

contractibility of an ordinary muscle (Sartorius) without producing any perceptible bathmotropic or dromotropic effect. The author, who has experimentally studied especially bathmotropic influence, exercised both upon ordinary striated muscles, which are under the control of the will, and upon ventricles and auricles, and has already published some of the facts discovered by him, adds in this paper some new data. Thus he points out that when the commencement of a portion of the sartorius of a frog was inoculated with curare, after this portion had been dilated in water and deprived of its contractibility, without having lost either its excitability or conductivity, the threshold of excitation (Reizschwelle) was often not sensibly diminished.

Experiments made with reference to the heart showed similar results. In many such cases the velocity of transmission of the motive power in a portion of the sartorius or in the heart, which had been deprived of contractibility, was not diminished and occasionally was even increased, thus producing a positive dromotropic effect side by side with a negative inotropic effect. Nuel discovered that the action of the vagus not only diminishes the frequency of the cardiac contractions, but also the intensity of the systoles. Schiff and Eckhard, and, more recently, McWilliam and W. Mills, have demonstrated that excitation of the pneumogastric causes the ventricles and auricles to lose their direct excitability by means of electricity. The author's experiments have confirmed this fact in so far as they have shown that the heart, or at least its auricle, can be made to remain for a very short time passive to electrical or mechanical excitation by a strong excitation of the pneumogastric, but he maintains that the excitability of the auricle very soon returns to its normal condition—in fact, long before the diminution or total stoppage of its contractibility has ceased. The new facts discovered by the author confirm, in his opinion, his theory that the physiological process of irritation indicated by the so-called "action-currents," is linked to other constituents of the muscle than the mechanical process of contraction; otherwise

a steel spindle rotating in a sleeve forming an accurate guide for "pitch" drilling, the variable self-acting feed motion being arranged so that it may be applied to or suspended from the spindles either collectively or independently. Each drilling headstock is fitted with an overhanging bracket for supporting the outer end of the drills, which steadies the drill when cutting, and prevents breakage of drills. The apparatus for supporting the work consists of two roller stays, each having three rollers, the stays being mounted on short transverse slide beds, which are adjustable along a base plate by rack and pinion, so as to suit the various lengths of drums. The drum is rotated and divided by a headstock with a balanced duplex arm fitted with worm and wheel, and with a dividing plate for circumferential seam drilling. The machine above described has been supplied to a leading firm of boiler-makers, who have taken up the manufacture of a patent water-tube boiler.—Engineering.

A SIMPLE EMULSION FOR MATT OR PRINTING OUT PAPER.

By A. J. JARMAN.

SINCE the introduction of platinotype the popularity of matt surface photographic printing papers has been largely augmented. The public taste for prints made upon matt surface paper has taken many years to educate. Not many years ago the majority of the photographer's patrons would accept nothing but highly glazed prints, while to-day the demand is almost entirely for matt surface portraits. Strange as it may appear, no one ever asked for or expected to see a steel engraving upon a glossy surface, no matter what that engraving represented. The matt surface engraving was always admired for its beautiful and artistic rendering of anything and everything that it represented, and yet the demand held sway for a glossy surface for any print made by photography.

Whenever a matt surface was required for a portrait the usual plan was to sensitize a sheet of albumen-

sion, which must be prepared and mixed in the order given. Failure will be impossible if these details are scrupulously attended to.

Having procured two half-gallon stoneware crocks with lids, clean them out well with hot and cold water, and place into one of these the following:

Distilled Water..... 10 ounces
Gelatine (Heinrich's, hard)..... 4 ounces

Cut the gelatine into shreds with a clean pair of scissors. Press these shreds beneath the water with a clean strip of glass and allow to soak for one hour. Now proceed to melt the water-soaked gelatine by placing the crock into hot water in the enameled saucepan, the water standing about half-way up on the outside of the crock. Bring the water to boiling-point, and keep the gelatine occasionally stirred until it is completely dissolved. Then remove the crock to allow the contents to cool down to 120 deg. F. Now prepare the following which can be done while the gelatine is melting.

No. 1.

Rochelle Salts..... 90 grains
Distilled Water..... 1 ounce

No. 2.

Chloride of Ammonium..... 45 grains
Distilled Water..... 1 ounce

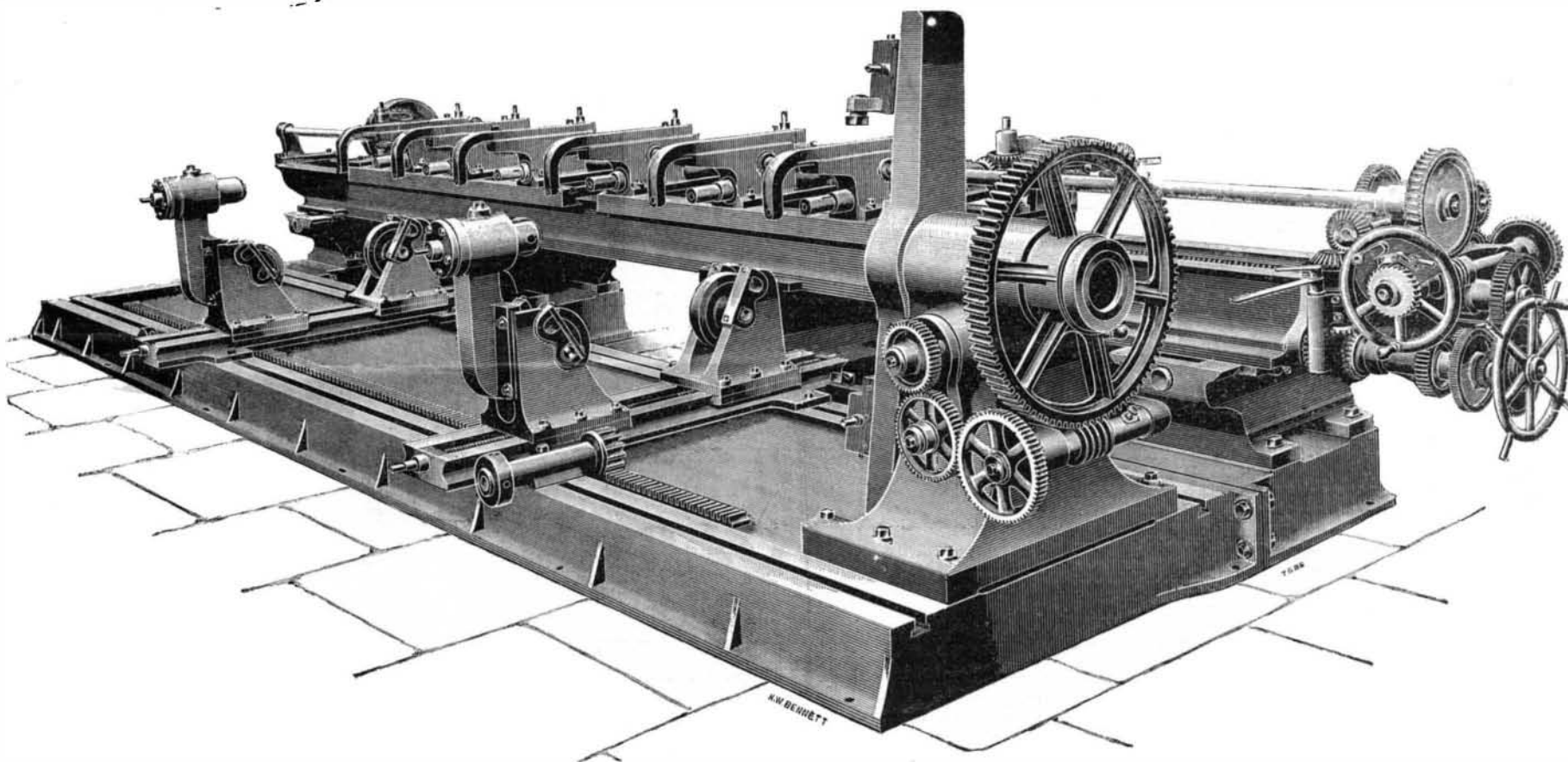
No. 3.

Nitrate of Silver..... 1 ounce and 75 grains
Citric Acid (crushed crystals)..... 95 grains
Distilled Water..... 10 ounces

No. 4.

Powdered White Alum..... 90 grains
Distilled Water (hot)..... 5 ounces

The latter solution may be made with boiling water. When these solutions are prepared, pour into the not gelatine solution No. 1, stirring all the while with a clean glass rod. Then add No. 2. Rinse the vessel with a little distilled water, and add to the gelatine. Now, while stirring gradually add No. 3, and lastly add No.



SIX-SPINDLE MULTIPLE DRILLING MACHINE.

their independence of each other would be incomprehensible. The question therefore arises whether the microscope may reveal to us the difference of these hypothetical constituents, or whether their difference lies beyond our limits of visual perception. The author has elsewhere (Archives Néerlandaises, (1) 27, 65, 1893), stated his reasons for assuming that the physiological effect indicated by the appearance of electric currents is linked to the birefringent portions of muscle fiber, while the mechanical effect of contractibility is linked to the monorefringent portions, and thinks that the result of his recent experiments strengthens his theory. G. G.

SIX-SPINDLE MULTIPLE DRILLING MACHINE.

WE illustrate a six-spindle multiple drilling machine, recently constructed by Messrs. Hulse & Co., Limited, of the Ordsal Works, Manchester, for drilling the steam-drums of a patent water-tube boiler which has just been placed on the market. The machine is capable of drilling the holes for the circumferential seams and butt-strips of steam-drums from 2 feet to 5 feet in diameter and 12 feet to 25 feet long. As will be seen, the drill spindles are horizontal, and the drum to be drilled is also chucked in the horizontal position. The main longitudinal bed on which the drill carriages slide is mounted upon short transverse beds, being adjustable on these to suit the varying diameters to be dealt with. Upon the longitudinal bed are mounted two horizontal slides, which are each independently adjustable by screw gear, and are provided with a dividing mechanism for drilling butt strips, which mechanism can be worked independently either by hand or power. Upon each slide are grouped three drilling headstocks, but all six may be placed upon one or the other slide, or otherwise grouped at will. The six drilling headstocks are each independently adjustable on the horizontal slides to varying distances apart by means of racks and pinions, and are each fitted with

ized paper upon the silver solution by floating it upon the back of the sheet instead of the glossy face. This plan answered well; the only drawback was that the grain of the paper was of a coarser character upon the back, so that for small portraits this grain was a little too pronounced.

Many photographers who had facilities would prepare a specially salted paper for portraits that were to be colored, and in this way overcome the objection of sensitizing albumen paper upon the back. Nearly every photographer had his pet formula, and guarded it with such care that he would trust no one to prepare the paper with its salting solution except himself. It is a well-known fact to-day that one of the very best surfaces to work upon for coloring in water-color is the carbon print. Apart from its absolute permanency as a base, the surface possesses the right tooth for the adhering of the pigment. It is just such a surface as this that is required upon other prints than carbon, both for finished matt surfaces and for the purposes of coloring. The way to obtain this surface upon almost any kind of paper, and to print it out so that the correct depth is ascertained on sight, will be here described, and anyone desirous of preparing special paper for his own use will be enabled to do so. Some of the crayon drawing-papers can be utilized, as well as many other plain photographic papers that may meet the desires of the photographer. If a glossy paper is desired, the emulsion should be coated on a baryta-coated stock.

There will be required, in the first place, two half-gallon stoneware crocks with lids. The best shape to employ is a crock with the sides running straight, with no depressed ridge at the top. One of these crocks is for the preparation of the emulsion, the other to receive the emulsion when filtered. An enameled iron saucepan of about two gallons capacity will be required, in which to stand the crock for preparing the emulsion, and also to remelt the emulsion after it has become set. The following is the formula for the emul-

4, which may be very hot. This will cause a decided change in the color of the emulsion. Lastly add two ounces of pure alcohol (photographic). This must be added very gradually with vigorous stirring, because if added too quickly it will coagulate the gelatine and form insoluble lumps. The emulsion must, of course, be mixed under a light not stronger than an ordinary small gas-jet, or under a yellow light obtained by covering the windows with yellow paper. The cover may now be placed upon the crock, and the emulsion put aside for two or three days to ripen.

At the end of this time the contents of the crock, now formed into a stiff emulsion, may be remelted in hot water by placing the crock in the enameled saucepan over a gas stove. The emulsion may be broken up by cutting it with a clean bone or hard-rubber paper cutter to facilitate the melting. Stir the mixture occasionally until thoroughly dissolved, and add the following as soon as the emulsion has reached a temperature of about 150 deg. F.:

Distilled water 4 ounces
Pure alcohol 1 ounce

The emulsion must now be filtered into the second crock. The filtering is best accomplished in the following manner: Take an ordinary plain-top kerosene lamp chimney, tie over the small end two thicknesses of washed cheese-cloth. Invert the chimney, and insert a tuft of absorbent cotton about the size of an ordinary egg. Press it carefully down upon the cheese-cloth. Fix the chimney in the ring of a retort stand (or cut a hole about three inches in diameter in a wooden shelf), so that the crock may stand conveniently beneath. In the chimney place a strip of glass, resting upon the cotton, to prevent the cotton from lifting. Now pour in the hot emulsion and allow the whole of it to filter through the absorbent cotton. This accomplished, we are now ready for coating the paper, which is best done in the following manner:

Cut the paper into strips or sheets, say, twelve

inches wide and the full length of the sheet. This will be, let us suppose, 12 x 26 inches. Attach, by means of the well-known photographic clips, a strip of wood at each end of the paper upon the back. Three clips at each end will be required. Having a number of sheets thus prepared, the emulsion should be poured into a porcelain pan or tray, kept hot by standing within another tray containing hot water. The emulsion tray being, say, 11 x 14 size, the paper now is easily coated by holding the clipped ends in each hand, then holding the left end of the paper up, and the right-hand end lowered, so that the curve of the paper just touches the emulsion. Then raise the right hand, at the same time lowering the left, hand at the same rate. Then lower the right hand, lifting the left. Repeat this operation once more; then drain the excess of emulsion at one corner of the tray, say, the left-hand corner. Just as soon as the emulsion has drained, the coated sheet of paper may be hung up to dry, by the hooks attached to the clips, upon a piece of copper wire stretched from side to side of a spare closet or room that can be kept darkened until the paper is dry. In this way coat as much paper as may be required. When it is dry it may be rolled up tight or kept flat under pressure until needed.

If any emulsion remains, it may be kept in a cool place for two weeks, and still be good for coating. Be sure to clean out all the vessels used before the emulsion sets, otherwise this will present a difficult task, since the emulsion sets into an almost insoluble condition.

This emulsion is so made that it does not require to be washed. If it is washed it will become spoiled. It is easy to make and easy to use. If it is desired that only small sheets of paper are to be coated, they may be floated on the emulsion, but in this case the paper must be damp, which is easily accomplished by wetting a sheet of blotting-paper, then covering this with two dry sheets of blotting-paper. Place the sheets to be coated upon these, and place under pressure during the night. Next day they will be in good condition for floating.

When the coated paper is dry, it may be printed and toned just the same as any other printing-out paper, with any toning bath, and fixed in hyposulphite of soda as usual. Toning may be carried to a rich blue-black, or if not carried too far will remain a beautiful sepia color. After well washing and drying it will be observed that the surface corresponds with that of a carbon print; if the paper has been of a somewhat absorbent character, the surface will be entirely matt, and will give an excellent tooth for coloring or finishing in sepia, black and white, etc.—Wilson's Photographic Magazine.

SUGGESTIVE OUTLINES OF A DYNAMIC EXPLANATION OF CHEMICAL PHENOMENA.

By FRANK A. HEALY.

AN inspection of the chemical elements arranged in the order of their atomic weights shows such remarkable periodicity and inter-relation of the members that one is naturally led to speculate upon the question of their origin as being evolved in some manner from the lowest term or its antecedent.

In this arrangement of the elements each succeeding member shows a certain change of character and properties, becoming successively more and more acidic until a point is reached where an abrupt change takes place and a strongly basic element follows. If lines of division are made between the strongly acid haloid and the strongly basic univalent alkali metal, a number of series is formed, in each of which the elements pass from a basic metallic state to a non-metallic acid state. On observing the number of elements in each it is seen that the series occur in pairs. The lithium-fluorine series contains seven members, so likewise does the following sodium-chlorine series. The next two have seventeen each. After them comes one beginning with caesium which, while incomplete, shows strong evidence of having a greater number than those it follows. Of the next series, however, but two are known with certainty, thorium and uranium, having the highest known atomic weights.

The first two series of seven are not complete with that number, but appear to have an inert gaseous non-valent element as the first (and last) member. The atomic weight of helium is given as 4 coming before lithium, or neon 20, being after fluorine and before sodium. That of argon is 39.9, considerably higher than its place in the periodic table would require. The discrepancy has been explained as being due to slight admixture of similar elements of higher atomic weight, such as krypton, to which is assigned the atomic weight 82, coming between bromine and rubidium, and forming the connecting link between the potassium-bromine and the rubidium-iodine series; xenon is also found in the atmospheric gases and the atomic weight (128) given it, places it between iodine and caesium.

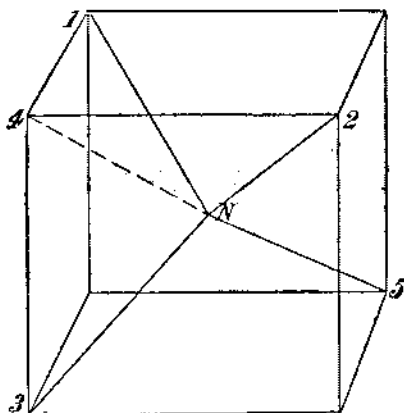
The series beginning with sodium is often taken as being the most typical of the series. If we include argon in it, there are eight members. As the valency rises regularly by one unit to each succeeding element, and chlorine, the seventh member, has a valency of seven, we might conjecture that, could the valency of the eighth term, argon, be made manifest in chemical combination, it would be octavalent. The chemically inert gases manifest no valency and as they come between elements which exhibit univalence, they are in harmony with the regularity of the system. In the three long series, the first few members and the last ones adhere most closely to the regularity of the typical series; the intervening members show peculiar variations.

The whole periodic system is strongly suggestive of evolution by some kind of additions from the lowest term or its antecedent whereby the eighth addition brings the atom to a condition similar to the first. Evidence has been produced by different investigators, notably Sir Norman Lockyer, giving indications of evolution of the chemical atom. After many fruitless efforts to obtain more light on the problem which chemical phenomena present, a simple conception or assumption was finally discovered which, when developed

logically, afforded results that show a remarkable parallelism with a great deal of the phenomena of chemistry, physics and biology. While the system thus developed from a simple but arbitrary assumption may come far from being in perfect accordance with the actual reality, yet, by its extensive analogy to actual observed facts we may be brought a step nearer the solution of the problems of matter by its suggestive value.

Imagine a portion of space devoid of ordinary matter. Into this space elastic ring-shaped formations are produced or brought, moving about with great velocity. Suppose, also, that an electric current flows in the ring substance without resistance or that the current is constantly maintained. This is the assumption simply, an elastic current-bearing ring, and from it can be evolved a system having great similarity to the material system with which we are acquainted.

It can be shown that these rings tend to collect into groups of eight, this being the most stable combination possible. The rings, by reason of their magnetic fields, tend to attract one another if free to turn about, so that the magnetic lines flow in harmony, otherwise there would be repulsion. On colliding the rings vibrate, being elastic, and this vibration tends to hurl them apart again. The vibrating ring would have three, four or more non-vibrating nodes about the circle with vibrating internodes between. Contact of two rings, if made at nodes, would have no repulsive effect, but if at internodes, that is, on the vibrating segment, both are thrown apart by the energy of vibration. Thus there are two repulsive effects, caused by a magnetic and a vibratory action; and two actions that bring the rings in contact, simple motion in space, and magnetic attraction. Because of these properties of the rings, it can be seen that certain groupings are impossible or very unstable. It is assumed that the rings are uniform in dimensions. Two rings would not form a stable group, for while the magnetic attraction brings them together, vibrations of the segments would repel. Three rings would likewise be unstable as a group. Four rings, if their planes form a four-sided prism, would not remain thus, but would immediately move into an even more unstable position; if arranged with their planes forming a tetrahedron, would be broken apart by magnetic repulsion. In considering the rings as circles inscribed on the planes of the regular polyhedrons, it can be seen that the cubic system is unstable magnetically and the same is true of all the other regular polyhedrons with the exception of the octahedral system which conforms perfectly with the conditions of stability. Some other groupings are stable, but not being as simple and compact, under condi-



VAN'T HOFF'S CONCEPTION OF THE NITROGEN ATOM.

tions of violent motion and great pressure would not survive the octahedral system.

The primary postulate—an elastic current-bearing ring—is capable of evolving, with the condition of motion, into a grouping of rings arranged on the planes of an octahedron. The properties of this octahedral system and the relations of one to another are very different from those of the simple ring and become more so as further additions of rings are made to it.

Additions to the eight-ring form might be made if one of its rings becomes pushed in slightly so that an extra ring in colliding lies over it with the three adjacent rings at their contacts separating the two. This nine-ring combination would still be arranged on the plan of the octahedron. The rings may be considered very thin, so that not until at least ten or more layers of rings had been added over the original eight, would the system become unstable, being unable to retain the added rings. The association in nature of utterly inert helium, corresponding to the original eight-ring form, with uranium of the highest known atomic weight is significant.

Each form in the system, whether composed of eight or eighty rings, would be vibrating principally in the outer layer of rings from the energy received in colliding, the inner rings of the heavier forms would be but slightly affected by vibrations, so that the energy received or given out through contact of other vibrating forms would be practically equal for light or heavy forms, provided but little of the total energy is used for free rotary or translatory motion, as in a solid. This condition parallels that of the elements expressed in the law of specific heat.

The addition of the ninth ring makes a great difference in the relations of the individuals. As long as any form of the system is free in space and colliding at intervals, it is revolving more or less rapidly; the sum of the attractive and repulsive magnetic fields in the vicinity of the eight-ring form is nil, as all of the fields are of equal magnetic value, alternately positive and negative. Near the nine-ring form there is a preponderance of either positive or negative lines, according to the location of the ninth ring, in a positive or negative position. There would be approximately an equal number of the two kinds of structures of nine rings, as there would be the same chance for either to be formed. The existence of two forms of the same element, one positive and the other negative, as an explanation of certain facts has been proposed lately by several, and although this view is rather a radical

departure from that usually held, it is not without evidence.

If a free ring collides violently with the nine-ring form it would, in all probability, be hurled back; if more gently, it would be attracted by the preponderating polarity to those faces of the structure that are of the same sign. Thus the tenth, eleventh and twelfth rings added are of the same polarity, either positive or negative, as that of the ninth. The thirteenth, fourteenth, fifteenth and sixteenth additions must necessarily be opposite in polarity to the preceding. With the sixteenth addition the sum of all the magnetic lines near the rotating structure is nil, as in the eighth.

As rings are added and the structure has acquired several layers, the inner portions are at comparative rest. The energy of translation of the free ring has become vibratory energy in the segments, and this energy is dissipated into space, and on being covered by rings more recently added, becomes quiet. In space which at first was uniformly filled with free rings, condensation would begin to take place with increasing amount of radiation from the evolving particles. A limit to the increase of temperature produced by condensation would be reached when the supply of free rings in surrounding space was exhausted and cooling would then result. But the effect of gravitation upon the gaseous mass would be to maintain the temperature or even to increase as the particles draw closer to the center of gravitation. When this is at a maximum there would be dissociation (atomic disintegration) within the mass and free rings would be liberated to rise by reason of their lightness to the exterior. In this cooler region they would condense with one another and with any forms of the system they encounter. This would cause the condensing layers to radiate intensely, as the translatory energy becomes vibratory in the segments of the condensed structures. This suggests an important factor, hitherto unrecognized, of volcanic activity.

A comparison of the ring system in the various stages of its evolution with the elements of the periodic classification shows a remarkable degree of parallelism. Leaving hydrogen out of consideration for the present, helium is seen to have a certain correspondence with the primary eight-ring structure.

Inert, monatomic, gaseous helium stands in strong contrast with the other seven members of the series, while the eight-ring form occupies a similar unique position in its series, by all of its attractive forces being completely nullified by rotation.

As the sequence of valency of the members of the first and second or typical series is the especial characteristic wherein the regularity of the periodic classification is best shown, it is interesting to note the comparison with the ring system in respect to the fields of attractive force in their vicinity in the various members of the series. (The symbols α and β in the table represent opposite polarities, either positive or negative.)

Rings.	Rings Over Balanced Forms.	Stronger Magnetic Fields Resulting.		Fields Not Balanced (Active Affinities.)	Corresponding Elements.
		α	β		
8	0	0	0	0	Helium
9	1	1	0	1	Lithium
10	2	2	0	2	Beryllium
11	3	3	0	3	Boron
12	4	4	0	4	Carbon
13	5	4	1	3	Nitrogen
14	6	4	2	2	Oxygen
15	7	4	3	1	Chlorine
16	0 or 8	4	4	0	Neon
17	1	1	0	1	Sodium
18	2	2	0	2	Magnesium
19	3	3	0	3	Aluminium
20	4	4	0	4	Silicon
21	5	4	1	3	Phosphorus
22	6	4	2	2	Sulphur
23	7	4	3	1	Chlorine
24	0 or 8	4	4	0	Argon

The element carbon has been the subject of far deeper investigation than any other element and a great deal is known concerning it. Many of the properties of the carbon atom have been ascertained or deduced with a reasonable assurance of correctness. For example, the theory, of which the development is largely due to Van't Hoff, postulating that the four valencies of the carbon atom are directed toward the corners of a tetrahedron from its center, is generally accepted by scientists, and many facts are explained satisfactorily upon this assumption, such as the phenomena of rotation of the plane of polarized light in compounds where an asymmetrically placed carbon atom exists; also the stability of certain groupings of carbon atoms and various other phenomena.

The form of the ring system which corresponds to carbon is the one of twelve rings. It has the four added rings all of the same polarity, and examination of an octahedron shows the centers of these rings are in the direction of the apices of a tetrahedron as viewed from the center of the system.

Van't Hoff has enlarged his original conception of the relation of the valencies of the carbon atom in space to apply to the nitrogen atom. Pentavalent nitrogen, united to four different alkyl radicals and a halogen atom, is observed, in some cases, to rotate the plane of polarized light. According to his view four of the valencies are directed from the center toward the corners, not adjacent, of a cube (as was the case with carbon, this makes angles of 109 deg. 28 min.), the fifth toward one of the remaining corners. The figure and reference is taken from his work, "Atoms in Space." "Of these 1, 2, and 3, which have equivalent positions, correspond to the alkyls attached to the three chief valencies. When nitrogen is trivalent they lie in one plane with it, here they are somewhat displaced through the influence of the chlorine situated in 4, in 5 lies the fourth alkyl." The directions of these five valencies from the center of the cube are identical with those in the thirteen-ring form corresponding to nitrogen. If straight lines are drawn from the center of each ring to the centers of the adjacent rings, a cube is formed; four of the added rings of the same sign are at non-adjacent corners, the fifth is at one of the others being of opposite polarity.