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THE SENSES.

PART FOUR OF THE ANIMAL KINGDOM, BY EMANUEL SWEDENBORG.

CHAPTER V.

THE EAR AND THE SENSE OF HEARING.

97. 1. *What pertains to hearing cannot be explored, unless we consider what sound is. The ear is only an organic or instrumental cause, while sound is the principle cause; nor can what sound is be examined, unless first what modification is be inquired into; for sound is a modification of the air which becomes sensation in the ear, whence is hearing; but what sonorous modification is cannot be investigated, unless we learn what air is; for thence or from its modulation sound springs forth; nor is it known what air is, unless its particle be known; for the particle of air is its smallest volume, or air in its smallest unity and simplicity; nor is it known what the particle of air is, unless the quality of the prior atmosphere be known from which it arises, or from which it derives its form and power, or from which it derives its existence and nature, wherefore its essence.* From these considerations it is apparent, 1, of how vast a science and knowledge is this unique sense. 2. That it cannot be fully exhausted, unless all things which are in the atmospheric world concur. 3. Knowledge, except from principles, is only common [proletaria] science, and as it were palliative,—only a science of the senses, not from causes, but the science of an animal, which enjoys no reason. 4. In order that we may explore causes it will be necessary for

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us to ascend even to the infinite, and descend thence to effects, when first we shall be able to proceed to causes by the analytical way. 5. Thus we, rational men, are able to act as angels, among whom we can be when we shall have explored truths, and are in them; this is the way to heaven,—to the primeval state, perfection. 6. But a superior power will meet us, which must be consulted; this power leads us into truths,—the senses lead us only into fallacies. 7. Therefore for rightly knowing one thing all things are required; the whole must be known in order to know a part of the whole; for in every part lies hidden an idea of the whole. 8. Nor is it given to know what is in any part of sensation, of modification, etc., unless we arrive by doctrines, especially those of forms, of order and of degree, of influxes, and of correspondences.

98. 2. *We must begin here with the particles of the air, for thence will be evident what its volume is;* for, 1, the particle is the smallest volume of its own atmosphere. 2. As the particle acts, so the congregation of particles act. 3. An atmosphere derives its all from its parts,—its very nature, the form of its fluxion, etc. 4. Hence how necessary the corpuscular doctrine is, becomes evident. 5. We arrive at this doctrine from a knowledge of volume, for the phenomena of the whole are similar to those of the parts. 6. Besides we learn that another sphere of acting begins in the particle, for a particle is a small volume; it derives its nature from its own particles which compose it; that is, from its prior things; the prior sphere is therein, the superior, and more perfect. 7. All unity respects its own unities, and these again theirs, thus even to the beginnings of all things. 8. Wherefore to terminate the idea in a single part, and to declare this the most simple, is to make so many wholes, and steadfastly to terminate the ideas in an occult quality; to do this is by no means rational, since it is not consonant with nature. 9. The above things now must be excluded, for we are not admitted to causes by the phenomena of the air alone.

99. 3. *From the phenomena of modification the quality of the part or particle of that atmosphere appears,* 1, for the parts are what are modified. 2. Thence the whole volume is modified. 3. The volume derives from the parts, that it acts thus

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and so. 4. Or it derives this from the nature of the parts, and the nature of the form, according as they act. 5. Nature acts according to its form; for substantial form corresponds exactly to the form of fluxion.

100. 4. *From many phenomena discovered in the air, it appears that its particle is of a perfectly sperical form, in such a way, however, that the endeavor of its prior parts is towards a spiral form.* 1. That it is spherical is evident from its fluxion. 2. From its equal pressure at every point, above, below and at the sides, it appears that it can be in no other form. 3. This is evident from its most easy yielding. 4. Especially is this apparent from its modification. 5. Also, by the spherical action in an object, as its action upon mercury, upon water without, and upon bubbles and vapors within. 6. A similar most equal action cannot result from the highest equality. 7. It is in the smallest volume as in the greatest. 8. That the air particles touch each other at every smallest point is evident from their yieldance.

101. *Air is compressible, expansible, in a word elastic.* 1. It appears from the experiments of Boyle that a very great volume of air can be forced into a very small volume. 2. So also it can be expanded. 3. If this can be done with the volume, then certainly it can be so done with the parts. 4. For there is no penetration of dimensions. 5. From somewhat hard particles no such thing exists; as in waters, mercuries and other liquids, which cannot be compressed and dilated. 6. This compressibility and expansibility air derives from itself from its prior and more perfect parts of which it consists, which unless they were thus far yielding, expansible and elastic, this composition could by no means be of such a nature as it is: thus further; 7, 8. The rule of elasticity is, that it may comunicate every impression with neighboring parts, in order that not anything of the impressed force may perish. 9. This holds good indeed for every distance. 10. Since this elasticity perishes in the air, and is measured by the distance to which it tends, it follows that it is gifted with some gravity, or some nature, which heavy and non-elastic bodies do not have. 11. Thus in order that it may absorb the impressed force; for what is truly elastic is neither heavy nor light. 12. From its weight, by in-

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cumbency according to its column, from gravity itself, the volume of air is measured. 13. It is measured from resistance and reaction. 14. Whence it is evident that it is not the purest atmosphere, but the last; and that there are purer atmospheres, in a certain order and degree of simplicity, not alone of expansion.

102. *That it continually strives towards its original form,* 1, or that from a form in itself most perfect it conspires towards its own form, which, such components being given, cannot be another form. 2. That its essence is constant, while its modes are variable. 3. Its modes are its mutations of state. 4. Experience testifies the same thing, for it immediately relapses, and, 5, remains permanent in form and measure, according to the gravity of the accumbent parts.

103. *That it derives this nature by itself from prior things.* 1. For it is the smallest volume, albeit the unity of its own atmosphere. 2. The more perfect parts will be those which constitute it. 3. Nor can they be otherwise than according to the form in composition. 4. Infinite things lie hidden, very few lie open. 5. Our senses detect the ultimates, 6, as is evident from microscopes, 7, from the smallest resultant phenomena. 8. The common forces of those things make themselves public; if there be forces, they will be substances, if substances, they can be assimilated to the parts.

104. *Since the parts of the air are elastic, they are fully modifiable.* 1. Its elasticity is an attribute of its modifiability, 2, and of its extension into a tubule, 3, so that afterwards what happens in one extreme may appear in the other. 4. Thence is sound; 5, but it is not elasticity; wherefor neither is it pure modifiability.

105. 5. *If the particles of the air are vesicles, and of such form, it is not to be concluded that their modification is brought about by intrapression of the surface, and as it were by a puncture* (vulnusculum), *or insinuation, as with a compressed bladder,* 1, for every point of that particle conspires to the conservation of its form. 2. Thus it cannot be modified at a distance, nor does the disturbed surface communicate this. 3. Every attack made upon the surface returns to the substance itself.

106. *But when they are touched or compressed they sud-*

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denly compress themselves into smaller spheres, and dilate themselves into larger ones, the same form being always conserved, varied only in dimension and diameter, always remaining spheres of the same nature. This is evident, 1, from their composition from similar and more perfect spheres, 2, which do not suffer another form to be induced upon them. 3. There is a striving together of all of them towards their own form. 4. This is seen from their similar nature in their smaller, indeed in their smallest volume perceptible to sight, 5, and in the smallest pores and vesicles, as in the lungs, a similar nature remains with the compressed particle according to the height of the column, if the air be compressed or dilated. 6. That pressure being removed a restitution and pressure results from the inclosed elastic particles. 7. It is similarly seen in vapors, 8, from the doctrine of forms. 9. That which produces the substantial form produces the accidental. 10. The space alone is varied.

107. *Therefore when the air is effected by a sudden or light compression, or by a blow, or other impulse, it similarly redounds*, wherefore, 1, the modification of its nature consists in the sudden compression and expansion, or action and reaction, therefore in the sudden rebounding of the particles into their original dimensions. 2. Wherefore if the modification should enter into the place where the air had been compressed, so that it should no longer be able to rebound, then the air would be destroyed.

108. *The more air is compressed, the harder it becomes, and the more strongly it rebounds;* 1. For it reduces it into a harder state, 2, the more it remains in that compression unwillingly. 3. It returns to the equilibrium of its exterior pressure, in which is the atmosphere itself. 4. Wherefore the modification is varied according to the density and rarity of the air itself, 5, as in diving bells under water, where a new pressure is added. 6. The pressure is insensible in air pumps. 7. For there is no rebound, except a light one, if the air be expanded. 8. The air is in its most complete equilibrium in our atmosphere, it is otherwise on the tops of mountains.

109. *Thence is sound, which is a modification of the air, or rather is to be called a modulation.* 1. Thus air suddenly com-

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pressed, and its sudden rebound causes that which sound hears; 2. For the same is communicated to the membranes lying in the way, which are likewise elastic. 3. Nothing received in these membranes perishes.

110. 6. *That such modulation propagates itself to a distance according to the elasticity of the more perfect particles.* 1. As, for instance, sound reaches to a certain distance. 2. When one particle is compressed, also another is compressed. 3. This could not be without local motion. 4. All contiguous touch confirms this. 5. This appears from sound in aerial atmosphere, and from light in the ethereal atmosphere.

111. *Every modification derives its origin from external causes which impinge.* 1. The external cause is what acts upon the particles, or upon the volume of the particles. 2. The internal cause in the particles themselves does not come to sound or the sense of hearing. 3. This may appear from twanged strings, from the strings of a musical instrument, from harps, lyres, drums, or when the air is beaten by a somewhat hard flexible switch. 4. It appears from trumpets and other wind instruments which sound when blown into. 5. It appears from elastic plates, which vibrate when beaten, and communicate their vibration to the air. 6. It appears from the larynx itself, and from similar things. Thus it appears that what produces the modification must be outside the particles of the air, but within the atmosphere of the air. 7. Wherefore from the origin of motion.

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SWEDENBORG'S SUMMARY OF THE PRINCIPIA.

(Concluded.)

CHAPTER VIII; CONCERNING THE THIRD FINITE.

The more kinds of finites, actives and elementaries that successively arise by means of multiplication, the more enriched, beautiful and perfect is the world. 1. The third finite as to its origin, parts, figure of the parts, position, motion, etc., is quite similar to its preceding substantials or finites, or to the second finites, the first finite, and the point. 2. The third finite consists purely of second finites. 3. Since this finite is similar to its antecedent finites, and is a third generation from the points, it is of the same quality with its antecedent finites. 4. [This finite] arises from the first elementary particles very greatly compressed, and indeed near the large active or solar space. 5. From these [finites] there may arise again new elementary particles.

CHAPTER IX; CONCERNING THE SECOND OR THE MAGNETIC ELEMENT OF THE WORLD.

1. The second elementary particle consists of third finites and of the actives of the second and first finites; and the above-mentioned finites occupy the surface and the actives the internal space. 2. The second elementary particles are, as to their origin, as well as to their figure, surface and space most similar to the first elementaries; they differ only in regard to dimension, namely, the second elementaries are larger in both space and figure, because they consist of larger finites and actives. 3. The second elementary particles possess the same elasticity as the first. 4. These [second elementary particles] may be compressed and expanded in like manner as the first. Their centre of gravity is in some part of the surface, and when in a state of compression is nearer the interiors than in a state of expansion. These elementaries have likewise an axillary motion and they make an effort to go into local motion. Those which are nearest the sun and which are in a greater

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degree of compression [make an effort to go] into a lesser gyre and circle; but those which are more remote from the sun and in a lesser degree of compression into a greater gyre or circle. By means of such an effort of each, together with an accessory force from some active and central space, they spontaneously conspire to the vortical gyre which is most agreeable to them, which they also perpetually preserve by means of the same action of the sun and the force and effort inherent in each [particle]. 5. The surface of this second elementary particle is exactly equilibrated between two forces; within it is pressed by its active space, but without by the first elementaries. 6. These second elementary particles are in like manner pressed by others incumbent upon them, and the pressure of the incumbent [particles] is according to the altitude in the plane of the zodiac, and likewise according to the area subjected to the pressing [particles]; provided their volume be reduced by motion to a regular and vortical position. 7. The third finites constituting the surface of this elementary particle join themselves in like manner and become passive as do the second finites in the surface of the first elementary particle. 8. The finites constituting the surface, in like manner as the finites of the first elementary, turn their convex or lighter part toward their internal space, and they are thus compelled to cohere as to their poles. 9. The motion and essentials of the volume are similar to the motion and essentials of the parts in all the elements, and reciprocally. 10. The particles of the second elementary may be compressed to their minimum, in the same manner and by the same cause as the first elementary particles; and in the greatest degree of compression, or near the large, active, solar space, they change into new finites, which finites are the fourth finites and similar to the preceding. 11. In every particle of this elementary kind there is everything in the world which has hitherto arisen from the point; and every elementary particle is a least compendium of the world and its preceding entities; thus there is a most perfect harmony of the parts and the compounds, and a most close connection with the first.

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CHAPTER X; CONCERNING THE EXISTENCE OF THE SUN AND THE FORMATION OF ITS VORTEX.

1. The large active solar space appears to have primitively consisted of no other actives than those of the first finite. 2. No space or place can be occupied or enclosed by actives unless it be surrounded by finites, in which alone it can be terminated and limited, and consequently in relation to which it can be called a space. 3. By the immense action of the space the surrounding finites can be reduced into such a position that one touches the other, and consequently they can finite themselves and by means of motion among each other flow into second finites. 4. The second finites now surround and enclose the same solar space, since the first finites, for the above-mentioned reasons, coalesced into the second finites. In like manner these second finites, which are now proximate to the [solar] space, may in a considerable number enter the space itself and become actives. 5. The first and likewise the second elementary particles may now arise around this large active space, and may successively form a sphere which gradually grows larger until finally they suffice to form a certain large vortex around the sun. 6. In the state of formation of the vortex among the elementary particles, as they are increasing into an immense sphere or volume, no other force was needed than a certain active centre which would institute the action (*quod ageret*); otherwise the elementary particles themselves would spontaneously dispose themselves into a general motion in agreement with the figure of the parts; and, by means of the action which takes place in the centre, they would perpetually continue this motion both as to each particle and the whole volume. 7. The sphere of the elementary particles, from the action of the solar space alone, flows into a vortical motion, and this motion cannot but accord with the equators and poles of the parts, and hence must extend itself into a spiral figure at a great distance from the centre, and thus by the fluxion and position of the parts form a zodiac. 8. Elementary nature is similar to herself both in the greatest and least things; in the macrocosm and in the microcosm; in a heaven and in a [small] volume; in a world and in a particle.

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PART II.

CHAPTER I; CONCERNING THE CAUSES AND MECHANISM OF THE MAGNETIC FORCES.

1. The first and also the second elementary particles, or the magnetic, are most apt and prone to motion; and indeed they spontaneously make an effort to go into a certain vortical motion, if there be only an active centre around which they can flow and gyrate. 2. In a volume of elementary parts all the motion is diffused and derived from a certain centre, where the origin of motion exists, to all the parts round about, and indeed to a greater or less distance according to the force of the centre, and the contiguity, elasticity and yieldance of the parts. 3. But motion among the elementary particles is not only propagated and extended according to the figure and natural position of the parts, but also terminates in them. 4. Hence it may be concluded that motion among the first elementary particles, and also among the second or magnetic, is diffused in every direction from the centre to all the circumferences; but because the figure and position of the parts is such that the poles and likewise the equators of all the particles are parallel, the motion among the particles is diffused in one way according to the poles and in another according to the equators. 5. Since the diffusion and emanation (*dissipatio et excursio*) of motion from the centre is of one kind according to the plane or parallelism of the poles, and of another and different kind according to the plane and parallelism of the equators of the parts, it follows that the motion cannot be diffused into circumferences equi-distant from the centre, or very similarly circular, but into the spiral ones. Such a motion in a volume of parts is truly vortical. 6. In this spiral or vortical motion the spires near the centre are formed with a greater curvature, but at a distance from the centre with a lesser curvature, and finally it terminates in a right line and thus in the natural position of the elementary particles. In a word, all motion among the elementary particles which we have called magnetic runs round the centre in a spiral figure; and when it has come to its state of rest it

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comes into a rectilinear position, and into the same with the position of the parts at rest. In this consists all the magnetism, concerning which it will be treated. 7. These spiral gyrations we call vorticles. As many spiral gyrations or vorticles may arise as there are centres of motion, and the vorticles themselves may be conjoined among each other agreeably to their figure and motion. 8. If the vorticles are conjoined as to their spires and as to the harmony of their motions, they are also as it were mutually colligated by their conjunctions and tend to remain (*velle permanere*) in that conjunction. 9. Vorticles or spiral gyrations of this kind are more apt to conjoin and colligate themselves with each other the nearer they are, or the greater the curvature of the spires by which they are conjoined. At the least distance from the centre of motion there is the greatest colligation because there the gyration has the greatest curvature. In an intermediate distance the colligation is intermediate; most remotely there is evidently none because the gyratory motion begins to be determined into a right line. Colligation can also exist where the angle of the spire is less than forty-five degrees. The more centres of motion there are in the same plane the greater is the gyration or colligation of the vorticles; the fewer in the same plane the less is the colligation; and also, there are as many colligations as there are centres of motion. 10. Corpuscles consisting of pores and meatuses so subtile as to be permeable only by the magnetic elementary particles I call magnetic corpuscles, and especially if the pores or meatuses are rectilinear. Of this kind are the least corpuscles proceeding from magnets and iron, or effluvia. 11. Such corpuscles or effluvia, if they be free (*soluta*), cannot be quiescent, but gyrate continually round their centre and according to the position of the elementary particles; and consequently they constitute active centres and form around themselves spiral gyrations or vorticles. 12. Therefore, as is the number of magnetic effluvia such is the number of vorticles formed round the magnet. 13. The greater the abundance of such effluvia round about the magnet, the greater is the abundance of circles and vorticles; and the greater the abundance the more nearly and closely may they be conjoined and colligated as to their in-

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terior spires; and *vice versa*. 14. The natural place of the effluvium is in the centre of such a vorticle; nor can the effluvium, residing and acting in its centre, eject itself out of its vorticle, but the effluvium is inseparable from the vorticle and is naturally carried in the same direction as the vorticle; and *vice versa*. 15. If within any hard or material body there be effluvia or least parts of this kind, free as well as bound, but [extending] in a right line or in a regular curve from one side to the other, or from one pole to the other, I hold that such a hard or material body is wholly magnetic. 16. The more regular the position of the particles and the greater the abundance of them both within and without the mass, the closer is the conjunction and the stronger the magnetism. 17. The colligation of the effluvia or vorticles is closer at a less than at a greater distance from the mass, and closest at its confines or boundaries, or near the mass. 18. The vorticles round about such a mass surround (*circumfusos*) each wall by a connection which is continuous from one pole to the other and thus they connect and enclose each wall by a kind of sphere. The sphere of the vorticles thus connected may remain for a considerable time around the whole magnet, nor is there any need for it to be constantly renovated and made whole by new effluvia, nor is the continual exhalation of such effluvia required in great abundance. The magnet itself (*lapidem magneticum*) likewise, surrounded by such a sphere of vorticles, cannot be removed from one place to another without the sphere being moved at the same time; nor can the sphere be transferred unless the magnet be transferred at the same time—the magnet and the sphere constitute as it were one body, nor can one be separated from the other, much less be transferred outside of the other, but the magnet in the centre of its sphere, whatever the position and motion may be, naturally and always accompanies the sphere, and the sphere its magnet. 19. Because of the connection of the vorticles from the one pole to the other, and the formation of the sphere, there exist two poles in the magnet; likewise two polar axes in the sphere at a distance from the magnet, which axes are not determined by the magnet itself, but by the sphere and its figure. 20. The axes of the vorticles are not in one parallel-

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ism and position with the axes of the sphere, but the axes of the vorticles are incurvated according to the figure of the sphere, and the incurvation begins around the polar axes of the sphere. 21. The axes of the vorticles and of the elementary particles round about the magnet are in the same parallelism, and the elementary particles are arranged by the motion of the vorticles into the same position and into the same figure of position as the sphere. 22. All motion in the vorticle is according to the position of its axes, or the axes have a flexure according to the motion. If the axes are in a right line the motions in the vorticle are concentric, but if the axes are incurvated the motions are eccentric; and if several vorticles are in the vicinity of each other, according to whose motion and application the axes are to be curved, there is also at different distances from the centre or effluvium a different eccentricity. 23. The axis of the sphere, or the common axis of the vorticles, lies in a parallel position with the common axis of the element itself, in a very exact manner (*convenientissime*); but nevertheless it may be easily turned from this towards any quarter. 24. The axis of the whole sphere, or the common axis of the vorticles, may be incurvated in like manner; and together with it the sphere itself, from one pole to the other, may also undergo some change and be incurvated according to the polar axis. 25. By the application of two or more magnetic spheres the figure of each sphere is immediately changed and from two or more spheres arises a larger one, and the whole distance between the spheres becomes an axis. According to the different application of the spheres is the larger sphere thence arising differently configurated. 26. Two or more spheres applied to each other are more closely colligated at a smaller than at a greater distance. 27. The conjunction of spheres is most close and direct around the poles, but between the poles it is slighter and oblique. 28. The greatest part of the effluvia of iron or steel is magnetic, but because of the irregular position of the parts in iron or steel there is no regular conjunction of the effluvia or vorticles; thus neither is any sphere formed by the regular position [of the parts], nor can any magnetism be produced before the vorticles with their effluvia interiorily in the iron or steel are reduced and arrang-

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ed into a regular position. 29. If the effluvia of the iron approach the effluvia of the magnet, or the sphere of one approach the sphere of the other, both spheres coalesce and unite into one that is larger and the whole distance becomes an axis and thus the magnetism is rendered stronger. Hence it follows that iron is conjoined with the magnet and the magnet with iron by means of spheres, that one invites and as it were attracts the other by a certain force, nor are they repelled and driven in different directions (*in diversum*) as magnets are by their similar or inimical poles; iron is also conjoined with the magnet in the degree that the common sphere either penetrates or surrounds the iron, and the whole mass of iron is conjoined with the magnet if the whole mass of iron be either penetrated or regularly surrounded, unless its weight should be greater than the force of conjunction of the vorticles or the sphere. 30. By the application and contact of the magnet and the iron all the effluvia which are in the compages of the iron, which are either entirely or partially free, are arranged into a regular position and the iron thus becomes magnetic.

CHAPTER II; CONCERNING THE ATTRACTIVE FORCES OF MAGNETS AND THEIR RELATION TO DISTANCES.

1. No magnet is absolutely similar to another, either as to its interior texture or as to the figure of its surrounding sphere; and the magnetism itself in the same stone may also be varied by the most diverse causes. 2. The attractive force or the conjunction of two or more magnets or pieces of iron depends not only upon the axis but upon the whole surrounding sphere. 3. The attractive force is stronger at a less distance from magnets—weaker at a greater; and there is none where the spires of the vorticles begin to embrace each other at an angle of forty-five degrees. 4. There cannot be two magnets possessing a similar attractive force, but in very similar ones there is always a constant geometrical ratio between the attractive forces and the distances.

CHAPTER III; CONCERNING THE ATTRACTIVE FORCES OF MAGNETS IF THEIR POLES BE ALTERNATED.

The magnetic sphere around both poles is not similar, nor is the axis at the south pole extended similarly to that at the

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north pole, but in the figure of the sphere there is always on each side a difference and consequently the same force is not always exerted at each pole; nor is the attractive force of two magnets the same if the poles be alternated, that is, if the magnets be inverted and thus the homogeneous poles opposed to each other.

Chapter IV; Concerning the attractive forces of magnets when their axes are in a parallel position.

1. When two or more magnets are so placed that the equinoctial of one lies upon the equinoctial of the other, the spheres of the two magnets combine into one that is larger and form a certain large axis between the poles of the magnets. But the spheres of two or more magnets are, as to the poles, mechanically so conjoined according to the motion of the vorticles that in the middle distance between the magnets they are in a parallel position with the axes, but at the sides they are in a perpendicular position, and consequently between the middle and extreme distance they are in an oblique [position]. 2. Two or more magnets when placed in a position in which their axes are parallel, or according to the equators, possess in like manner a conjunctive force, but not at the same distance as when they are conjoined by the application of their axes or poles.

Chapter V; Concerning the disjunctive forces of magnets when the cognominal or inimical poles are applied to each other.

1. If two or more magnets be so applied to each other that the south pole of the one be opposed to the south pole of the other, or the north pole of the one to the north pole of the other, that is, if two cognominal poles are opposed to each other at various distances, the spheres of each magnet will coalesce into one large sphere. But in the middle distance between the magnets so applied the position and fluxion of the vorticles are nearly contrary to each other, but at each side they more and more inflect themselves into their natural and homogeneous position. And consequently in the middle of the

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column there is a disjunction of the parts, but at the sides, or laterally, a conjunction. 2. If the cognominal poles be turned toward each other the magnets are partly repelled, partly attracted, and their repulsive force is increased according to the distances and ratio of the spheres, but is presently diminished at a lesser distance. When two or more magnets are opposed to each other then in the space outside their perpendicular line they combine their energies (*conniti*), if the poles be in the least oblique or the magnets be moved to one side [out of the line] of diametrical opposition. 3. There cannot be any constant rule between the distances and repulsive forces of two magnets unless the magnets with their spheres be absolutely similar. 4. Therefore, if two or more magnets be so applied to each other that the homogeneous or friendly poles face each other, then from two or more spheres arises a single larger sphere, whose poles are two, one at each end of the magnet, and the middle distance between the magnets becomes the axis, which equals the entire side of each magnet. But if two or more magnets are so applied to each other that their poles are parallel, but the equators opposed to each other, from two or more spheres there also arises a single larger one, having four poles, two in each magnet, but it is otherwise if their cognominal or inimical poles be turned toward each other. These things being assumed as a basis, an examination may be made as to the nature of the coalition of spheres, or what must be the figure of the larger sphere if more than two magnets be applied to each other; likewise [what it must be] if two or more magnets be opposed to each other in some other position more or less oblique from the axes or equator and at various distances and angles.

CHAPTER VI; CONCERNING THE ATTRACTIVE FORCES OF THE MAGNET AND OF IRON.

1. When iron is applied to the magnet or the magnet to iron, from the two spheres there exists a larger one, which encloses the magnet as well as the iron, but not in like manner as when a magnet is applied to a magnet. 2. The reciprocally attractive force of the magnet and of iron is greater than the attractive force of two magnets. 3. The magnet exercises its greatest

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force upon iron of a given proportion of mass and thickness; a less degree if the iron be too thin or if it be too thick. There is a maximum and a minimum in the mass and thickness of the iron, within which the magnet can operate with the greatest force. 4. The magnet exercises its greatest force upon iron of a given proportion of size and thickness; in less degree if it be too small, and in a less degree also if it be too large.

CHAPTER VII; CONCERNING THE OPERATION OF THE MAGNET ON IGNITED IRON.

The magnet operates with less power upon iron red hot (*candefactum*) or ignited, than upon cold iron; and its force on ignited iron diminishes according to the degree of ignition.

CHAPTER VIII; CONCERNING THE ABUNDANCE OF THE [MAGNETIC] EXHALATIONS AND THEIR PENETRATION THROUGH HARD BODIES.

1. The magnetic sphere is capable of very freely permeating not only volumes of the elements, as air and ether, but also water and flame; likewise hard bodies, as woods, stones, or metals. Nor do the effluvia which permeate the texture of harder bodies anywhere lodge, impinge against, or become affixed to, any of their parts or parietes, but flow with entire freedom throughout the entire mass, without contact, occursion, or incursion. 2. Nor can the magnetic sphere conjoin with itself any other kinds of metals than iron or steel only, or such as participate of iron. By a greater abundance of emanating effluvia the magnetism and conjunction of bodies is rendered stronger. Still, however, there is no need that a wave and abundance of effluvia should constantly emanate from the magnet so that the magnetism should be renovated and restored by a continual influx and efflux of effluvia. 4. Iron cannot acquire any augmentation of weight by friction against a magnet; but the least parts of the iron which become perforated in a right line and partially loosened by the friction of the magnet are only made transverse and put into a regular position, and thus the magnetism is communicated to the iron; and consequently neither does the magnet suffer a loss [of its

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forces], but one magnet would be capable of rendering magnetic all the iron in the world. 5. Whoever wishes to form and establish principles by means of a certain geometrical and mechanical construction of things (*per nexum quendam geometricum et mechanicum*), and afterwards to confirm them by experiment, ought not to assume and refute the opinions and arguments of others, but only present causes and demonstrate the connection of the principles with the experiments.

Chapter IX; Concerning chemical experiments with the magnet.

1. By means of ignition and great heat (*excandescentiam*) the magnet suffers a loss of its forces, and all its rectilinear and regular [position of the parts], and together with these its magnetism; and consequently it assumes the nature of iron, nor is it able to form any regular sphere round about itself; and after becoming red hot (*candefactionem*) nothing remains which enables it to adjoin itself to another magnet except the parts of iron. 2. From sublimations, solutions and other chemical operations made on the magnet, its parts, and texture, nothing further can be elicited than that a magnet may consist of different kinds of parts, but that the magnetic strength and quality reside only in the iron particles. 3. By comminution of the magnet into dust the magnetic quality perishes and becomes confused. 4. However, by the application of some kinds of salts the interior parts of the iron or of the magnet may possibly become so implicated with them that there remains no abundance of iron or magnetic effluvia which may be exhaled and separated, until a melting heat frees the iron parts from their bonds.

Chapter X; Concerning the friction of the magnet against iron.

The magnetic parts in iron are arranged into a regular position by means of friction and thus a magnetic sphere is formed round about the iron. But iron may be rendered most highly and permanently magnetic if it be brought into frictional contact with the magnet; but less magnetic if it be not in contact. If it be at a distance from the magnet it is indeed rendered

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magnetic as long as it is within the magnetic sphere, but if the sphere be removed the mechanism immediately vanishes. 2. Iron is rendered most highly and permanently magnetic if all its parts or the whole compages be reduced into the same regular position, but less or very weakly magnetic if [it be reduced into a regular position as to the parts] only as to some points, or as to a short length. 3. When the least parts in iron are reduced into a regular position by means of friction they cannot by means of any numerous reiterated frictions be reduced into a still more regular order; neither can the magnetism of the iron be rendered stronger and stronger by a multiplication of frictions. 4. Iron is rendered most highly magnetic by means of friction if it be of a determinate magnitude, mass, thickness and surface. But the magnitude, mass, thickness and surface may be determined by experience, taking into account however the nature of the iron and of the magnet.

CHAPTER XI; CONCERNING THE CONJUNCTIVE FORCE OF THE MAGNET ON SEVERAL PIECES OF IRON.

1. One magnet may consociate with itself in order several pieces of iron and may enclose all within one and the same sphere. 2. The conjunctive or attractive force of the magnet may increase and be rendered stronger by the application of iron, or by an armature. 3. There can be no two magnets which are absolutely similar as to their conjunctive force.

CHAPTER XII; CONCERNING THE OPERATION OF IRON AND OF THE MAGNET UPON THE MARINER'S NEEDLE, AND THE RECIPROCAL [OPERATION] OF ONE [NEEDLE] UPON ANOTHER.

The sphere of effluvia around iron extends itself to a great distance, so that the vorticles or gyrations of effluvia emit themselves like radii on every side and arrange the magnetic element itself into the same position, so that the magnetic element regards the iron as its pole or centre from which the vorticles go forth in a long series. Such as is the position of the vorticles or the figure of the sphere, such also is the position, or figure of position, of the elementary particles vortically moved. 2. Innumerable spheres, as well those which pertain

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to iron or those which are magnetic, may be formed within one and the same [larger] sphere. 3. In every magnet there are forces and qualities of two kinds; one, of conjoining with itself another magnet or piece of iron, which is called the attractive force; the other, of accommodating itself to the parallelism of the magnetic element or to its poles, which is called its polar force or declination. 4. Within the sphere of the iron or at some distance from it the mariner's needle becomes turned toward the iron not by an attractive force, but by its own polar quality. The axis of the sphere, or the common axis of the vorticles, lies the most conveniently in a position parallel with the common axis of the element itself; but nevertheless it may be easily converted therefrom towards any other quarter.

Chapter XIII; Concerning other methods of rendering iron magnetic.

Iron may be rendered magnetic by other modes besides friction and contact; the art and method [of effecting it] consists only in reducing the least parts, which can exhale in the form of effluvia, into a certain regular position. If therefore iron be exposed to the continual action of the magnetic element for a considerable and stated time, it will be rendered magnetic, especially if it be kept [in a position in agreement with] the parallelism of the elementary particles. 2. Iron may likewise be rendered magnetic by repeatedly stretching and bending it; as also by a regular rasping and by hammering it out. Experiments therefore confirm [the position] that all the magnetic force consists only in the regular position of the parts, and that all effluvia from iron are magnetic (*mere esse magnetica*). From these data there flows mechanically all that has been said concerning the modes and qualities of the magnetic forces in the magnet and in iron.

PART III.

Chapter I; Comparison of the sidereal heaven with the magnetic sphere.

1. All the elements, as was taught in the first part of our *Principia*, operate in the same manner in a small volume as in a great one; in a volume in the same manner as in a system;

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in a vorticle around the magnet, as in the great vortex around the sun. They operate in the same manner whether the centre be some insignificant effluvium continually movable round its axis, or whether it be a large active or solar centre which is continually movable. In the heaven or finite universe there may be innumerable vortices of this kind if there be innumerable active centres; or there may be as many vortices as there are suns or stars. 2. The motion of each vortex is from the active or solar centre to the circumferences; but the motion towards the equators of the parts is not similar to the motion towards their poles on account of the geometrical difference in the figure of each part. By such a diversity of motion the formation of the spiral gyrations is towards the poles and axes of the parts; that is, in the larger system, towards the poles of the zodiac. The spiral gyrations have a greater curvature when they are near an active centre, or near a sun or star; from which the farther they are the less is their curvature. That spiral motion according to the poles and axes of the parts is expanded and unfolded into one more and more rectilinear, and finally it ends in a common or rectilinear or parallel position of the parts. 3. Two solar or stellar vortices are more closely colligated by the spires nearer to the centres than by those which are more remote, as is plainly the case with the magnetic vorticles. They [the solar or stellar vortices] may be colligated either at a great or at a small distance; they may be reciprocally colligated if their axes be opposed to each other, but not if their equators be opposed to each other. Colligation according to the poles is direct, but that between the poles and equators of the parts is indirect and oblique. There is no colligation according to the equators of the parts, that is, in the great vortex, according to the zodiac. The centres of motion, or the suns or stars, may thus be at greater or less distances from each other. If there be several in a smaller space or at a smaller distance, the gyration of one is not disturbed by that of the other. 4. The active, solar or stellar spaces in the middle of the vortex are there in their own natural locality; they cannot be removed out of the vortex; the centre is indivisible and inseparable from the vortex, and the vortex from the centre, and one follows the other. There cannot be two or more suns,

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stars or active spaces in one vortex. 5. Further, one vortex with its active centre constitutes one heaven by itself, or one world (*mundum*). Several vortices with their centres form together a certain sphere. A sphere consisting of many vortices of the same kind has its own figure and the figure of the sphere its own axes. The vortices inflect themselves in every direction from one axis, and curve it toward another; around the other axis they inflect and incurvate themselves in like manner, and by the colligation of the vortices the sphere passes over to another axis; thus the sphere is so colligated with its axes, that all the vortices in the entire sphere refer themselves to axes, so that no vortex can be moved out of its place, unless the figure, connection, order and course of the whole sphere be in some measure disturbed. Vortices are larger and larger in the proportion that their distance is greater and greater from the axis and in the axis. The whole visible sidereal heaven is a great sphere, and its suns or stars together with their vortices are parts of the sphere connected in the manner which has been mentioned. 6. The axes of the vortices in this sphere are variously inflected or incurvated and all the elementary particles in this sphere have the same position as the vortices themselves, or the sphere itself; and thus the vortices, as well as all the elementary particles in the very axes of the sphere, are in a rectilinear position, but those extending from the axes in a curvilinear position, or one which is inflected relatively to the axes. The elementary particles in the whole of this sphere or sidereal heaven do not regard one and the same pole, except in the verimost axis of the sphere. All the vortices or worlds which are in this axis possess the same poles; but all the vortices or worlds out of this axis do not possess the same poles, but the poles are according to the position of the worlds in the sphere. 7. There may thus be axes variously inflected according to the application of the neighboring or circumambient vorticles. If the axis of a vortex be inflected, the spiral gyrations according to the equators of the parts, that is, according to the zodiac of the vortex, are not circular but elliptical. The active centre cannot be in the middle of the vortex, but is in one of its foci (*sed in umbilico*). If the axis be variously inflected, then at various distances from the centre there are vari-

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ous ellipses, or various eccentricities, relatively to the active centre. The planets move (*circumfluant*) elliptically in a vortex of this kind, the axis of which is variously inflected; and their sun is not in the middle or centre of the vortex, but situated variously in one of the foci (*sed illum in umbilicis varie teneant*). All the vortices which are directly in the very axis of the sphere or sidereal heaven are not inflected as to their axes; but their gyrations are spirally circular, and their centre is in the middle; but around the axis, where they begin to circumflect themselves, their gyrations are elliptical, and their active centre is not in the middle; and thus there are different and numerous eccentricities. Consequently our solar vortex is not in the axis of the sphere, but is near the axis where there is a considerable incurvation or inflection. 8. The common axis of the sphere or sidereal heaven seems to be the galaxy where there is the greatest congeries of stars. Along the galaxy all the vortices are in a rectilinear position and series and cohere as to their poles; likewise, they are there colligated more intimately and with spires of greater curvature. The other solar or stellar vortices afterwards proceed from the axis and variously inflect themselves; but, nevertheless, all refer themselves to that axis. 9. No change can occur in one vortex which is not in some manner felt in the others even to the axis and hence throughout the entire sphere. 10. From a given eccentricity and elliptical figure at various distances from the centre the skilful geometrician may come to a conclusion as to the position of the neighboring vortices and the incurvations of the axis; and, contrariwise, from the given position and distance of the neighboring vortices, and from the incurvations of the axis or from the position of the parts, he may come to a conclusion as to the spiral gyrations which may exist at various distances. And thus from given ellipses or orbits of the planets he may know the incurvations of the axis, likewise the position of the neighboring vortices, besides several other things. 11. There may be innumerable spheres of this kind or sidereal heavens in the finite universe; these may be colligated with each other like the spheres of two magnets; and the whole visible sidereal heaven is perhaps but a point in respect to the universe.

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CHAPTER II; CONCERNING THE DIVERSITY OF WORLDS.

1. No world (*mundus*) can exist, abounding in any variety of visible things and phenomena, unless it arise successively, and during intervals of time, and by successive changes (*vices*), and contingencies, modes or modifications; by series of things successive, simultaneous and co-existing, and by connections of series, and iterated separations and connections, whence arises the perfection of its compositions. A world is more perfect in the degree that a greater number of changes and contingents concur in its formation, also in the degree that there are more modifications and existences thence arising of things successive, simultaneous and co-existing, and their connections, or, in the degree that there is a greater series of the things and the connection of the series (*sericrum*) more multiplex. 2. The world subsists by the same series by which it existed, and, as to its subsistence and existence, perpetually regards its first. The more perfect the world exists and subsists the better it is able to regard its first and consequently it is more perfect and beautiful in its direct than in its oblique series; in things composite and connected than in things simple and separate; in series possessing a greater and freer motion than in those possessing one which is less. 3. The changes and contingents may be infinite, as also the varieties of modifications, and hence there may be infinite genera of entities compounded simultaneously as well as successively, and afterwards connected; and consequently there may be infinite series of these entities. If the world consists of a series of parts and compositions arising simultaneously and successively there may be as many series as there are worlds, or as many worlds as there are series; and thus there can never be a world altogether similar to another one. 4. Nevertheless, geometry is similar in every world, and likewise nature and mechanism as to principles and motive forces; but the diversity consists only in the diversity of series, in respect to degrees, ratios, and figures.

CHAPTER III; CONCERNING THE FOURTH FINITE.

It is similar to the third finite, this to the second, this to the first, and this to its simple or point; consequently this fourth

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finite is similar to all and to the point; whence also it is moved similarly, it can be similarly passive, and constitute the surface of some particle, and can also be similarly active. Its attributes, essentials and modes are similar to those of the third finite, from which it differs only in dimension, and consequently in respect to degrees and moments. Its origin is similar to that of the preceding finite, namely, from the second elementary particle, as the third is from the first elementary particle. The cause and place of its origin are similar, namely, near the active solar space, where the second elementaries were capable of being compressed into finites.

CHAPTER IV; CONCERNING THE UNIVERSAL CHAOS OF THE SUN AND PLANETS.

1. By reason of the same causes as in the case of the first elementaries, the second elementaries are most highly compressed near the active solar space, and by this very high compression they cease to be elementaries and finites come into existence; but these finites are of a higher dimension [than the preceding finites] and are the fourth in order, the former being third in order. 2. Although all finites possess the power of actuating themselves, nevertheless, these finites which have arisen near the sun cannot become actives and introduce themselves into the solar space to its actives, on account of a difference of velocity, circles, and mass. But the actives which may have been casually made immediately cease to be actives and thus necessarily remain mere actives round the solar space of the actives; and consequently the functions they perform there are those of guarding and defending, so that the other finites of the same genus may not enter into the solar space and any longer introduce themselves into it. 3. Thus the number and abundance of finites of the fourth kind increases more and more by the successive compression of the elementaries, and there is a condensation around the solar space. Thus these finites concrete into an immense volume, and they crowd and enclose the sun like a crust; nor do they cease [to act] until the vortex is fully formed. 4. Nevertheless this crust, formed of fourth finites around the sun, is rotated in a certain gyre; it is thus representative, as it were, of an

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active centre in forming and perfecting the vortex, around which, consequently, the elementaries can nevertheless flow like a vortex, but with a force and power different [from that which they would possess] were the solar space to act nakedly and contiguously upon its circumfluent elementaries. The whole of this immense crust, together with the enclosed solar space, is not unlike an elementary particle, for within an elementary particle is the active space, without the finites flow; and thus as to figure and motion this chaos is, on an immense scale, an effigy similar to each individual part in an element. Thus, again, nature is similar to herself in greatests as in leasts; thus does she appear in her immensity and at the same time in that which is very small. 5. This crustaceous matter, being endowed with a continual gyratory motion round the sun, in the course of time removes itself more and more from the active space, and in so removing itself occupies a larger circle and consequently becomes attenuated until it can no longer contiguously cohere, but bursts in some part or other. 6. The solar crust, being somewhere disrupted on the admission of the vortical volume, collapses upon itself, and indeed toward the zodiacal circle of the vortex, or according to the position and motion of the elementary particles, so that it surrounds the sun like a belt or broad circle; and this belt, which is formed by the collapse of the crustaceous expanse, in like manner gyrates and removes itself [still farther], and in removing is attenuated until finally it bursts and forms into larger and smaller globes; that is, into planets and satellites of varying magnitude, but of a spherical figure. 7. This crustaceous expanse may subside partly into itself and thus consist merely of a volume of finites. It may partly subside inwardly toward the solar space and thus revolve itself around some active space, or it may partly subside exteriorly toward the vortex and thus enclose a volume of elementary particles. Thus there may exist bodies of three kinds, namely, planets, their satellites, and the bodies wandering around the sun which we are accustomed to call sun-spots. It follows that these bodies, separated into globes, consist of fourth finites, and that they project themselves into the field of the vortex according to their magnitudes and weights and in the course of time more and more

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remove themselves from the sun until they arrive at their fixed circumference or orbit in the solar vortex where they can be in equilibrium with the volume of the vortex.

CHAPTER V; CONCERNING THE ETHER OR THIRD ELEMENT OF THE WORLD.

Every planet therefore, however great, is nevertheless such as is the finite, or it is only a large finite; the difference is only one of degrees and dimension. And if a planet derives its similitude from its own finite or its individual [parts], it does so especially in regard to its tendency to a similar motion, or a similar intrinsic and progressive motion, and a similar axillary motion. Planets which are rendered active by their local motion round the sun have the same motion as actives. 1. The fourth finites, of which the infant earth consists, cannot actuate or finite themselves still further, that is, they cannot form themselves into similar larger finites except near the surface; but not between the surface and the centre, because there they have no place to unfold themselves. Even near the surface they cannot actuate themselves because the vortical element or the first elementary particles flow around, press upon and impede them, and whenever they are set free immediately absorb them. The earth thus floats in an elementary volume, or in the vortical element of the sun, with which alone it is now enveloped and equally pressed on every side. 2. These fourth finites flow more at liberty near the surface of the earth, and there only can dispose themselves and have free scope for any motion; this is a consequence of the former proposition. Thus they are there occupied by the particles of the circumfluent element and formed into new elementary particles, which contain within a small volume of the particles of the first element, the fourth finites constituting the surface; that is, those finites of which our new orb consists; and these new elementary particles are identical with the ether. In the course of time there came into existence a very great abundance of these elementary particles, or ether, because an immense volume of elementary particles may arise from a small volume of finites, and thus the new earth experienced a considerable diminution at its surface before the whole sphere of ether was entirely formed around it.

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3. Because this new earth is continually rotated round its axis and exposes once every day its whole surface to the sun, these new elementaries which arise on the surface are generated over the whole of the surface and do not proceed from one part more than from another; and thus the earth, however diminishing [at the surface], nevertheless retains its spherical or oval form; and since, as was said, it has an axillary rotation, the elementaries just produced are immediately, together with their earth, carried into a certain motion. As it were colligated together by means of this motion they arrange themselves round the earth, neither do they suffer themselves to be carried in any other direction, and this [is the case] while the sphere increases from its minimum to its maximum. 4. The ethereal particles are much larger than the first and second elementary particles and they differ also in this, that the ethereal possess an internal space consisting not of actives, but of elementaries, but the first and second elementaries consist of pure actives; consequently they are not similar in figure, but the ethereal are most exactly spherical, while the first and second elementaries have poles or polar cones. 5. These new spherical particles cannot but be in perpetual motion and the first elementaries which are enclosed dispose themselves in every manner suitably to the motion of their composite or the ether, and so much the better and more suitably in the degree that the ether is in a greater motion, namely, according to the degree of motion they arrange themselves in order from the centre to the circumference; and thus the enclosed elementaries which are near the centre are more expanded than those which are near the surface. The enclosed first elementaries lie in the position which is the most natural to them, and the more in proportion as the motion of the ethereal particle is more intense; and in this position they are insensible to the motion of the surface or of the whole particle. 6. The ethereal particles thus formed may exist with perfect aptitude under any kind of motion; and the surface itself is expanded and equilibrated between two forces or is pressed as much from without as from within. 7. The ethereal particle thus formed and equilibrated is most highly elastic and therefore deserves to be called elementary; but it owes its elasticity to the enclosed first elementaries in which is latent

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the primitive elasticity. Only by the aid of the enclosed elementaries may it be expanded, compressed, and [be made to] yield, and it derives its elementary nature from the first elementaries, and thus it is endowed with the character of an element (*elementata sit*). Nevertheless in every degree of compression and expansion it is most exactly spherical, and the more exactly spherical the more it is moved. 8. The ethereal particles and the first elementaries differ in this, that in a higher degree of motion the former more and more expand themselves and become less elastic, and thus they offer a greater resistance to any external force. But the first and second elementaries when the degree of motion is higher become more compressed, and when compressed become less elastic and with all their force resist an external pressure. Consequently the expansion of the particles of ether is more tense (*durior*) in a greater motion and more flaccid (*flaccidior*) in a lesser motion; the tension of these particles is always proportioned to their degree of motion, and consequently in every degree they are more or less tense. 9. Under every degree of extension and compression the ethereal particles are most highly mobile, and in their state of tension they are most highly active. 10. By their tension when they are in the highest motion as well as by their compression when they are under an incumbent weight they may arrive at such a degree of resistance that they cannot become more elastic, but like hard bodies they resist every compressing or opposing force. 11. They may also be expanded without motion and in such an expansion which has arisen without motion they are not rigid but elastic. The more expanded they are and the more quiet, the more laxly (*laxius*) elastic and yielding they become; also, the more compressed they are the less or more rigidly (*rigidius*) elastic do they become. 12. In the highest degree of expansion the elementaries may become disrupted and cease to be elementary; but nevertheless the finites, inhering in their surface, and which are now falling away by reason of the disruption, cannot actuate themselves, but immediately illapse into some of the surfaces of the neighboring particles and there continue their motion as finites in some other surface as before; so that by the dissolution of the particles and their illapses into

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the neighboring surfaces there is given to the neighboring particles the faculty of further expanding themselves and of occupying more space, so far as the quantity of enclosed elementaries permits. 13. The fourth finites constituting the surface of the ether are placed in a most regular position, [extending] as it were by continual spires from one polar point to its opposite; and by means of this position of the finites there is a mutual connection between them; consequently a motion received by such a surface cannot but, on account of the contiguity and position of the parts, circumfuse itself in a moment and occupy the whole surface of the particle simultaneously. And thus, by means of the spiral position of the parts in the surface, these ethereal particles arrive with difficulty at a state of rest, especially when rendered the more rigid by motion, in which case they revolve with the utmost rapidity round a centre in the same manner as the first and second elementaries around their axis. 14. The surface of an ethereal particle may be doubled, tripled, or multiplied in various ways within, and this in its state of compression; but the part of the surface which recedes towards the interiors is convolved into new spherules and bullules, or such as are similar to the larger; and in a greater degree of compression the bullular spherules thus formed within are multiplied, and when multiplied arrange themselves from the surface toward the centre. These bullules nitent within are, in the state of expansion of the ethereal particle, again set free, and they recede to the surface and enter into the expanse. It follows, moreover, that in its highest degree of compression the entire ethereal particle is at length occupied from the surface to the centre by similar small spheres and thus ceases to be both elastic and elementary, becoming hard and similar to a kind of material finite. 15. The elasticity of the volume is such as is the elasticity of each particle; and the elasticity of an inferior volume is equal to the weight of the whole superior volume pressing upon it, because they press and are pressed [in proportion to the weight of the incumbency], and by means of this incumbency it is that they secede into themselves in the manner which has been mentioned; hence in order that they may sustain the superincumbent weight their elasticity must be similar to the force and weight

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of the superincumbent volume. It follows also that the elasticity of the compressed volume is greater than the elasticity of the same volume when dilated in proportion to the mass or weight of the superincumbent volume. But nevertheless it is not a consequence from this that the density of the inferior [volume of] ether is in like manner proportioned to the density and weight of its superincumbent volume. 16. The ethereal particles mutually press upon each other according to the altitude or weight of the superincumbent volume. They likewise press most equally in all directions, upwards, downwards, and obliquely; [their pressure is] also according to the side or angle opposed to them at any given angle. The elasticity also makes an effort [to proceed] in every direction. They [the particles] likewise exercise such a pressure in every direction upon the interior parts of any hard body, whose pores and the interstices of whose texture they are capable of entering and permeating, and thus they [the particles of the hard body] contain the lesser parts [those of the ether] within their texture (*inter se*). 17. The motion of the volume of the ethereal particles is such as is that of the particles. It is most perfectly equal in all directions, otherwise than the motion of the volume of the first and second elements. Every particle contributes something to the motion of the volume and thus from the figure and mechanism of the particle may be seen what is the motion of the volume, and from the figure and mechanism of the motion of the volume what that of the particle is. 18. Particles moved in volume (*volumatim*) nevertheless preserve their equilibrium among one another in their mutual positions and cannot by reason of any general motion be forced out of their equilibrium or natural state. Consequently in a single volume in motion there may exist innumerable other volumes, and indeed as many as there are centres or causes of motion, or as many as there are particles. Nevertheless every volume, from a motion arising from its centre, diffuses and configurates itself most equally and regularly according to the geometry of the parts; that is, spherically. 20. If the volume of ethereal particles flowing from a centre into perpetually equidistant surfaces pass through any hard body or its more open meatuses so that the motion of the fluent ether be continued from the other side in the same

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ratio, course, and mechanism, I say that such a body is transparent or pellucid; but if it pass through irregularly so that, the flowing of the ether being changed, the motion be variously continued from the other side, I say that the body is of a white color. A volume which is directly moved from a centre extends itself like rays, and where it cannot pass through it is reflected and indeed according to the angle of incidence, just as all elastic and spherical bodies are resilient from any other elastic or hard body; but if [the volume of ether] pass through it is reflected and refracted according to the same angle, or that of incidence. Within one volume in motion there may be similar and dissimilar motions, motions concordant and discordant, motions more or less harmonic; and all these may simultaneously pass through the organs of the eye and simultaneously and similarly present themselves to the soul. 21. Motion diffused from a given centre through a contiguous medium (*per contiguum*) or volume of particles of ether produces light, for by means of this motion the ether is reflected from every entity it meets and thus an idea (*idea*) of the thing is presented to the eye. The central motion of the particles of the ether causes not only a rigid expansion of every particle, but also heat; and if this motion be urged from some centre towards circumferences light together with heat is caused. But if the motion be urged from centres towards circumferences, or into a local motion without the central circumvolution of every particle, there thence exists light in a cold state. There are corpuscles which resemble a kind of effluvia which are so small that they can move only a volume of ether, but not a volume of air; if they be spontaneously moved light is excited to [some] distance; if they are not moved spontaneously, but by means of the tremulation of the parts in a hard body in which they are, light is also excited and likewise electricity, as long as the tremulation continues.

Chapter VI.; Concerning the fifth finite.

It must arise where there is a quantity of finites of the fourth kind, and in the place where the latter can somewhat unfold and finite each other. And because the fourth finites are now nowhere else than in the planets or here in the earth, neither

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can they unfold and finite themselves in any other place than around the surface of the earth, not even between the surface and the centre because there they have no room for unfolding themselves; hence it follows that they must arise near the surface of the earth, and indeed at some distance from the sun where the pressure of the vortical element is not so great as in the vicinity of the sun.

CHAPTER VII.; CONCERNING AIR OR THE FOURTH ELEMENT OF THE WORLD.

Air consists superficially of fifth finites and within are enclosed the first and likewise the second elementaries; thus air is most similar to ether from which it differs only in degrees and dimensions. With regard to their locality, the origins of the ethereal and aereal particles are similar, namely, near the surface of the earth, where, as was said, the ethereal particles came into existence. With regard to the manner of their origin, the aereal particles originate in a manner similar to that of the ethereal, namely, among the first and second elementary particles. The aereal and ethereal particles are consequently similar in form and differ only in magnitude and dimension. 1. In the course of time there is produced a great abundance of these elementaries, or of air, because an immense volume of such elementaries may arise from a small volume of finites; thus our new orb, always decreasing as to its surface, becomes considerably diminished before the whole atmosphere around it can be entirely formed. The things *concerning air* [which now follow] are similar to those *concerning the ether* [concerning which see the *Principia*, Part III.], Chapter V., sections 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 18; [concerning which see above in Chapter V., on *Ether or the Third Element of the World*].

CHAPTER VIII.; CONCERNING FIRE OR THE ACTIVES OF THE FOURTH, FIFTH AND FOLLOWING [FINITES].

Finites of every power and dimension may actuate themselves, if only they have space for so doing, or for running very freely, naturally, and without retardation into their circles, and if only they are not implicated in circumfluent elementaries

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and become convoluted into surfaces or new bullular, superficial, or elementary particles. 2. There are no actives of the third finite, but all [the particles of this kind] are third finites and in the surface of the second elementary particles. The actives of the fourth finite constitute a subtle elementary fire, the actives of the fifth finite the common or culinary fire. 3. There also apply to these actives the things which were mentioned above in Part I., Chapter V., section 7; also, Chapter VII., sections 6, 7, 8, 10, 11, 18, 12, 13, 14, 15, 16, 17, 19, and in Chapter V., sections 8, 10, 11, 12, 13, 14, 16, 16, 17, 18, 19 20, 21, 22; and, in the same chapter, sections 14, 27, 29, 29, 30. 4. The fifth active is nothing else than the fifth finite set at liberty, or sent into space, where, like the preceding actives, it can run freely into eccentric circles and gyres, by means of which it may form as it were continual surfaces, and thus by its weight and impetus act upon the things it meets. These fifth finites, as to their greater part, constitute the surfaces of the particles of air. The active of the fourth finite is nothing else than the fourth finite set at liberty, or sent into a space, where, like the preceding actives, it can run freely into eccentric circles and gyres and by means of them form as it were continual surfaces and thus act upon the things it meets with velocity and mass or weight. These fourth finites, as to their greater part, constitute the surfaces of the particles of the ether; they likewise occupy the central globe of the earth. [5. The fifth finites cannot become active as long as they occupy the surfaces of the particles of air; and if by chance they should be set free from the surface by the expansion of the particles of air, they nevertheless cannot become active without immediately illapsing into the surfaces of the remaining particles of air, and there, together with their like, performing a general motion; the case would also be similar with the fourth finites in the surfaces of the particles of ether.] 6. The actives of the fifth finite cannot form any active space except among the particles of the air, by which they are enclosed and bounded on every side, and thus they can form no space among the particles of ether, and still less among the particles of the more subtle elements, or the first and second. These actives cannot have any boundaries, but become immediately dissipated unless enclos-

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ed by the particles of air. In like manner the actives of the fourth finite can form no space except among the particles of ether, but not among the particles of air, nor among the second and third elementaries, because they would be immediately dissipated. 7. The space formed by the actives of the fifth finite in the volume of the particles of air cannot subsist unless the space be constantly supplied with a fresh quantity of actives; that is, unless the active space continually receive fresh aliment. Otherwise the actives are immediately occupied by the first and second elementary particles and converted into particles of air, or they illapse into the surfaces of the circumambient aereal particles and thus perish and are dissipated. In like manner the space formed by the actives of the fourth finite in the volume of particles of the ether cannot subsist unless continually fed by new actives, otherwise they become immediately occupied by the first elementaries and converted into ethereal particles, or, illapsing into the surfaces of the circumambient ethereal particles, they perish and are dissipated. 8. A great abundance of the [fifth] finites or actives of the fifth finite enter into the compages and texture of mundane bodies, such as vegetable, sulphurous, oily, and other [substances], from which new actives may continually emanate and germinate into the active space, that is to say if those bodies are in the space itself. Many aereal particles may also enter the compages and texture of these bodies, and simultaneously with the solution of the bodies rush into the active space. Aereal particles, which are separated from the volume of their particles and merged into an active space, immediately become free, and all fifth finites residing in their surface thus become actives; in this manner fire may receive much aliment from the air. The case is similar with the actives of the fourth finite which reside in the surface of the ethereal particles. 9. The particles of air nearest the active space are in the highest degree of motion and consequently most highly and rigidly expanded. But those which are more remote from the space are in a lesser motion and in a lesser expansion and tension, and thus [there is a ratio] according to degrees of distance from the space. In like manner the active space cannot subsist unless the aereal particles be expanded according to their distance from it; that is,

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unless there be formed around the space a sphere of particles gradually less and less expanded and mobile. The case is similar with the ether around a space consisting of actives of the fourth finite. 10. The aereal particles themselves, when put into the highest degree of motion by the actives of a space, present something which is similar to the actives themselves; they likewise produce something which is igneous and warm and dissolve the connections of certain parts. Thus, in their state of expansion and mobility, the aereal particles resemble a kind of active, but not in this, namely, that they do not excite the volume of ethereal particles into such a motion that any light is diffused round about. 11. The ethereal particles can be in the same space together with the actives of the fifth finite, but when in that space they are excited to a most intense motion, and consequently when thus moved they are very highly expanded and made rigid. The ethereal particles thus contribute in a signal manner to the degree and production of heat. The actives of the fifth finite may in their space urge an ethereal volume into such a motion that the original [motion], appearing in its modifications, presents light. The ethereal particles also which are within the space may be dissolved and the space thus made stronger and larger by the actives of the fourth finite. Finally, the ethereal particles may also be in some measure exterminated as the active space is increased in force and extent. 12. The first and second elementaries can be in one and the same space with the actives of the fifth finite and not at all disturb their circles and gyres and yield to them, just as the atmosphere yields to a weight which is gyrating and revolving within its volume. [13. The force of the active space increases according to the abundance or number of actives collected in the same space, and according to the addition of the actives of the fourth finite to the number of the other antecedent finites.] 14. The space consisting of the actives of the fifth kind has no weight except what is given to it by the volume of ethereal particles or of the first and second elementaries forming what is contiguous in that space. This space has no determinate position except that which is contributed or determined by the enclosed ethereal particles and elementaries, likewise by the aereal particles, which are

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circumfluent and made lighter by their expansion. 15. The actives of the fifth finite operate by their degrees and impetus upon the things they meet and dissolve their connections. The ethereal particles also, which are in a state of most intense motion, operate upon them by their central gyrations and the activity flowing thence, likewise by their expansion. And the space itself, by reason of its lightness, acts upon the connections of the harder bodies, and dissolves them by the equilibrium and ratio of its pressure on both sides, that is, both without and within the compages of the bodies. Several causes may thus concur in the solution of bodies by fire in an active space. Now because the active space cannot subsist except by means of new actives, which perpetually enter into the space and so constitute it, it follows that it cannot subsist unless it be always replete with parts of the same kind and which the above mentioned actives supply by their dissolution, so that the space must thus be crowded with sulphurous, oily, saline, vegetative, and several other kinds of particles, whence it is that the space can extend itself no further than the tide of those particles from which the actives come. From this it also follows that it may be stronger or weaker according as the parts floating in it supply a less or greater abundance of these actives. 16. The space consisting solely of actives of the fourth finite and enclosed by the ethereal volume can pass through the atmosphere with a very free current; it may cleave through and penetrate even hard bodies, and in its passage it may break and dissolve their more subtle connections and present phenomena in addition to those presented by a space of actives of the fifth finite. 17. The central globe of the earth consists of fourth finites, but these finites cannot break forth and actuate themselves without being immediately occupied by the first elementaries and converted into ethereal particles, according to the theory presented above. But if there were a passage leading from the centre sufficiently open for the above mentioned finites to break forth through it, an active space would be formed by that part at our present distance from the sun; and having been formed it might subsist as long as fresh finites constantly emanated and germinated into the space. But by means of such a space the sphere of the ether would grow

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considerably and the earth would lose that equilibrium which it now maintains at its present distance from the sun and in its present vortex; consequently it would undergo some signal change not only in regard to its position and its circle in the vortex, but also in regard to its polar position and axillary motion.

CHAPTER IX.; CONCERNING WATER OR THE PURELY MATERIAL FINITE.

1. A particle of water is similar to a compressed particle of air in which there remains nothing elementary, yielding and elastic, but a something hard, consisting of contiguous spherules formed within another larger spherule. The particle of water is not a finite like one of the preceding finites, namely, capable of actuating itself, but it is a purely material finite. Consequently water is not an elementary particle. 2. [Particles of] water or finites of this kind cannot move among one another like elementaries unless there be interfluent elementaries to carry these particles with them into motion. The [particles of] water thus entirely owe their whole motion and fluidity to the interfluent ether; and the aequeous particles are the more mobile and fluid in the degree that the circumfluent ethereal particles are the more mobile, extended, and rigid, and the less mobile and fluid in the degree that the circumfluent ethereal particles are the less mobile, extended, and rigid, but as it were flaccid. And when at length the ethereal particles become deficient in mobility and tension it is plain that the aqueous particles must grow torpid and languish, uniting and concreting into a hard mass. 3. The ethereal particles are capable of permeating the interstices of water; but the aereal particles cannot do this on account of the difference in their dimension. The aereal particles are therefore contiguous with the aqueous as to surface and are incumbent upon them according to the altitude or the weight of their volume.

CHAPTER X.; CONCERNING AQUEOUS VAPOR OR THE FIFTH ELEMENT.

1. Vapor is formed on the surface of water, and indeed from the motion of the interfluent ethereal particles. When vapor is formed it encloses within itself a small volume of ether; ex-

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ternally, however, it is pressed by both the air and the ether. The surface is thus equilibrated by forces from without and from within and preserves its spherical form under every degree of compression. 2. Vapor may be compressed and dilated and thus it possesses a yielding and elastic surface; but it owes all its elasticity to the enclosed ether, and the ether to its enclosed first elementaries. Thus vapor is a particle not fully yielding and elastic, consequently not fully elementary, but similar to an elementary, or endowed with elementary properties (*elementata*). The surface of the vaporous particle may be variously multiplied and in its state of compression it consists of numerous duplicatures, series, and expanses, but in its state of expansion it consists of fewer duplicatures, series, and expanses; thus it may be expanded and compressed according to the governance and state of the enclosed ether and the surrounding air. 3. A large volume of vapor may arise from a small volume of water and this volume may become more and more expanded by heat when there is a fire near it. It may be expanded with so great a force and tension (*rigore*) that large weights may be lifted up and walls of iron and brass be burst asunder. Vapors which are in a contiguous form may be most highly expanded; and the expansion may grow more and more if only a constant stream of water be furnished from which new vaporous particles may not only continually arise and pass into the contiguous mass, but also be in a continual current from one vapor to another, flowing from the bottom to the top, and thus affording them room and opportunity for expanding themselves still further. And if any of these particles burst by too great an expansion, the diffluent water hence arising and illapsing into the surfaces of the neighboring particles always furnishes them with fresh means for a still further expansion. 4. Particles of vapor differ from bubbles of water in this, namely, that the former contain only ether, while the latter contain both ether and air. 5. In every bubble of water is contained all that had previously existed up to this time even from the first simple, not only every genus of finites and actives, but also the elementaries, concerning which it has been treated; thus in a small bubble our world, both visible and invisible, is latent.

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CHAPTER XI.; CONCERNING THE VORTEX SURROUNDING THE EARTH AND THE EARTH'S PROGRESSION FROM THE SUN TO THE CIRCLE OF ITS ORBIT.

1. In the solar vortex formed by the spiral motion of the elements from the centre to the circumferences, the elementaries are not only reduced and arranged into a regular position and motion, but are perennially kept in this position and motion by the sun which is in the midst. Consequently there is in this vortex a force or effort from the centre and to the centre according as the bodies are lighter or heavier in the volume of the element. 2. The earth perpetually revolves around its axis like a large finite, and spontaneously, that is, from the effort of its individual parts constituting its central globe; and thus, immediately on its leaving the sun, the earth began to pass through days and nights. When the earth first left the sun it seems to have performed its revolutions more rapidly than afterwards at a distance from it, when a great part of it had been used up in the formation of ether, air, water, and terrestrial matter and when it was more bound and coerced by a crust consisting of various entities. 3. The earth, like a large active, has a tendency to a second motion, or to circles around the sun, by means of which it forms a surface not unlike the above mentioned actives; but still it is carried around the sun principally by the stream of the solar vortex. Consequently, from the beginning of its excursion, winters and summers, springs and autumns, in a word years, were continually passed through and completed, but much more briefly and rapidly than at the present day. 4. The earth, revolved among the elementary particles of the solar vortex according to its magnitude and the velocity of its motion, formed around itself a vortex, not otherwise than the very small magnetic corpuscle [treated of in the Second Part]; consequently in the beginning of its excursion it first described a larger but afterwards a smaller vortex. The earth, when thus lying in the centre of its vortex, is in its natural position, neither can it be transferred out of its vortex, nor move unaccompanied by the vortex. As long as the axillary motion remains so long the vortical motion of the parts also remains, always determined

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and proportioned to the size and velocity of the body. 5. The vortex formed around the earth seeks an equilibrium in the solar vortex, that is, occupies the place where it can be in a state of equilibrium. Were the vortical motion greater or swifter it would seek a different locality from what it would were the motion less or slower. This, however, does not prevent the elements of the solar vortex from exercising a pressure within the minor vortex also, in proportion to their altitude and similarity in every direction. Nor does it prevent them from exercising this pressure if smaller vortices be formed within the larger; and thus from the general pressure of the solar vortex there arises a tendency (*nisus*) to the centre of the earth. 6. The greatest motion of the solar vortex is around the centre and is less and less towards the circumferences, and least or none in the ultimate circumference; and this in the plane of its zodiac. 7. The earth, which is compelled to form innumerable spiral circles in its passage around the sun, travels with a velocity gradually diminishing in proportion to its distance from the sun. Its motion also is diminished according to the circles it describes, or its annual gyrations in a simple ratio; but in relation to the diameter or right line drawn perpendicularly to the sun, in a duplicate ratio. 8. But with regard to the velocities in the solar vortex at the various distances from the centre, I say that they are in the diameter in the subduplicate ratio of the distances from the ultimate circumference, or from that circumference where all motion ceases. In like manner in the solar vortex the times are in the subduplicate ratio of the distances from the ultimate circumference to the centre. If, however, the vortex be such that the least motion is in the centre, and always greater towards the circumferences, then the velocities and times will be in the duplicate ratio of the radii from the centre. 9. If two planetary bodies are flowing in the solar vortex, each at a different distance from the centre, and each in a circle or ellipsis around the sun, I say that the squares of the periodical times of each body will be as the squares of the radii divided by the distances or complements of the radii extending to the ultimate circumference. If, however, the vortex be so formed that its least motion is in the centre, and its greatest always towards the cir-

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cumferences, then the squares of the periodical times will be as the cubes of the distances from the centre. 10. Two planetary bodies flowing at unequal distances from the sun or centre differ in their velocities; and their velocities are as the rectangles of the radii and times reciprocally. If, however, the motion increases from the centre towards the circumferences, then the velocities will be in the subduplicate ratio of the radii. 11. If two planetary bodies gyrate at unequal distances from the solar centre the centripetal forces are as the distances from the ultimate circumference divided by the radii. In the vortex, however, whose motion is less at the centre and greater towards the circumferences, the centripetal forces are reciprocally as the squares of the radii.

Chapter XII.; Concerning the Paradise of the Earth and the First Man.

1. A crust formed itself upon the water by the dissolution of the parts in the water and the interjection of finites which emerged to the surface and formed upon the water a crust which continually increased by an addition of parts one under another. 2. The earth underwent innumerable changes before it arrived at its orbit or fixed circle, that is to say, changes as numerous as the circles it completed, or the different distances of these circles from the sun; as numerous also as were the degrees of velocity in the course of its annual and diurnal revolution; in a word, it underwent some new change every day and hour while it travelled from the sun to the circle of its orbit. The system of the earth (*mundus telluris*) must have undergone innumerable changes before it could have been fully perfected and have consisted of so many series of things simultaneously and successively arising, or before it could have been enriched with so many entities as would suffice for all its kingdoms, the mineral, vegetable, and animal; before also it could have sown (*poneret*) its seeds, afterwards unfolded and expanded them, and so delightfully and variously adorned its own surface. 3. In that state of the earth, when it revolved more rapidly about its axis and gyrated more rapidly around the sun, or when the earth measured out shorter days and years, there was a kind of

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perpetual spring upon the whole earth, a condition most highly adapted for the generation as well as the procreation of things. Without this perpetual spring no seeds would have germinated (*nascerentur*), nor could vegetables and animals of every kind have been produced.

The End.

NOTE AND COMMENT.

Change in Editorship of the New Philosophy: In accordance with the action of the Swedenborg Scientific Association at its last annual meeting the New Philosophy passes, with this number, under new editorial guardianship, and Dr. Harvey Farrington, of Glenview, Illinois, is the editor selected. Dr. Farrington has been prominently connected with the Swedenborg Scientific Association since its inception and has been one of the most interested and active workers on its committees. These facts, together with his well-known experience in the field of medicine upon which so many of Swedenborg's early works intimately touch, give great promise for the future of the journal under his care.

SWEDENBORG AND THE LOCALIZATION OF BRAIN FUNCTIONS.

The Newly Awakened Interest in Swedenborg's Scientific Works in Europe.

Under the title *Swedenborg redivivus* Dr. Max Neuburger of Vienna contributes an article to the *New Free Press,* of Vienna, in its issue of Sunday, September 20, 1903, in which he describes the zeal displayed by the recently appointed committee of distinguished scientists of the Swedish Academy of Sciences for the purpose of investigating and publishing the scientific works of Swedenborg. "What a contribution the history of scientific thinking has to expect from this bringing to light of Swedenborg's works may be judged from the list of names of those engaged: Retzius, Loven, Henschen, Arrhenius and Nathorst." The article is lengthy, occupying six entire columns of the Vienna daily, and is written in a style of much literary beauty, without sacrificing the scientific accuracy the subject demands. Only a brief extract can here be translated.

"A mighty and enflaming spirit must indeed breathe forth from those dust-covered papers which went directly from the author's desk to the shelves of the Academy's Archives, when investigators of such fame, men who have hitherto occupied themselves only with searching out

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the secrets of nature, come together to devote themselves for a time to the self-sacrificing labor of text-study and criticism. There must dwell a substance in those pages far outreaching the limits of a single searcher's lifetime when the representatives of such varied fields of labor, Anatomy, Physiology, Pathology, Chemistry and Physics, Geology and Paleontology find here the object of a common enthusiastic devotion."

"These renowned names, their diversified lines of study, the unusual fact of naturalists turning themselves to the service of Clio in order that they may cleanse the monument of the "Swedish Aristotle" from the grime of contemporary abuse, must certainly strike with wonder those multitudes who on second-hand rumors have been accustomed to smile at the "arch-phantasist" and "spirit-seer," without holding it worth while to halt and give a glance into the scientific works of this extraordinary man. Those, however, who already before this imposing announcement of an authoritative body of judges have studied the revered author in a spirit equally void of enthusiasm and of prejudice and have recognized in many a line of his scientific works the anticipations of modern, even of the latest, scientific conclusions, will regard this as a tardy, but not less significant triumph of justice, that the gates of the Walhalla of the Learned at length open to the great investigator."

Dr. Neuburger proceeds here to raise the question, how could so exact a scientific mind and so devoted a student of nature lend himself to the later role of the mystical interpreter of the Bible and seer of spiritual things, and he replies: "To one who knows the scientific works of Swedenborg this chasm of separation is not so deep. For there was a common fundamental principle which bound the early scientific with the later theological writings and that was the striving after the transcendental knowledge. Swedenborg lets his whole life be told in one sentence. It was a *Search for God.*" . . . . "Pre-eminent as Swedenborg stands, whether setting forth the hypothesis of the central sun, whether deriving the process of chrystallization from the grouping of bullular atoms, whether making the nebular hypothesis the basis of a cosmology or trying to resolve chemistry into geometry and anticipating like a Leverrier of Chemistry the composite nature of water,—in reality he reaches a far greater height exceeding the loftiest expectations, when by the inductive method, from anatomic physiological facts, he arrives at the very laws of life itself and in this realm discovers many particulars by virtue of his own research in both physiology and anatomy which had escaped the learned profession."

The article closes thus: "The hasty sketch has accomplished its purpose if it has succeeded in directing into entirely new ways the interest in the 'Spirit-seer.' The joint labors of the Stockholm savants will gratify this interest in all respects. We believe that as soon as their results are known the name of Seer, now ironically given, will be first

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applied to the great Swedish philosopher in its true meaning, for the great Swedenborg was indeed a Seer in all the realms of nature!"*

Besides this significant notice we have received two brochures containing extracts from the August and September numbers of "Janus" Huitieme Annee VIIIe Livr. The first being an article of Dr. Neuburger on "Swedenborg and the Doctrine of the Vita Propria" (*Swedenborg's Stellung zur Lehre von der Vita Propria*), the other entitled "What did Swedenborg teach regarding the Function of the Corpora Quadrigemina? (*Was Lehrte Swedenborg uber die Funktion der Vierhugel?*")

In the first Dr. Neuburger says: "The great physiological system set forth by Swedenborg in his two works, *Oeconomia regni animalis* (Amsterdam, 1740-'41) and *Reguum animale* (Hagae Comitum, 1744), contains such a number of successful anticipations of modern science that we do not wonder when we see how feebly his contemporaries grasped the true greatness of this Aristotle of the North. All the more strange is it however that the spirit of medical investigation elsewhere so lively in these times should have left untilled a field so rich as this in possibilities. The splendid task still awaits the competent pen that shall adequately present the anatomical physiological system of the great Seer at once in the framework of his own time and in the light of present knowledge."

The author here, in a note, calls attention to the fact that "as early as 1845 no less an authority than the world-famed anatomist Anders Retzius has recognized the merits of Swedenborg in this field of research. . . . In an address before the Swedish Academy of Sciences he said of Swedenborg's *Reguum animale:* 'One finds here ideas which belong to the most recent learning, a spiritual horizon, a logic, a comprehensive grasp which can only be likened to that of Aristotle. One may well assume that it will take more than a single decade to attain to a truly worthy estimate of this work."

Dr. Neuburger proceeds to remark in his essay: "In the same spirit I have not long ago delivered an address, which pointed out that Swedenborg discovered before Schlichting the respiratory motion of the brain and that he was the first to assign exclusively to the cortex cerebri the psychical functions and indeed located the centers of the muscular activity in the cortex. The friendly recognition accorded to this address encourages me to present to the profession the following modest

*It may be worth while to remark here that Swedenborg never himself assumed the title of "Seer" either before or after his illumination, and that while those who accept his theology and his revelations of the spiritual world will regard the seership of nature as incomplete without the informing light of the higher revelation, still for those who can only follow Swedenborg in his natural researches the title of a "Seer in all the realms of nature" is one admitting of no narrow and materialistic interpretation, according to Swedenborg's own definition of his purpose and aim.

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sketch, a drop of water merely, which, with their co-operation, may develop into an ocean of Swedenborgian medical research."

The address referred to is that delivered by Dr. Neuburger before the 73d Convention of Naturalists and Physicians in Hamburg, and published in the Vienna Medical Weekly, 1901, No. 44. Its title is *Swedenborg's Relation to Brain Physiology.* It was translated into Swedish by Professor C. G. Santesson (Hygeia, 1902), and referred to in the British Medical Journal March 21, 1903. By this means the attention of the medical faculty has been widely drawn to the two works—the *Animal Kingdom* and the work on *The Brain.*

Professor Gustav Retzius wrote to Dr. Neuburger on the 9th January, 1903: "Your address has roused my wonder, especially your proof that Swedenborg had really in sight the localization" (of the psychic functions). It was on Professor Retzius's motion that the Swedish Academy of Sciences has appointed its committee to publish the unedited MSS. of Swedenborg. To this committee belong Retzius, Loven, Nathorst, Arrhenius and Henschen. Dr. Neuburger expresses his regret that on writing this Hamburg lecture he was still unaware of Dr. Tafel's translation of the work on the Brain, and also of the eloquent endorsement given this work by Professor Loven in a private lecture delivered before the Swedish Academy in 1883, wherein he calls attention to Tafel's translation and shows that Swedenborg detected the localization of intellect and motility in the cortex; that he discovered before Cotugno the existence and meaning of the liquor cerebro-spinalis and anticipated in a marvellous way the results of the researches of Key and Retzius regarding the cerebral lymph system.

The essay itself of Dr. Neuburger is full of striking instances illustrated by full quotations of Swedenborg's doctrine of the vita propria or the instinctive vital intelligence, choice and activity shown in the minutest organs of the body, and we hope to see it translated in full for our pages. He concludes:

"I have purposely allowed Swedenborg to speak for himself so that the reader may be left to an unbiased judgment. That I should have paid little attention to reminiscences of the past and comparisons with contemporaries and found far richer material in the resemblances to the latest physiological views is only another strong evidence showing how little the great Swedish thinker has become antiquated. At his lamp well might the science of today light her torches! What he with Seneca awaited: "Venient. qui sine offensa sine gratia judicent" may yet at last come true. The time is come to fulfill the requirement of justice."

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The Function of the Corpora Quadrigemina.

In the second of the above mentioned brochures from the monthly periodical "Janus" Dr. Neuburger treats of Swedenborg's teaching regarding the Functions of the Corpora Quadrigemina (die Funktion der Vierhugel). He begins:

"To waste words with the Medical Faculty about Swedenborg's physiological achievements I regard as unnecessary, since the Stockholm Academy of Sciences is about to publish the manuscript remains of the Swedish Aristotle."

"In this treasure, among others, there is a special treatise on the Brain already made accessible through the valuable labors of Dr. R. L. Tafel, but hitherto unutilized by the medical historians. To invite to a study of this monumental work and to show how Swedenborg, in spite of the poor facilities of his time, outstrode with giant steps his own century in this difficult field, I will cite a passage from his treatise which will throw convincing light on the force of his achievement." After referring to Swedenborg's discoveries of the central canal of the spinal cord, the psychical functions of the cortex of the brain, his surprising conclusions as to the localization of motility in distinct parts of the cortex, and his view of the purpose of the liquor cerebrospinalis, the article proceeds:

"In the same anatomical method he sought also to explain the function of the Corpora Quadrigemina (Vierhugel) in relation to the neighboring region of the Sylvian duct. The result must astonish equally the historians and the neurologists, the former in view of the errors of the old authorities, the latter in view of the latest data of our present knowledge. It means that the *Vierhugel, and the gray matter of the duct of Sylvius, control the movings of the eyes* (especially their co-ordination) *and the accommodation of the iris.* . . . Modern science has not only established the fact of the ocular-motor lying beneath the Sylvian duct, but it is known by clinic observation that diseases of the Vierhugel are accompanied with the weakening of the nuclean eye-muscles and sometimes also with a disturbance of the pupil's reaction and accommodation. . . . Swedenborg wrote his work on the brain in two efforts. the first in the years 1735-1738, the other in 1741-1744. If one will compare the cited passages with corresponding productions of his contemporaries the true conclusion declares itself."

The medical profession of America, as well as that of Europe, may feel itself greatly indebted to Dr. Neuburger for his bringing to light these treasures of practical anatomical and physiological knowledge from a source they have so long and so unworthily treated with neglect.

Frank Sewall.

Washington, D. C.

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Swedenborg and Solar Energy: In an essay on the *Source and Maintenance of Solar Energy,* by J. Morrison, M. A., M. D., Ph. D., reprinted from *Popular Astronomy,* October, 1902, the author speaks of the theory now known as the "Nebular Hypothesis of Laplace" as being "first suggested by Sir William Herschell from a careful study of the nebulae, and subsequently and independently by three of the most profound and learned philosophers that ever lived, viz.: Swedenborg, Kant and Laplace." This statement contains two errors. Swedenborg's theory was not subsequent to Herschell's, as the latter astronomer was born in 1738, and Swedenborg's *Principia* containing his entire cosmogomy was published in 1734. Instead of the nebular hypothesis being "first suggested" by Herschell, the Russian astronomer Nyren has pointed out that that distinction clearly belongs to Swedenborg. See *Vierteljahrschrift der Astron. Gesellsch.* Leipzig, 1879, p. 81.

Kant, Buffon and Laplace to whom the nebular hypothesis is generally accredited all wrote subsequently to Swedenborg and had access to his writings—Laplace informs us himself that his first ideas on the subject of the nebular cosmogony were gotten from Buffon, and the very copy of the works of Swedenborg owned by Buffon and bearing his signature may be seen at the Swedenborg book rooms at 3 W. Twenty-ninth St., New York.

FRANK SEWALL.

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TO

The New Philosophy.

VOLUMES I—VI.

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The Roman figures refer to the volumes and the Arabic to the pages.

E. F. S.

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C. H. A.	Carl Hj. Asplundh.
C. R. M.	Prof. C. Riborg Mann.
C. E. D.	Prof. C. E. Dœring, A. M.
C. T. H.	C. Th. Odhner.
E. S. P.	Prof. E. S. Price, A. M.
F. S.	Rev. Frank Sewall, M. A., D. D.
H. F.	Harvey Farrington, M. D.
J. R. S.	John R. Swanton, Ph. D.
J. W.	Rev. John Whitehead.
L. B.	Miss Lillian Beekman.
L. F. H.	Rev. Lewis F. Hite.
L. P. M.	Rev. Lewis P. Mercer.
N. C.	Note and Comment.
Q.	Quoted.
R. W. B.	Rev. R. W. Brown.
Sw.	Emanuel Swedenborg.
S. S. A.	Swedenborg Scientific Association.
W. F. P.	Rev. W. F. Pendleton.

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