magnetic phenomena

I have indicated the general place of electricity in the anthroposophical world view, and I will now try to apply this to a number of phenomena involving various aspects of electricity and magnetism.

4.1. Electricity and magnetism as realms of sub-nature

First, how does the general character of the electromagnetic domain agree with the anthroposophical concept? I have already referred to some aspects, including the dual role of these forces, beneficial and also potentialy harmful. It does seem that a point in evolution has now been reached where special attention needs to be paid to the possible harmful effects of the further exploitation of electricity and the associated forces. A deeper understanding should help the exercise of effective control of developments in this field. As I mentioned, it is magnetism, with its cold, gravitational character, which, added to electricity, has made modern technology possible. This indicates the tendency in this realm to penetrate deeper into sub-nature. This is also the direction in which experimental investigation has led: the discovery of the electron, proton and other particles has played a decisive part in the development of the atomic theory of matter, culminating in the release of atomic energy, with its harmful effects. From the conventional standpoint, this appears to be a normal line of development, but from the standpoint of anthroposophy, it is clearly moving away from normality into regions in which man is a stranger.

As regards the relationship between electricity and the realms of life; electricity is often used to split up substances into their constituent parts, in electrolysis, but rarely to build up substances into more complex ones, as is achieved, for example, by natural light in the process of photosynthesis. Electrically produced heat and light are sometimes almost indistinguishable from the natural products, but in general, they are less beneficial to man. Some of the differences may be measured or detected through their effects on, for example, plant life, others may be apparent only to individuals of particular sensitivity. In the atmosphere there is an increasing amount of electromagnetic radiation, used for broadcasting, radar (civil and military), and private communications, but the effects of these on man have not yet been properly investigated. Electricity provides the means of creating an artificial environment independent of Nature, this has made man less sensitive to the earthly and extra-earthly influences and rhythms of nature which played such a large part in the life of men of earlier days.

Electricity has also been used to produce the 'thinking machine'. This imitates one aspect of man's thinking capability, the logical component, and developes it far beyond the ability of man. As a result of the application of these machines in the commercial and industrial spheres, the impersonal and materialistic elements have become more pronounced.

These various details support the description of electricity as a sub-natural domain, described by Rudolf Steiner as a realm 'tending to emancipate itself from Nature in a downward direction'.

4.2. Electricity and communication

I referred to the application of electricity in communications. This provides an illustration of how closely electricity and magnetism work together (comparable, perhaps, to the relationship between light ether and chemical ether) and also of how the electric and magnetic forces seem peculiarly suited to copy almost every activity in the natural world. Radio communication was made possible by the use of the resonant circuit shown in Fig. 15. The capacitor stores electricity, whilst the coil possesses a magnetic field when a current is flowing. If the capacitor is charged, it immediately starts to discharge through the coil, setting up a magnetic field around it. When this field collapses, a further current is produced which recharges the capacitor. The process then repeats itself,

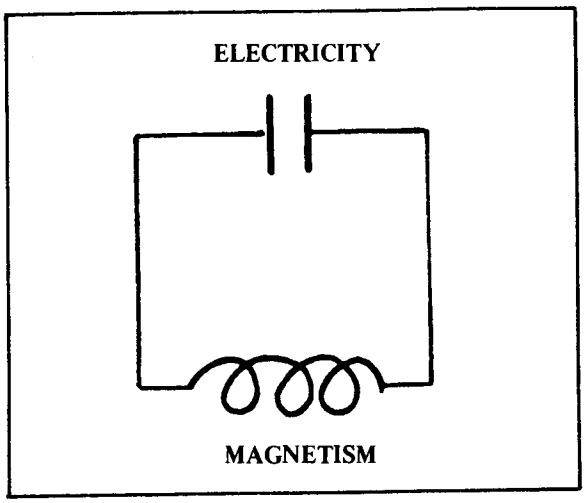

fig. 15

the to-and-fro rhythmic action continuing at a frequency determined by the sizes of the coil and the capacitor. The two components are extremely simple, and it is virtually the basic relationship between electricity and magnetism which sets up this rhythmic motion. Corresponding undulations appear in the surrounding space and these may be transmitted outwards at high velocity in the form of radio waves. Here again the electric and magnetic components mutually sustain one another, as one collapses the other comes into being and vice versa. Dr. Lehrs has compared the resonant circuit to the structure of the human being. Communication, that is, speech, in man is based on the rythmic breathing system which alternates between the poles of the nervous system (centred in the head) and the metabolic, digestive system. The head corresponds to the static element of the resonant circuit (the capacitor), and the digestive system to the coil (shaped rather like the intestines) where movement and transformation of electricity into magnetism takes place.

4.3. The electric polarity

Anthroposophy provides the means of enquiring further into the nature of the relationship between positive and negative electricity. When, for example, a piece of elastic is stretched, the tensions at the two ends are equal in magnitude and opposite in direction. In a similar way, the two ends of an electrical polarity may be regarded as equal and opposite for many practical purposes. There are, however, other differences between the two poles which, from the conventional standpoint seem unaccountable: this is not surprising since the conventional method is based primarily on aspects of phenomena which can be measured and expressed quantitatively, with little attention to the more elusive qualitative aspects which demand a wider approach. From this wider standpoint, electricity is seen to have evolved out of the realm of matter, and it still bears an intimate relationship to matter. In appearing at Nature's lower border, it is as though the electric force had held on to matter at one pole whilst being drawn out in the direction of ether at the other pole. There is evidently a very close relationship between the positive side of the electrical polarity and matter. The two sides do, in fact, exhibit opposite relationships towards matter. The basic positive particle, the proton, is associated with mass and, in atomic theory, with specific properties of matter and nuclear structure. In contrast, the negative particle, the electron, is comparatively free and virtually weightless, being about 1800 times lighter than the proton. In electrolysis, the current at the positive electrode may be accompanied by disintegration of the metal of which the electrode is made, whilst there is no similar action at the negative terminal. This coincidence of electrical change with changes in solid matter, at the positive pole, in the discharging condition, seems to be typical of what would be termed in alchemy a Moist state.

Whilst positive electricity has a special relationship to matter, negative electricity has a special relationship to ether. The application of heat at the negative electrode of a thermionic valve causes an increase in the flow of current in the valve, whereas the same effect cannot be obtained at the positive electrode. In the photoelectric cell, a direct relationship is observed between the incidence of light on the cell and the production of particles of negative electricity.

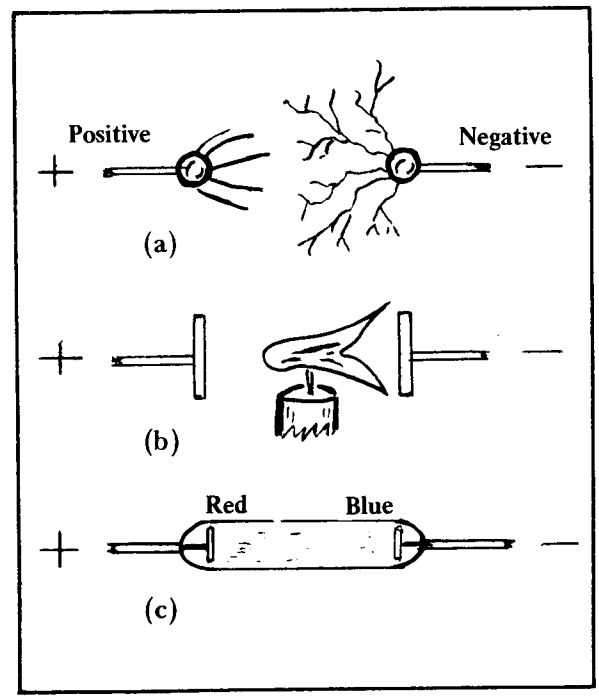

fig. 16

When the flame of a candle is placed in an electric field, the flame is attracted towards the negative pole, as in Fig. 16 (b), indicating, perhaps, an affinity between negative electricity and ether (flame).

Differences between the conditions at the two poles may also become manifest through the medium of Form. Photographs taken of the conditions preceding an electric spark in air show different forms in the vicinity of the positive and negative terminals, as indicated, very roughly, in Fig. 16(a). The geometric forms characteristic of the Moist/Dry polarity are the straight line and the curved plane respectively, and the conditions at the positive and negative terminals bear some resemblance to these forms. Studies of form could also be made using the 'tracking' patterns that sometimes appear on the surface of insulators supporting conductors carrying direct current at high voltages.

Differences of colour, as well as of form, are observed in another phenomenon, that is, the discharge of electricity in conditions approaching a vacuum. Red colours appear at the positive end of the glass tube and blue at the negative end, as indicated in Fig. 16(c). The ether/gravity relationship in the colours red and blue are moist and dry respectively. In Geothe's theory of colour, the red band of colours and the blue band, represent, of course, a secondary polarity. Red may be described as darkened light and blue as lightened darkness.

The investigation of the nature of the electrical polarity evidently opens up a wide field for observation and experiment. For the present, at least, the Moist/Dry concept provides a useful guide in this field.

4.4. The generation of electricity

When considering the process by which electricity is generated, it is noticeable that there is, in this field, a close connection between the study of electricity and the nature of substances. Electricity derives its name from amber, that rather unusual substance with which the attractive force was first associated. Later there came the division of substances into the Vitreous and Resinous categories, which is clearly a Dry/Moist classification, and which determined the polarities appearing when two different substances were rubbed together. Then there was the arrangement of metals in the Voltaic series, with noble metals on one side and base metals at the other, according to the potentials produced when two different metals were placed in an electrolyte. The more recent discovery of piezo-electricity is dependent on a knowledge of the properties and structure of a quartz crystal. Anthroposophy seeks a comprehensive, cosmic knowledge of matter and its evolution, and it is out of this background that the study of electricity emerges: as the anthroposophical study of matter progresses, it should be continuously enhancing our understanding of electricity. This contrasts with the conventional position, where the electric and other intra-material forces are regarded as fundamental and the cause of all the macroscopic states and properties of matter.

Processes resulting in the production of electricity have two features in common. First, they are of the type that normally produce heat, such as friction or the dissolving of a metal by an acid. Secondly, some form of secondary polarity is present, such as the vitreous/resinous substances, like glass and silk, in the frictional method. The idea of matter having an upper and a lower border is fundamental in the anthroposophical view, and it seems to follow that whenever there is a change affecting the upper border, there is, at least, a tendency for a simultaneous change of some sort to occur at the lower border. Certainly, during the last 30 years, electrical potentials have been detected in conditions and processes where they had not previously been thought to exist. It is interesting to observe how frequently electrical potentials arise in everyday operations, such as washing-up or between articles of clothing and the human skin and hair.

The release of heat is, in general, a process concerning ether and the upper border of matter. Where, however, substances of contrasting natures are present, tensions are likely to arise at the lower border, manifesting as electricity. In, for example, the frictional process, the rubbing of one surface against the other, under pressure, produces the electric potential directly; this appears to be the action at the lower border corresponding to the production of free heat at the upper border. In frictional electricity, positive polarity appears on the vitreous substance. In the simple cell, negative polarity appears on the more corrosive metal, for example, zinc, and positive on the more noble metal, copper. It is at the negative pole where the dissolving action occurs, and it is, perhaps, more helpful to think of this phenomenon in terms of the nature of the process taking place, in this case, a Moist process at the zinc electrode, rather than consider merely the Moist/Dry contrast between the two metals. (See: Hans Gebert, 'Uber einen Wesenzug der Elektrizitat' in 'Elemente der Naturwissenschaft, No. 15, 1971').

In general, the conditions when electricity is being generated are the opposite of those when electricity is discharging; for example, in the simple cell, a dissolving action is observed at the negative electrode but in electrolysis, a dissolving or disintegrating action takes place, usually, at the positive electrode.

Rudolf Steiner drew particular attention to the connexion between the nerve/muscle polarity, in the bodies of man and animal, and the existence of electrical tensions within these organisms. This comes to expression in a pronounced way in the electric eel, where the organ producing the electric shock is found to consist of alternate layers of tissue similar to nerve and muscle respectively, forming a sort of battery.

The production of electricity by means of a turbo-alternator, as used in power stations, involves the same two basic principles. The 'heat' producing element is

represented by the movement of a conductor against the resistance of a magnetic field. (The current induced in the moving conductor produces a magnetic field which tends to oppose the motion.) The necessary polaric condition is inherent in the structure of the magnetic field of the machine.

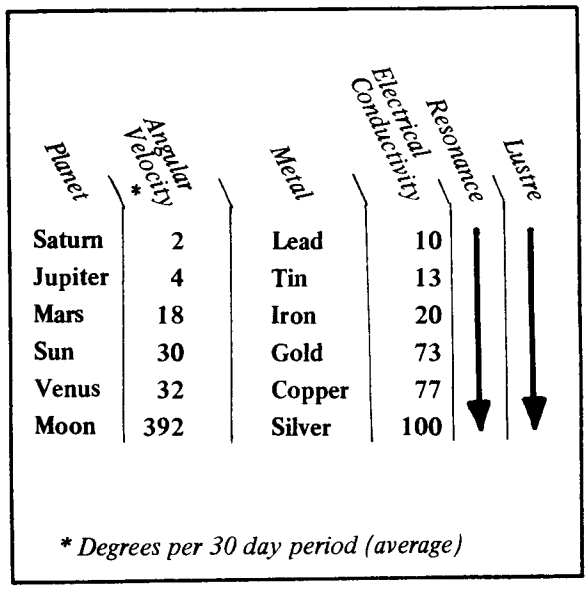

fig. 17

4.5. Planetary influences and metals

I have referred to the relationship between the study of electricity and the study of matter. In this connection, the work of L. Kolisko on planetary influences and metals is of interest. The table in Fig. 17, taken from Dr. Hauschka's book 'The Nature of Substance', shows the relationship between the electrical conductivity of metals and the speeds at which the planets associated with these metals appear to move, viewed from the earth. The figures against each planet represent its angular velocity, and they are arranged in order, with the slowest planets at the top and the faster ones at the bottom. It is found that the electrical conductivity of the metals follows the same order. The metals lead, tin and iron, associated with the slower, outer planets, Saturn, Jupiter and Mars, are the least lively in relation to electricity, whilst silver, copper and gold, associated with Moon, Venus and Sun, have highest conductivity. Mercury, which is a liquid at normal temperatures, is omitted from the table.

Another physical property, resonance, the quality of the sound produced when a piece of the metal is struck, follows the same pattern – silver being the most resonant and lead the least. The same order is obtained when the metals are arranged in accordance with their property of lustre or sparkle, silver being the brightest and lead the dullest.

The planetary relationships also extend to the chemical properties of the metals. Those which have the highest lustre, resonance and conductivity are, chemically the most noble, whilst those associated with the outer planets Mars, Jupiter and Saturn are the most corrosive.

This line of investigation shows that even when working with electricity, there is a cosmic aspect.

4.6. Lightning

The phenomenon of lightning has proved difficult to explain by comparison with an electric spark produced in a laboratory. If, however, the phenomenon is regarded in its totality, in accordance with Goethean principles, embracing all aspects both qualitative and quantitative, a more satisfactory picture emerges. From this standpoint, lightning is to be regarded as, primarily, a meteorological phenomenon, in which the evaporation of moisture from the surface of the earth, and its return as rain, is accelerated due to the sun's heat, instead of following a more gradual course, as is normally the case.

Here again it is important to distinguish between the activities taking place at the upper and lower borders of matter. The production of rain or hailstones and the release of light and heat relate to the upper border, while the accompanying action at the lower border consists in the rapid discharge of electric potentials built up during the preceeding meteorological changes. The flash we see lighting up the sky is pure light not electric light, as Dr. Lehrs states in his book. This seems to agree with my own impression, especially of tropical lightning. I am not sure whether this can be regarded as proven, whether existing measuring instruments would show similarities between the lightning flash and sunlight, or whether a more sensitive method of detection is needed. An electric discharge does take place at the same time but this concerns Nature's lower border and should not be confused with the release of light ether at the upper border.

4.7. Fundamental particles

Some of the most far-reaching experimental discoveries during the last century have concerned the production of particles when electricity is discharged in a vacuum or rarefied gas. In Sir William Crookes' experiments, a luminous emission was observed from the cathode: this was later found to consist of electrons. Crookes called this emission 'molecular light'. Other workers detected a stream of particles moving in the opposite direction which were found to be protons. Viewed from a Goethean standpoint, it is essential that the part played by the apparatus in these experiments be taken into account when attempting to draw any general conclusions from the results obtained. We have already come to regard electricity as de-vitalised ether held in the grip of the

materialising agency in a state of mutual polarisation, and the vacuum tube phenomena seem to confirm this description. The tendency of the materialising agency is to reduce matter to a number of separate, identical point-centres or 'dust'. When electricity is freely observable, in the special conditions of the vacuum tube, particles arise, and also light, evidently representing the gravitational and etheric ingredients of electricity, respectively.

Science has, however, interpreted these phenomena in a different way, in accordance with the prevailing climate of thought, accepting certain aspects and ignoring others. As we know, the disadvantage of such a one-sided approach is not merely its incompleteness but its tendency to draw the investigator, and mankind as a whole, further into the realm of sub-nature. This seems to me to emphasise the importance of anthroposophy being at work within the sphere of influence of orthodox science.

4.8. Radio-activity

Another phenomenon studied in atomic physics is that of radio-activity. Some of the heaviest metals, including uranium and radium, suffer spontaneous disintegration; particles and radiation are emitted and the substance itself finally changes into lead. These metals are heavier than the metal connected with the oldest of the planets, namely lead, and their disintegration has been described as a phenomenon of old-age in the realm of substance. The uniting influence of ether is insufficient to withstand the disintegrating influence of gravity. In any substance, both ether and gravity are active, and when matter disintegrates both ether and gravity are released. It can be shown by the effects produced that all four ethers, warmth, light, chemical and life ethers, are present in the products of radio-active decay. The fact that Nature's lower border is also involved is confirmed by the appearance of both positively and negatively charged particles. Radiation similar to X rays, capable of penetrating matter, is also observed, which evidently combines both etheric and gravitational properties.

Historically, the discovery of radio-activity was taken as confirmation of the atomic structure of matter. As in the case of lightning, the phenomenon can be understood in a wider, and deeper context when it is recognized that Nature has an upper and a lower border, and that it is possible to distinguish the aspects of any phenomenon relative to each border.

4.9. The electric shock

It has been said that man can have no *direct* experience of the electrical phenomena of Nature but, perhaps, the closest we can get is the experience of the electric shock. Steiner said: 'If you have ever allowed an electric current to pass through your nervous system, so as to experience it consciously with a genuine power of vision, you will realise that electricity in Nature is not merely a current, but that electricity in Nature is at the same time a moral element. Those who can experience the whole extent of electricity, experience at the same time the moral element in Nature.' He went on to qualify this by saying: 'In the same way in which the moral element one day acquires real shape in Nature, so the electric element once contained a moral reality. If we contemplate electricity to-day, we contemplate the images of a past moral reality that have turned into something evil.' He also referred to the way electricity affects man's nerves, 'expelling from them everything that tends towards the spiritual'. In electrical phenomena, we observe the results when electricity disappears. The electric shock is, perhaps, rather different in that we experience electricity 'disappearing' in ourselves. It feels as though it is entering straight into the nervous system, with a strong sense of compulsion.

4.10. Electric and magnetic fields

The two ring magnets, demonstrated here, show how space may, at times, behave almost as though it were solid matter, keeping the magnets apart, owing to the repulsive force between them. Of course, if the polarity of one of the magnets were reversed, they would rush together as though there were a vacuum between them. Evidently those opposite conditions are dual aspects of the magnetic field, indicating the presence of both gravitational and etheric influences. Similar observations could be made using electric charges instead of magnets. Electric and magnetic fields have these special properties, but very often, we are able to picture their structure in much the same way as we think about the spacial structure of solid matter. In a similar way we sometimes find it easy to think of electricity as though it were a ponderable substance; we speak of the *flow* of an electric current or the *quantity* of an electric charge.

The idea of electricity as being non-material yet exhibiting properties similar to matter agrees well with the concept of electricity as ether that has been drawn downwards through the realm of matter, in the course of evolution, and now appears as a force realm active at Nature's lower border. It is not surprising that we observe similarities between the laws of electricity and the laws of matter, and that electricity behaves at times as though it were a physical substance.

4.11. Electrical concepts

The anthroposophical standpoint can be applied to the examination of the nature of the concepts used in electrical science as has been done by Dr. G. Unger. From this standpoint, it is important to know whether a particular concept is abstract, purely operational or springing from experience. Concepts which have a direct relation to experience are, of course, likely to

have a wider significance and validity than those which are primarily utilitarian. Voltage or potential is, perhaps the most direct of the electrical concepts: this gives a measure of the intensity of the electric force and its ability to produce a spark or a shock. The nature of the current is, however, less clear. It was at one time thought to consist in the flow of something similar to a fluid, and to-day is usually described as the movement or 'flow' of electrons from atom to atom along a conductor or other substance. This, however, lies more in the realm of hypothesis than reality. The term current may be applied to the flow of electricity in a metal, in an electro-magnet, a lamp, a liquid, a gas, a semi-conductor or a living organism. If we examine the physical processes taking place in each of these phenomena, we find that they are all different. In some chemical action is observed, in others particles appear, in others light, heat or mechanical movement are observed. There is nothing common to all of them which would allow us to define an electric current as a particular physical process. It must, therefore, be an abstraction, although, within limits, it is a useful abstraction. It is important to clarify the nature of the current in this way, since the next step must, obviously, be to examine the different phenomena covered by the term current, see how they compare physically and how each can be understood *in its own way*, in accordance with our wider concept of electricity.

Other basic electrical concepts such as field and charge may be similarly examined, and their degree of abstractness or accessibility to direct observation assessed.

5. The role of mathematics in the anthroposophical approach

Mathematics must play an important part in the anthroposophical approach to electricity. General anthroposophical considerations will apply, in which mathematics is seen as a fundamental part of the wisdom out of which the world and man have evolved. The most important parts and aspects of mathematics are those which man can relate to his own experience. The qualitative descriptions which I have given can, no doubt, be elaborated with the aid of mathematics. One possibility would be the application of the geometrical concept of polarity, as developed by George Adams, to the study of the different forms and patterns observed, under certain conditions, at the two ends of the electrical polarity. A mathematical element is also involved when studying the relation between the electrical properties of metals and the planets. It may also be possible to devise methods of measuring or assessing the quality of light, so that a distinction can be made between light of natural and sub-natural origin.

The general form of the mathematics appropriate to the study of any particular realm is of interest in providing some indication of the nature of that realm. In, for example, plant morphology, there seems to be a close relationship between the imaginative qualities of projective geometry and the living forces at work in the plant kingdom. In the study of electricity, mathematics is used in a more logical and predictable way and it is a powerful aid to investigation: any imaginative element has, however, little relation at present to experience. The nature of the experimental discoveries seems to have determined the way the mathematical formalism has developed. As the phenomena have become more specialised and remote from normal experience, so has the mathematics tended to take on a new and more independent form. The essence of modern science lies more in the mathematical forms than in any physical correlations. This is accentuated as we enter the field of atomic energy, but paradoxically the forces released by this way of thinking are more powerful than ever before, indicating, of course, the need for a more comprehensive understanding of the processes involved and of their relation to man.

6. Natural science and spiritual science

I mentioned earlier the possibility of enlarging the scope of orthodox science, under the influence of spiritual science. Two possible conditions may be considered. First, the application of the full anthroposophical approach within the field of orthodox science. For the purpose of illustration, we could perhaps consider the hypothetical situation in which all those working in the field of science and technology were suddenly to become anthroposophists with a desire for a wider understanding of electricity. Some change in emphasis would be immediately noticeable. Existing theories would not be regarded in any dogmatic way; the role of electricity in the world would be seen in a new light; the inadequacy of the present concept of electricity would be apparent. Those concerned with education would, no doubt, show greater flexibility regarding existing methods, and would endeavour to introduce wider relationships into the teaching of the subject. However, it would be equally apparent that life must go on. The world is dependent in a million ways on the methods, techniques and store of practical knowledge that has accumulated in this field. Everywhere, on land and sea, in the air, under the sea, under the earth, in the home, in hospitals, the existing knowledge is playing a vital role. Emergencies are arising every minute. In the steady progress of design and research, new outlooks could be cultivated, but the existing knowledge and methods could not be replaced overnight. So the familiar methods would have to remain, at least for the present. Ohm's Law, Lenz's Law, Maxwells equations, network theorems, line transmission equations – all these would still be necessary. The outlook of these anthroposophical workers would, of necessity, be a composite one: they would certainly find opportunities of pursuing a purely anthroposophical

approach to electricity, but for most of the time they would be working with coventional methods. Out of this situation, it would probably not be long before a transformation began to take place. On the one hand, some progress in the purely anthroposophical understanding of electricity would be made. At the same time, the whole conventional field would tend to take on a new complexion. The philosophical basis of the scientific method would, no doubt, be examined in a constructive way, and the status of theories of the structure of matter revised, allowing the possibility of other and wider approaches to the study of matter. From this might follow a new appreciation of the role of polarity in Nature. The limitations of mathematics in the interpretation of electrical phenomena would be noted, as well as the tendency of mathematics, in its present form, to support what we would describe as the Ahrimanic element in this sphere. There would be increased awareness of the important role of electtricity in world evolution.

All this refers to possible developments in a hypothetical situation, but if we follow Rudolf Steiner's advice to grow in union with the world, there is, I think, something to be learned from this mental exercise.

The second situation I would like to consider is the more realistic one in which the influence of anthroposophy in the sphere of electrical science and technology is not very extensive. In this sphere, as in other aspects of modern life, a wind of change is blowing. Established ideas are being questioned. The younger generation are particularly concerned that human and social values should be included. The limitations of science, and consequently of its authority, are being discussed. These conditions seem to me to provide an opportunity for anthroposophy to grow in union with the world. In fact, in some respects, the way has already been opened up for us. Dr. Schumacher has shown very persuasively how the traditional wisdom of mankind is relevent to the world of modern economics and technology, the Club of Rome has focussed world-wide attention on the dangers of continued uncontrolled industrial development, an eminent authority on the philosophy of science, Professor Dingle, has challenged some fundamental aspects of modern physics, in his book 'Science at the Crossroads'. A well-known anthroposophist, Dr. Lievegoed has described the forms of anthroposophy suited to the late 20th century. He refers to the pursuit of anthroposophy in the world in the form of 'sensible social concepts'. In a comparable way, it should be possible to develop 'sensible economic concepts' and 'sensible scientific concepts', to allow some aspects or principles of anthroposophy to be applied in conditions as we find them. This would require the fundamentals of the full anthroposophical approach, to which I have already referred, to be assimilated and re-cast in a necessarily restricted form, adapted to particular circumstances.

7. Economic and social effect of electricity

I have now moved about three quarters of the way round the circumference of the circle in pursuit of a comprehensive understanding of electricity. It remains to say a little more regarding the economic, social and intellectual effects of electricity. The economic and social aspects are closely related. One remarkable feature is the pace at which change has occurred. The sixty years since the end of the first world war is a short period in the history of civilization, but the changes have been far greater than in any similar period. Just as, through technology, electricity has made man independent of nature, so it has rendered economic life largely independent of geographical and geological factors. Efficient transport, telecommunications and the use of power lines for the transmission of electricity over long distances have completely changed the criteria for the siting of industry. This has resulted in a redistribution of population, with accompanying social changes. The application of electrical technology on a world-wide scale has resulted in a great increase in the rate at which the earth's natural resources are being used up. In the power stations themselves, coal and oil are consumed in large quantities. This activity might be described as a process of disintegration, affecting the whole planet. Rudolf Steiner referred to the physical disintegration of the earth, with associated effects in man, as a significant factor in the present and future evolution of mankind, especially the evolution of consciousness, and he associated electricity with this phenomenon. There is also, perhaps, a connection with the fact that, in the human organism, life processes must be arrested and replaced by a process of partial decay, in the nervous system and brain, in order that consciousness may light up.

Social, political and educational changes have also flowed from the widespread use of radio, television, the telephone and all manner of domestic services and appliances based on electricity. In medicine, where the use of electricity is increasing for a wide range of purposes, the benefits obtained are accompanied by the possibility that the human judgement of the doctor may tend to take second place to information provided by a machine.

In all its applications, electricity seems to exhibit these two aspects, one beneficial and the other possibly harmful. In some spheres the undesirable effects are becoming serious. Continuing technological development is threatening the quality of life of large numbers of people, for environmental and other reasons. One of the greatest contemporary problems in the Western world is that of unemployment – created largely by the very efficiency of the electrically powered and automatically controlled factory which requires very few people to run it.

I have already mentioned the influence of electricity on human thinking, both in science and in the

wider community. In technology to-day, the trend is towards an increase in the thought content, as electromechanical practice is superseded by electronic. In the history of electricity, several important discoveries have been made by chance and in an unexpected quarter, and theoretical thinking has had to be adjusted accordingly. This whole realm assumes a more consistent character when viewed from the anthroposophical standpoint.

Electricity is encountered so widely that we would expect the two characteristics of the forces opposing normal evolution – materialism and fantasy – to be associated with it. The sketch in Fig. 18 is based on the well known sculptured group at the Goetheanum, Dornach. Materialism is inherent in modern commercialism based on technology. There has always been an element of fantasy, mystery and speculation about electricity: this is, perhaps, present to-day when children are shown coloured pictures of the structure of the atom in the form of a miniature solar system or in science fiction decriptions of the world of tomorrow, where space, time and thought are all supposed to come under electronic control. These considerations emphasise the need for continual effort to ensure that electricity plays a constructive, and not a distorting, role in human evolution.

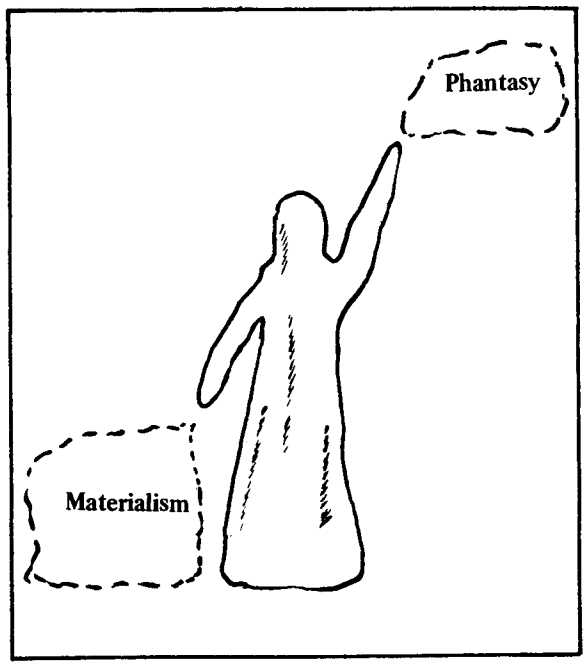

fig. 18

8. Conclusion

That completes the journey round the circle. All these aspects of electricity and the nature of the relationships between them need, of course, to be elaborated in much greater clarity and detail. One aspect I should mention is that of the ultimate redemption of the negative beings. In for example world-wide telecommunications, Lucifer and Ahriman are being drawn into the sphere of true human relations, matters of joy and sorrow, life and death. Perhaps the consciousness of this experience may contribute towards the eventual redemption of these beings. And still looking to the future, I will conclude with some words of Herr Schiller's which underline the importance of thinking about, and working with, electricity in the right way: 'It is of immense significance for the very far future whether *or not* man explains the whole of nature out of the electric forces. This realm of thought and deed provides the substance for Jupiter evolution.'

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The Unidentified Identified?

by Howard Smith

A Note on U.F.O.'s

The very term "U.F.O." embodies, understandably, two pre-conceptions which should be closely examined. Firstly, that the strange phenomenon is indeed "objective", that there really is "something out there". Secondly, this "something" *flies*, with all the mechanistic and biological overtones which that conjures up.

Since "sightings" began in any number (in the 1940's), several groups of theories have emerged. The main theories, as far as my limited reading on the subject has revealed, seem to be the following:

1. UFO's or "Flying Saucers" are space-craft manned by intelligent beings who are technologically (and possibly spiritually) far in advance of us.
2. UFO's are of an "etheric" nature, materialising and dematerialising at will; they can travel in another "dimension".
3. UFO's are *biological* in nature. They are "animals", often globular in shape, which live in the etheric world, sometimes "materialising" enough to be clearly seen.

There are various intermediate theories and shades of each of the above, limited only by the ingenuity and imagination of the writer. The first theory is often admixed with strong psychic elements (telepathy, psychokinesis etc.). The second theory, while often purporting to be "spiritual" in nature, is nonetheless usually little more than a refined mechanistic model, involving a "less dense" form of matter subject to laws which closely resemble the usual physical causality. This is evident in such concepts as a "higher vibratory rate of matter", which is akin to the early spiritualistic conceptions of life after death.

Trevor J. Constable (1) is a proponent of both the second and third theories, claiming that all UFO's are etheric, some being biological in nature and resembling giant unicellular organisms, others being constructed by intelligent etheric beings. I mention Constable here because in his book he claims that much of his research has been guided by the works of Rudolf Steiner, among others. It is indeed a strange book, swollen with the most astonishing vitriolic diatribes against what he calls "Official Science", and yet containing a very reasonable chapter on Steiner and Anthroposophy. In between death-dealing blows to "Orthodoxy", he rises above the first type of theory with its purely mechanistic contents, and links UFO's with more subtle forces – the same forces which underlie our own existence. But one can question whether his conception of the "ether" accords with what one may glean from Steiner; Constable regards it as *denser* than ordinary matter, rather than less tangible. He also claims that it can be photographed with infra-red film, thereby confusing it with infra-red radiation. He tries to escape "mechanistic thinking", but to some extent he imports it into the "etheric".

An entirely different approach to UFO's is taken by Georg Unger (2). His monograph, also based on an Anthroposophical understanding, contains a fourth type of theory: UFO's are really spiritual perceptions, which are "projected" by an uncomprehending mechanistic mind and thus appear as external "objects". (The theory is sufficiently refined to take account of mass sightings and other factors which might superficially appear to disprove it). Steiner evidently warned that "quite soon" (he died in 1925) people would begin to have new experiences – inner spiritual perceptions – which however were in danger of being misunderstood if man could not rise above materialistic habits of thought. He has mentioned the Spiritual World as "knocking on the door of the physical world".

During the Science Conference held at Kings Langley from January 1–4th, 1978, Joyce Beevor made reference to UFO's in the "Short Contributions" section. Her idea is essentially a contribution to Unger's basic theory. Miss Beevor included the following in her paper:

> "There seem to be two outstanding facts connected with UFO's. One is that the "Saucer" has a personal connection with the viewer, as if it carried a special message for him alone; and the other fact is that after the encounter, the "Saucer" retreats at phenomenal speed. Could this not be that the viewer has been slightly out of his body for a

short time, bearing in mind that time and space are not the same in the etheric world as they are in the material world. The viewer does not know that he has been in the etheric world; he does not realise there is anything but the physical world. So when he sees the "Saucer" tearing away from him at great speed, could it really be the opposite? It could be he himself returning to his own body."

This link with out-of-the-body experiences could explain a lot, provided it is remembered, as Miss Beevor states, that one can be *partly* out of the physical body without realising it. "Re-entry" may then be experienced as the opposite, as described. Rudolf Steiner draws attention to the apparently inverted characteristics of space-time relationships in the Astral world (3, 4).

In this brief sketch, we can see a sort of evolution of theories of the "UFO". But are these ideas mutually exclusive? From the Anthroposophical standpoint, does Steiner's Man-orientated Cosmology definitely exclude other similar physical evolutionary systems such as are traditionally thought to underlie UFO's in the first type of theory? Such ideas do indeed *seem* incompatible with Anthroposophy, and we would probably make more progress by working on the fourth type of theory. But Steiner was always so full of surprises himself, that I wonder if the last word has been said in this puzzling domain!

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Correspondence

I would like to wish you every success in your venture of launching Science Forum, which will certainly fill a long-felt need in Britain. Germany has the Mathematisch-Physikalisches Korrespondenz and America the 'parallel' Mathematical Physical Correspondence, and, excellent though they are, it will be very good to have an Anthroposophical science journal in this country. Although the American M.P.C., for instance, is intended for articles on all scientific subjects, it does seem to attract mathematical articles on the whole, and many of us are grateful for this! However, I hope that the Science journal will elicit a balance of articles on a wide range of subjects.

Has anyone any reference to work done in the field of homoeopathic potencies tested by modern analytical/instrumental techniques. For instance, I have tried to repeat a few (only a few) nuclear magnetic resonance tests as reported on homoeopathic potencies (where different potencies of one substance, in ethanol/water, showed changes in OH peak area*) and concluded, by using certain controls, that the results (mine) showed nothing significant apart from the usual instrumental error. Has anybody fresh, strictly controlled work to report in this area?

Also, how about new work/ideas in chemical phenomenology?

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* Editors' note: see, e.g., R. B. Smith & G. W. Boericke, Journal of the American Institute of Homoeopathy, Vol. 50, 1967, Nos. 9–10, p 259–272.

Next Science Conference

The next main Science Conference, organised by the Science Group, will be held during the Christmas/New Year holidays of 1980/81, at Wynstones School, Whaddon, Gloucester. Participation is normally limited to those with a professional background in science (including students), and a sympathetic interest in Anthroposophy. Further details will be published nearer the time. Those not already on the mailing list, and interested in attending, are advised to write to: Dr. H.J. Smith, 17 Armoury Road, West Bergholt, Colchester CO6 3JN. (Tel: 0206 74936).

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