Sympathetic Vibratory Physics - *It's a Musical Universe!*

Dr. Abrahms' Electron Theory

by William Hudgings

INTRODUCTORY

This treatise on the electronic structure of matter and the effects of electronic vibrations within the atom has been undertaken in the belief that the general reader is deeply interested in the work of scientific men if informed about it in comprehensible phrase. It is regrettable that so few scientific works have been written in language that the popular mind can understand. The average person habitually yearns for knowledge concerning the mysteries of the universe, and every scientific discovery is hailed with popular enthusiasm when the story is told in language simple and lucid. But too often our scientific writers, being brilliantly endowed and accustomed to thinking in abstruse and technical terms, find it quite impossible to come down to the layman's level and express themselves in popular phraseology. It is the purpose of this booklet to acquaint the ordinary reader with the most recent findings of science in the field of physics, particularly in relation to living organism and the pathology of disease. Dr. Albert Abrahms of San Francisco, being a pioneer in this field of physical research, has made certain discoveries of such consequence that much space is devoted to a detailed consideration of his findings. After his experiments have been described, the reader will find in Part II of this essay a full, popular treatise on the modern electron theory of matter upon which the Abrahms research work is based. This part of the essay is really a simplified condensation of all the technical works on physical science of the past twenty years insofar as they relate to the electronic structure of atoms and to chemistry, recording every important discovery on the subject down to the present time. Acknowledgment is gratefully made to Francis A. Cave, M. D., D. O., Dean of the Physico-Clinical Institute of Boston, Mass., for his valuable criticism of the text throughout before the material was put in final form. The author is also especially indebted to Dr. John B. Buebler, Dean of the Connecticut Branch of the Electronic College, for assistance rendered at his New York office during the investigation.

W. F. H.

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Part I

RELATION OF THE ELECTRON THEORY TO DISEASE AND DIAGNOSIS

MODERN knowledge of the electronic structure of matter has revolutionized many ancient concepts in nearly every field of human endeavor. The great and important field

of therapeutics is by no means an exception. The public press has had considerable to say of late about Dr. Albert Abrahms of San Francisco and his application of the electron theory to the diagnosis, treatment and pathology of disease. Some have acclaimed him as a scientist of the first wicked impostor who has discovered nothing more than the pecuniary fact that Barnum was right. Every revolutionary discovery has met with opposition from some quarter. Copernicus, Gallileo, Kepler and Newton, each in his turn contended with the forces of reaction, prejudice, superstition and ignorance so rampant in their day, until the truths of their discoveries eventually emerged triumphant.

The one thing worse than being talked about is not to be talked about at all. But the newspaper publicity, favorable and unfavorable, which Dr. Abrahms has received, is of little importance as a means of determining the value of his findings. The one thing needed is in dispassionate consideration of his claims in the light of known scientific facts concerning atomic structures, and this is in fact the aim of the present treatise. Inasmuch as health is of first importance to everybody it seems appropriate that the Abrahms theory shall first be outlined, then consideration will be given to the electron theory in general upon which it is based. Our treatment of this subject is wholly in the interest of science. It is not for the purpose of propagandizing any person, school or cult, although it is obviously essential to a fair presentation of the facts to mention the name of the investigator and if he has made any discovery worth while he is entitled to just credit therefor. If no discovery of importance has been made then the public is entitled to that knowledge. We shall refrain from presenting any partisan argument for or against any practical endeavor to bring needed relief to suffering humanity. We are concerned with making an unbiased examination into the experimental efforts of an investigator who claims to have a valuable contribution for the accumulating fund of knowledge concerning electrons and the structure of matter. If Dr. Abrahms has made, or thinks he has made, any actual discovery in this field of physical research he is unquestionably entitled to an honest hearing.

To begin with, Albert Abrahms, M. D., LLD., F. R. M. S., is a Jew who was born in San Francisco about sixty years ago. At nineteen he graduated from Heidelburg University and later took post graduate courses in London, Berlin, Paris and Vienna, and on his return to America became a rather prominent figure in West Coast medical circle, according to his biographical sketch in "Who's Who in America." At twenty six he was elected Vice President of the California State Medical Society, accepted a professorship in Cooper Medical College (Leland Stanford University) at thirty, and later became president of Emanuel Polyclinic.

During this time he made certain medical discoveries and was author of several textbooks on disease and diagnosis. But his more recent findings, referred to above were considered to be so revolutionary and startling that he claims not to have mentioned them to his fellow physicians for a long time, fearing he would not be believed. This interim was industriously spent in private verification of the system he had formulated, thousands of cases being used to check and recheck his basic theory until he had gathered what be believed was sufficient proof to convince the whole medical fraternity; then he announced his experiments to the world. It appears that his previous fears were well

founded. The medical profession with characteristic conservatism tabooed the discoveries and condemned the discoverer without much regard for his accumulated proofs, and the Journal of the American Medical Association heaped him with satire and virtually proclaimed him a prince of quacks. On the other hand a minority of "regular" physicians, laying professional prejudice aside, have dared to investigate the Abrahms theories: and these now declare that he has made one of the greatest "finds" of the century. They furthermore assert that his "persecution" from the old school conservatives simply proves him to be several years ahead of his time. Regardless of the merits of either side of the controversy, it is obvious that should Dr. Abrahms methods meet with popular approval, as they are already doing in many quarters, many great medical institutions, drug factories and drug stores would have to find other lines of business or close their doors.

The Abrahms method of diagnosis and treatment is called the "ERA System," the letters E. R. A. having been chosen by the founder to represent "Electronic Reactions of Abrahms." In view of the electronic structure of matter and its general property of radioactivity, Dr. Abrahms conceived the idea that in order to uproot a disease in the organism it is essential to go beyond the cellular tissues and really get at the electronic structures of the atoms. It seemed reasonable to his mind that disease is capable of producing certain changes in the rate or manner of rotation of the electrons in the affected atoms, and that so long as the electrons are not vibrating normally the entire organism will be out of balance. All this sounds logical, but how to correct, the abnormality of the electronic vibrations is the great problem. It is manifest that the planetary electrons of atomic systems are capable of many different motions at once, even as planets of a solar system undergo several simultaneous motions in their orbital journeys. It appeared to Abrahms, therefore, that each disease may have its characteristic vibratory rate, or rather the power to affect the motion of the electrons in a characteristic way, without destroying the vibratory motions which the electrons previously possessed, if this be so, an electronic analysis of the blood or tissues should reveal the existence of whatever diseases may be present therein, provided a means could be devised to do this.

Being of an inventive turn of mind, Dr. Abrahms set upon the task of developing an apparatus that would sort out these hypothetical vibratory rates and record them separately. After several unsuccessful efforts to produce a mechanical device of sufficient sensitiveness, be finally turned to the human nervous system as the most sensitive electrical machine on earth. He now claims that by using the nervous system of a normally healthy person in conjunction with a set of rheostats and an amplifier it is possible to cause each disease vibration in the specimen under examination to manifest itself by definite reactions which are produced upon certain nerve terminals. As a result of thousands of experiments he has now charted and classified the reactions thus elicited, and therefore maintains that by analyzing a drop of your blood (which of course really contains billions of atomic systems with their diversified electronic movements) it is possible to tell you what diseases are in your body, the stages of development of each, exactly what organs are affected, and whether a particular disease has been inherited or acquired by exposure. Sex and nationality may also be determined from these blood tests, it is declared.

To those who doubt that so much information may be elicited from a single blood drop, Dr. Abrahms retorts, "The mineralogist finds it unnecessary to examine a whole mine to determine the nature of its products. One drop of blood, with its countless billions of electrons, is a condensation of the multitudinous vibrations of the entire body." If a drop of blood can really reveal so much then there is a hitherto unsuspected depth of meaning to the Levitical proverb, "The life of the flesh is in the blood." It is apparent that by such a method of diagnosis the patient would not need to be personally present. He may be a thousand miles or more from the diagnostician. All he would be required to do would be to mail a drop or so of his blood to the clinic. The fact that the blood would be dry by the time it reached the physician should not affect the accuracy of the diagnosis, since the atoms are there whether the blood is in the liquid or dried state; and the diseases which had affected the electronic motions of the atomic systems would continue to affect them regardless of the molecular condition of the blood specimen. Hence it should be just as feasible to make a diagnosis from a specimen a year old as it would be to make it from a drop of blood taken from your body only a few moments before; the only difference being that the year old specimen will only disclose what your condition was up to the time it left your veins. Nor would the patient need to mention any symptoms to the examining physician, although the diagnosis might be facilitated if he should.

Admitting that Dr. Abrahms and his disciples may be somewhat over enthusiastic about their system, nevertheless I am not of those who see nothing but self-deception and humbuggery in the proposition. It is natural for most people to receive any unusual claim with pronounced skepticism, and characteristic for adherents of any well established school to disdain the views of a rival. But there can be no question about the fact that the Abrahms instruments, in conjunction with the human nervous system, do elicit abdominal reactions. I have repeatedly witnessed them, have taken part in the experiments, and have cross questioned at length several physicians whom, I familiarly know, who have studied and are practicing the Abrahms system regularly. To simply declare that all the thousand or more physicians from the medical and osteopathic professions who have adopted the 'ERA' are wicked deceivers or hypnotized dupes is a weak way to meet an important issue, and is as preposterous as it is unfair. Even if these physicians were hypnotized by Abrahms while studying at his clinic, why should the spell continue with them after they return to their home cities and take up to practice? And why should they continue to enthuse, and their patients continue to come, if no result are accomplished? I do know instances where remarkable cures have certainly been effected by the system of treatment; but even if we account for the cures in some other way it it nevertheless must be admitted by any honest investigator that the diagnostic process employed by Abrahms is not a hoax. Whether he correctly interprets or misinterprets the reactions which he elicits does not nullify the fact that reactions are produced; and where there is an effect there must be a competent cause.

Before attempting an explanation of the scientific principle involved, the following details of the author's initial investigation (which was followed by several months of study and experimental research into the matter) will acquaint the reader with the apparatus and process of electronic diagnosis which Dr. Abrahms employs. Upon arrival at the clinic I stated my purpose in few words, explaining that I am "from Missouri"

decidedly averse to anything psychic or spiritistic, and that nothing but the most tangible evidence of scientific fact would be acceptable to my state of mind.

"Most people bring their skepticism along with them when calling for the first time," I was told, "but unless wireless telegraphy and radio communication are psychic neither should the Abrahms' instruments be so considered."

Expecting to find a "mystic shrine" I was immediately disillusioned by finding the place about the same as any ordinary physicians office, with the much-talked-of Abrahms apparatus in full view. For hours I sat watching the procedure as the doctor went about his usual routine. Patience was required on his part as I repeatedly stopped him to check up on something I had witnessed, and as I plied him with numerous questions and made notes of the things I heard and saw.

A patient entered, a man of about fifty, accompanied by his niece. Plainly he was a sufferer from some aliment of long standing. The doctor did not question the man about his symptoms; he simply pricked the end of the patient's finger with a needle and squeezed out two or three drops of blood onto a tiny piece of white blotting paper. It was then placed alongside the Hemoglobin Scale to determine by its color its corpuscular percentage.

Part II

Operation of Dynamizer

At hand was a table upon which were four pieces of electrical apparatus which I was permitted to examine in detail. The first piece is called a Dynamizer, a small hollow fiber hose about five inches in diameter. Upon being opened it was seen to contain simply two electrodes which were connected to a ground wire. The top of the Dynamizer is an ordinary condenser consisting of two aluminum discs, an intervening piece of cardboard and a top made of bakelite. An aluminum wire ran from the top of the Dynamizer to an Amplifier, which is constructed on the principle of the Magnavox used on radio receiving sets. From the Amplifier the wire passes through two rheostats, called Reflexophones, both of which are equipped with numbered dials and indicators. One of the rheostats is used for measuring the rate and the other the potentiality of the electronic vibration from the blood specimen in the Dynamizer. From the rheostats the energy is carried through a wire to an electrode which is fastened to the forehead of a reagent, sometimes called the subject. This reagent or subject is not the patient, although the patient is sometimes used in that capacity. The reagent may be anybody, either male or female, the healthier the better, whose nervous system completes the electric circuit. In other words, the reagent is merely part of the apparatus, and a most important part at that.

By noting the reactions on the nerves of the reagent as the rheostat is shifted from number to number, the physician is able to detect what disease vibrations are in the blood specimen in the Dynamizer. I am well acquainted, with some of the reagents who were used in several of the cases which later came under my observation. One is a young man

about 20, strong and healthy, whom I know as well as I know my own brother. I have questioned him at length to ascertain if the reactions might be accounted by any mental attitude, either on his part or on the part of the diagnostician. He assures me that neither he nor the physician ordinarily knows anything about the history of a case until after the diagnosis is complete. Sometimes several dozen specimens may be diagnosed at one sitting; and the following is the usual procedure as he explains it (and I have every confidence in his word, knowing him as familiarly as I do).

The specimens are first marked and placed in individual white envelopes by an assistant, the diagnosing physician (by preference) not ordinarily knowing to whom the specimens belong; nor does the reagent. One by one, the blood specimens are placed in the Dynamizer, the rheostats are shifted from number to number, and the reactions are observed. This reagent informs me that he can usually feel the reaction on his abdomen sooner than the physician can locate it by percussion. His never automatically reacts to the various vibratory rates from the specimen, as they are made to pass one by one through the rheostat, a dilation of certain blood vessels occurs, and the abdominal reaction results.

Dr. Abrahms has recently announced that he has at last succeeded in inventing an instrument that promises to do away with using a human reagent. He claims it to be sufficiently sensitive to record these reactions mechanically. He is now perfecting this instrument, which he has named The Oscillophone. The device contains differently tuned wires about four feet in length which are connected with the rheostats and Dynamizer, and also with the ground. The various vibratory rates from a blood specimen produce changes in tones at certain marked positions along the wires as they are tapped with a small mallet. A trained ear is then able to detect the presence of disease vibrations produced upon the tuned wires. Dr. Abrahms has also experimented with an electric buzzer and Magnavox for detecting vibratory rates, with some success.

But returning to the particular case we started out to describe: Our, demonstrator not being equipped with the Oscillophone was obliged to use a human reagent, who was stripped to the waist and asked to stand, with face to the west, upon two zinc plates attached to the floor and connected by a wire to the ground. The ground connection, it may be mentioned, was obtained by simply soldering the wire to a nearby steam pipe. This steam pipe system was in contact with the earth in the basement of the building hence it afforded a perfect ground connection. In electrical parlance both the Dynamizer and the reagent were now "grounded," for both were connected with the earth. The purpose of this may be understood when it is mentioned that no batteries whatever are used with the Abrahms apparatus.

How, then is the energy conveyed through the mechanism? It is the magnetic currents of the earth that do the trick. These are the currents which cause a compass to point in a northerly and southerly direction. They flow continually between the north and south magnetic poles, our planet being in reality a great magnet. Now these electro-magnetic currents, as they pass back and forth between the poles, flow up through the ground connection, into the Dynamizer, there picking up the radioactive energy of the blood

specimen, passing it into the amplifier where it is intensified many times, then into the nervous system of the reagent and down through his limbs and feet into the zinc plate upon which he stands, then down again into the ground. The body of the reagent thus completes the circuit. If the reagent should face north or south then his body would be fully en rapport with the earth currents, thereby becoming charged like a magnetized compass sufficiently to drown the fine electronic vibrations coming from the Dynamizer. Likewise if he should face eastward, then the "drag" of these currents, due to the earth's rotation from west to east and certain other causes involving the magnetic lines of force from the sun, at once render the electronic vibrations quite indistinct. Hence the reagent must always face squarely in the direction of the geographical west.

It is not the radioactivity that actually passes over the wire from the Dynamizer; radioactive particles, of course, are not conductible by wire. Nevertheless an energy which is produced by the radioactivity from the vibrating electrons does pass over the wire. In the same sense we observe that the human voice is not actually carried over a telephone wire. What is carried is an energy from the vibrating disk of the transmitter which is excited by the vibration of our vocal cords. This vibratory energy, traveling to the other end reproduces a similar effect in the receiver disk. We are therefore accustomed to saying that the human voice is carried over the wire, but technically the statement is incorrect. It is the effect of the voice that is carried. In the same way we may say it is the effect of the electronic vibrations that is carried, through the Abrahms rheostats and down through the nervous system of the reagent, thereby producing the tell tale reactions.

As soon as the reagent had taken his place upon the grounded zinc plates and the other connections were made, a horseshoe magnet was then held near the Dynamizer to destroy the radioactive effects of the preceding specimen, and then the new specimen was inserted. This done we were now ready to witness our first diagnosis. The doctor explained that the vibratory impulses of the nervous system are more easily detected in the abdominal region than in any other part of the body; although by moving the electrode from the reagent's forehead to the crown of his head the same reactions may be produced upon the nerves of his back. Abrahms claims, in fact, that there are about twenty-five different ways of eliciting reactions, thus enabling the diagnostician to painstakingly verify the correctness of a diagnosis if he will take the time to do go.

Both rheostats were first set at 49. Abrahms claims that reactions will appear upon the stomach when the rheostats are set at this number, provided the specimen in the Dynamizer is that of human blood, and that no reactions will occur if any other kind of blood is used. Furthermore, it can be determined whether the blood is that of a human male or of a female by noting the location of the reaction. As the doctor placed the specimen into the Dynamizer he marked out upon the abdomen of the reagent a small area a trifle below and about an inch to the left of the navel, and a corresponding spot on the right of the navel. He then explained that if the specimen is male blood the reaction will appear at the left, and if female it will appear on the right, in the areas indicated. Immediately the reaction was plainly visible at the left, indicating "Human blood, male."

In the present instance I of course knew this fact beforehand; for I had witnessed the blood taken from the patient's forefinger only a few moments before. But it is obvious that the diagnostician cannot always know in advance what kind of blood he is asked to analyze. Specimens are continually received by mail. Frequently a skeptic undertakes to trick the physician by sending him a specimen of blood from the butcher shop. Hence all specimens are first tested at 49, and if no reaction appears he knows the specimen is not human blood. Then he shifts the rheostat to one figure after another until he does obtain the reaction. He then turns to the Abrahms chart or table which, it is claimed has been worked out as a result of thousands of experiments, and ascertains the particular kind of blood that is known to produce reactions at the number at which the rheostat then stands - cow's blood, sheep's blood, dog's blood, or whatever it may be. Whenever a trick like this is tried it is usually detected, and the specimen mailed back to the sender with the name of the animal from which the blood was obtained, much to the astonishment and chagrin of the would be joker.

After this formal test at 49 the dials of both rheostats were immediately shifted one point, to 50, which has been found to be the vibratory rate of cancer. Nothing but this particular rate of vibration can pass through the rheostats when they are set at this number. If the cancer vibration is in the atoms being tested, the radiant energy therefrom will send its pulsations through the rheostats when set at 50, and down through one particular branch of the nervous system and will manifest itself at a certain spot on the abdomen by causing a dilation of the blood vessels in that region. Thus the head of the spinal column is actually a switchboard for the nervous system which sends the various vibratory rates down only certain nerve branches attuned to them and none others.

The dilation, or "reaction" as it is called, may be detected either by percussion or by the attraction of a pith ball or glass tube held near it. Percussion consists of laying the fore and middle fingers of one hand on the spot and then tapping with the forefinger of the other hand. This always elicits a clear, ringing sound if the region is uncongested; but if the blood vessels at that spot are at all dilatated the sound will be a dull thud. With a little practice this difference in sound may be quickly detected. In the case in question, as soon as the rheostats were set at 50 the dull sound appeared when the indicated area was percussed. Then the glass tube test was applied, the diagnostician running it lightly over the abdomen with the result that it would invariably stick at the spot where the Abrahms chart indicates cancer reactions are due to appear. This reaction revealed the presence of cancer in the blood specimen. When the rheostats were moved from the 50 mark, however, the reaction would disappear within a few seconds, the glass tube no longer sticking and the dull sound no longer being heard when percussed. It was easy to demonstrate that the disappearance of the reaction was due entirely to the shifting of the rheostats to a point of resistance which made it impossible for the cancer rate to pass through.

As a practical test of the matter I requested the privilege of holding the glass tube in my own hand. The request was granted, but with precisely the same results as when the physician held it -- the tube always sticking to the cancer area when the rheostats were set at 50 and refusing to be attracted when the rheostats were changed from that number. As

another test I had the blood specimen removed from the Dynamizer altogether. Within ten seconds after this was done the reaction had entirely disappeared, the tube no longer sticking to any part of the reagent's abdomen, whether the rheostats were set at 50 or any other number. When I placed the specimen back into the Dynamizer, the reaction reappeared at the same identical spot as before and remained there as long as the rheostats stood at the 50 mark. This experiment was later repeated without my knowing that the specimen had been removed. The results were the same as before, thus showing that the reaction and disappearance of reaction could not have been the products of imagination or of any mental state whatsoever.

I then requested the reagent to turn so as to face in a direction other than due west. Immediately this was done I could get no reaction anywhere, even though the specimen was in the Dynamizer and the rheostats both stood at 50. As soon as he turned back and stood squarely to the west the reaction reappeared after a lapse of about ten seconds.

Part III

Cancer Strains

It having been determined by the reactions that a cancer strain was in the blood specimen, the next operation was to determine the strength of that strain. This was done by leaving the first rheostat at 50 and setting the second one at zenith, and then gradually moving it down from point to point until the reaction reappeared. When the point was reached at which the dull thud disappeared, the physician called "stop" to his assistant, and the number at which the second rheostat stood was marked down. It was a high number, indicating that a cancerous condition of much magnitude was lurking within the patient's body.

The next thing to be ascertained was whether the cancer strain had yet concentrated its virus in any particular part of the system, and if so where. The electronic energy for cancer, while always passing through the rheostats when set at 50, nevertheless differs slightly in intensity depends upon where the virus is concentrated. If one person has cancer of the stomach and another has cancer of the breast, the blood of each person when placed in the Dynamizer will send impulses through the rheostats at 50 and produce the same general abdominal reaction for cancer; but in addition thereto they will affect two different "organ" nerves. It is known that every organ of the body is connected by nerves to well defined areas in the abdominal region. Our demonstrator, therefore, set both rheostats back to 50 and proceeded to percuss all the organ areas of the reagent's abdomen. Eventually he detected a dull area (aside from the one already alluded to which revealed the presence of cancer at the beginning). To this second dull area the glass tube was then applied. It was attracted to the spot, thereby verifying the matter. The doctor marked the spot and then turned to the Abrahms chart to ascertain what organ or part of the anatomy that nerve area represented. This enabled him to tell the patient that he had a well developed cancer in the upper, intestines right hand side. The patient turned deathly pale, admitted he had been suffering intense pain in that locality for several weeks and had entertained fears that it might be a cancer or a tumor, but had hoped the diagnosis

would prove his fears to be unfounded. An X-ray examination next day collaborated the diagnosis.

After trailing down the cancer strain the diagnostician proceeded in similar manner to test the patient's blood specimen for other diseases. He set both rheostats at 42 (which is the rate for tuberculosis) but obtained no reactions at that number. Then he shifted them to 57, the rate for congenital syphilis. This produced a definite reaction, thereby revealing the presence of that disease in the blood. Dr. Abrahms contends that syphilis and gonorrhea are common foundations for all disease and that nearly everybody has one or the other or both, either by exposure or by heredity. One common means of acquiring syphilis is by vaccination. This form Abrahms calls "Bovine Syphilis." Syphilitic reactions may be obtained from a vaccination scar. The same reactions are usually obtained from "pure" vaccine when placed in the Dynamizer. Dr. Abrahms , however, is not an antivaccinationist. He believes in vaccination; but says the vaccine must be purified. This he claims may be done by exposing it for five minutes to the rays of a blue light, then to the rays of a yellow light, the vibratory power of these rays having the effect of destroying the syphilitic and tubercular proclivities so prevalent in this bovine virus.

While having no reason to suspect collusion between physician and patient. I nevertheless resolved to put the matter to a still more certain test: I would have him diagnose a drop of my own blood, also the blood of somebody whom I intimately knew. This was done, and without the mention of a single symptom on our part both diagnoses proved accurate in every important particular, although the two cases were decidedly dissimilar. Since then I have come into personal contact with over one hundred men and women who have been diagnosed by the Abrahms method, many of whom are my most intimate friends. Although their aliments are almost as diversified as nature itself, nevertheless I find that with few exceptions their diagnoses are remarkably correct. I will not burden the reader with details; one instance will serve as an illustration. One of my closest friends, a young man, whose father and brother are M. D's, submitted to an Abrahms diagnosis. He was told that he had a small tumor of the intestines, its precise location being pointed out to him. He was skeptical and came away convinced that the diagnosis was a failure; for he was then in apparently the best of health and had never had the slightest evidence of a tumor anywhere. A night or so later, out of mere curiosity, he began manipulating his lower abdominal region with his hands to see if he could detect any soreness whatever in the vicinity where the tumor was supposed to be . After pressing deeply with the fingers of his right hand he was astonished to discover a hard, lumpy growth, about the size of a small chestnut, exactly where the Abrahms blood test had revealed the tumor's presence.

The work of diagnosing by the electronic process is necessarily tedious and requires much skill and carefulness. If, for instance, the diagnostician should overlook any of the several abdominal areas while endeavoring to locate the foci of a disease, that area which he neglected to percuss might have been the very one that would have revealed the diseased organ. His neglect would therefore result in the rendering of an inadequate diagnosis of the patient's condition. It is to avoid such oversights that physicians using this method prefer to be furnished with some history of the case and an outline of the

more pronounced symptoms, although this is not essential where the diagnostician takes the necessary time and precaution to thoroughly trace out all reactions. Furthermore if the physician neglects to demagnetize the Dynamizer, by touching it with a horseshoe magnet to destroy the radioactive effects of the preceding specimen, he will not obtain correct reactions for the next specimen inserted. Then again, any remedy the patient may have taken within 48 hours of the time the blood was extracted from him, may influence the results; or a spinal concussion may interfere.

Then, there is the handicap of obtaining suitable reagents. Many physicians are obliged to pick up anybody or men about town who are out of steady employment; and many of these are so physically run down or diseased that it is impossible to utilize their nervous systems for detecting reactions. Very often an overloaded stomach will completely prevent the observance of reactions, either by percussion or by other methods.There are so many things that might alter the reactions of a specimen that it is often necessary to check up with several tests. It sometimes happens, therefore, that two diagnoses of the same patient may be dissimilar in certain respects, as is also the case with any other diagnostic method. But where the conditions are equal there should be no difference in the results obtained from any number of electronic diagnoses of the same specimen, even though they be made at different times, on different instruments and by different diagnosticians. Many of these handicaps are expected to be removed by Abrahms ' Oscillophone, which will eliminate the use of a human reagent.

It is not to be expected that any imperfect human being could always make a perfect diagnosis by any system; for nothing into which the human element enters is infallible. It is steadfastly maintained, however, that errors in diagnosis by the Abrahms method are few in comparison to those of other systems, with the possible exception of iridiagnosis, which is claimed to be reliable as far as it extends. And to minds outside the medical and surgical professions it does not appear unreasonable that a mechanism for determining the reflexes of the patient would be more scientific and accurate than the haphazard "question and answer" method now generally employed. The average physician relies mainly upon what the patient tells him about his condition, together with whatever simple laboratory tests may be convenient or possible in the case. Then based upon the information thus gleaned, he is obliged to venture a plain guess both as to the nature and the location of the diseased organs. He then attempts to reach the probably affected parts via the stomach. Some times a cure results and sometimes not depending upon the accuracy of the guess and the efficacy of the serum administered.

If a drug does produce some beneficial reaction the underlying reason of it is admittedly unknown. On this point we quote from Dr. Paul H. DeKrulf of the Rockefeller Foundation who, while writing in Heart's International in defense of the medical profession and against the Abrahms electronic method, makes this interesting admission; "Despite the great advances that have been made in knowledge of the cause and prevention of various diseases the actual cure of most of them remains a mystery." According to Dr. Abrahms the "mystery" consists in changing the electronic motions of the diseased atoms back to normal. Certain drugs are able to do this measurably, and to that extent they are beneficial; but too often they counteract what benefit they may have

accomplished, by filling the system with other poisons fully as injurious as the particular disease vibrations which they have overcome.

ELECTRONIC THEORY OF TREATMENT

The Abrahms theory of treatment consist in throwing into the patient's body an electric impulse having the same vibratory rate as that of the disease. The object of this is to sympathetically increase and intensify the vibration so that it will be eventually broken, just as the trot of a dog across a shaky bridge has been known to set up such an intense sympathetic vibration as to cause the bridge to collapse. The recent appalling disaster in Washington, D. C., when the roof of the American Theatre collapsed and fell upon the audience, killing and maiming a multitude, has been attributed largely to the sympathetic vibrations in the rafters, produced by the music from the giant organ used during the performance. It is due to the same cause that reinforced concrete has been unable to stand up alongside solid concrete in certain prolonged tests; the metal used for the reinforcing often taking up sympathetically the vibrations from outside sources, thereby causing the concrete to become eventually weakened. Abrahms accordingly contends that if a vibration sympathetic to that of the disease is set up throughout all the tissues, cells, molecules and atoms of the patient's body, it will ultimately cause that particular electronic movement to collapse. When this is done the disease has been mastered, he declares, and it then remains for nature to use its untrammeled powers of carrying off the accumulated poisons and restoring the patient to normal. The Abrahms method of treatment is therefore essentially destructive not constructive.

The instrument which Dr. Abrahms has invented for purpose of treatment is called an Oscilloclast. The word means "vibration breaker." After being attached to an electric light socket the machine is then connected up with the patient's body. By means of its rheostat various vibratory rates may be produced. If a patient is suffering from tuberculosis the Oscilloclast is set so as to throw into his body a vibratory rate corresponding to that which the disease has already created in his system. The patient feels no sensation, because those vibrations are smaller than what our senses may detect; yet they may be recognized by the effects which they produce.

The organism of a single tubercular germ contains millions of atoms with their multitudinous retinue of rotating and vibrating electrons. The tuberculosis rate of vibration is characteristic of these infectious parasites. When a person becomes infected with them they communicate their rate of vibration to the electrons of his blood and tissues, meanwhile breeding and thriving in the favorable environment which they have there created. The Oscilloclast treatments are expected to increase and intensify these vibrations until the electrons of the germ-bodies, as well as the electrons of the disease cells of the patient's body, are overcome and broken up this should kill the tubercular germs; for their lives depend upon the vibratory rate peculiar to their nature. It is impossible for them to live in any other state or condition.

Part IV

Oscilloclast

The breaking up of the tuberculosis rate of vibration in no wise affects the other vibratory motions of the atomic systems involved. Each motion must be dealt with separately. If the patient is suffering from both tuberculosis and cancer, the Oscilloclast is set first at the one rate and then at the other, alternating the treatments as the conditions may require. The treatments usually last about an hour, but the time may be varied to longer or shorter periods as the case may demand. Intermittent treatments are sometimes more effective than prolonged, continuous treatments. About once a week during treatments the physician is expected to take a new blood test to determine if the potentiality of the disease has been reduced, and how much. As soon as reactions disappear upon the reagent when the potential rheostat has reached the zero point the Oscilloclast treatments are discontinued. Much harm, it is said, may result from over-treatment.

Some kinds of germs have greater power to communicate their vibrations to the electrons of our bodies than do others. Hence some diseases are very contagious, others are less contagious, and still others are not contagious at all. Whatever part of the body becomes exposed to contagious disease germs, sympathetic vibrations of the electrons in that part of the body are immediately set up. This new and added electronic motion is soon communicated not only to the blood but to every atom within the entire body, and even to things outside our body which we might handle or touch. The electronic movements in living organism are so pronounced that they may be easily communicated to inanimate matter. Hence if we pick up a pen or pencil to write, the various vibratory rates of the electrons of our body are communicated at once to the pen or pencil in our hand, and through its atoms to those of the paper upon which we write, and are lastingly deposited thereon by the ink from the pen or by the graphite of the pencil.

It is because of this that Dr. Abrahms is able to diagnose diseases from the patient's handwriting, obtaining therefrom the same tell-tale reactions as he obtains from a drop of the person's blood. Blood, therefore, is not the only portion of the anatomy from which diagnosis may be made. A portion of flesh will do just as well, although blood specimens are more convenient to obtain. Dr. Abrahms claims to have diagnosed the dust from Egyptian mummies 3000 years old, obtaining familiar disease reactions. He has also diagnosed from handwriting of Longfellow, Emerson, Poe and others and elicited the disease reactions. Time does not easily destroy electronic motions in atoms. Only powerful sympathetic vibrations can do that.

An eye witness informs me that he has seen Dr. Abrahms put to the test on this matter of handwriting diagnosis. Fifty persons each gave a specimen of their blood and then wrote their signatures on fifty separate slips of paper. The specimens and signatures were then shuffled together in a hat, and Dr. Abrahms drew them out one by one and put them into the Dynamizer. From the reactions elicited he was able to identify each blood specimen and also to designate the signatures to which each specimen belonged, without making a single mistake. His apparatus should therefore prove a boon to bank cashiers and courts of law in identifying handwriting. If a man denies having done a certain piece of

handwriting, simply take a test of his blood and of the writing in question. If the reactions are identical he is lying; if dissimilar he speaks the truth.

Dr. Abrahms exhaustive experiments have demonstrated to him that the reactions of no two human beings are exactly alike. Although the vibratory rate of human blood as well as the vibratory rates of the various diseases are the same wherever found, nevertheless there is a distinctive vibratory motion in the electrons of each individual which differentiates him from all other human beings. When this distinctive rate is once ascertained, then, says Abrahms , neither age nor environment nor any physical changes will prevent the Dynamizer from identifying that person wherever found. This would seem to be an improvement over the old fingerprint system of identification hitherto so indispensable in police records. The claim is also made that the Dynamizer will detect the sex of an unborn infant and will definitely establish whether a man under suspicion is the father or not the father of a questionable child.

Another remarkable accomplishment accredited to the Abrahms instruments is the ability to approximate the location of an individual. First the "distinctive" vibratory rate of the person is ascertained by testing a sample either of his handwriting or of his blood. Then the corresponding radiant energy which the individual is continually "broadcasting" from his person is picked up by the Dynamizer and auxiliary attachments, acting as an ordinary radio receiving set, the effect being manifested by reactions on the nervous system of the reagent. Radio experts, of course, tell us that the radio, waves, or energy quanta, when once generated, continue to travel indefinitely in all directions, far beyond the limit of our at present most sensitive receiving instruments. They expect to eventually perfect a receiving set sufficiently sensitive to pick up those waves at any terrestrial distance. Communication with other planets is not considered beyond the bounds of ultimate possibility.

If, therefore, all matter is radioactive, it is not in the least fantastic to suppose that energy thus radiated, of definite frequency, may be picked up at a considerable distance, with a sufficiently sensitive instrument. Dr. Abrahms maintains that the human nervous system, augmented by his apparatus, constitutes such an instrument, and that he has repeatedly demonstrated its efficacy. After eliciting the reactions caused, as he contends, by the radiant energy from the distant human "broadcaster" it is then said that he can roughly determine the direction of the radiations and the distance to their source, by noting the strength of the reactions as the electrode is horizontally revolved. Dr. Abrahms admits that this phase of his researches has not yet been extensively pursued. He has, however, successfully diagnosed blood by radio, with the Dynamizer placed at the "sending" end many miles away.

The many remarkable achievements claimed for the Abrahms apparatus seem, of course, incredible; and for this reason they have been generally dismissed by physicians and others as either psychic or the fantastic imaginings of a diseased or overwrought brain. But the thousand or more professional men who have to date made unbiased investigation into the matter generally declare otherwise. I have not personally investigated all of the Abrahms phenomena, and cannot therefore vouch for any of the aforementioned

accomplishments except that of diagnosis and treatment of disease. But what I have witnessed along these lines appears quite practicable. The diagnosing process seems to rest upon a scientific principle well known to physicists but never before applied in the field of therapeutics. As for the method of treatment I have found many who declare they have been completely cured, others who say they have been greatly benefited; and the practitioners tell of many wonderful results. Still Dr. Abrahms says he is learning more about the matter of treatment every day, and he has recently invented a "Depolarizer" and other equipment to be used in conjunction with the Oscilloclast. These, he declares, make the machine more effective.

When Abrahms work has passed the tests of time and professional prejudice it will then be regarded as no more psychic than the radio or wireless telegraph. In the words of Sir James Barr, Past President of the British Medical Association, who wrote recently to the British Medical Journal: "When every important member of the community has a wireless telephone in his house and on his person, then medical editors and medical men will begin to perceive that there was more in Abrahm's vibrations than was dreamed of in their philosophy. Abrahm's discoveries have come to stay, whether we like them or not." Those who withhold rash criticism of any scientific discovery are spared the pain of humiliating acknowledgments later on. If Dr. Abrahms has uncovered a basic law of nature intended for human benefit certainly no amount of skepticism and prejudice can thwart its ultimate purpose. In that event not only would his system meet eventually with a manifestation of popular interest but continued scientific research into its principles should result in such strides and improvements of mechanism as will relegate the present instrument of Abrahms to the ash heap, even as modern ocean greyhounds have outstripped Fulton's first steamboat.

It cannot be denied that this is an age of progress along all lines of human endeavor. No generation has witnessed such advancement in knowledge of the laws which govern the universe and all things within it as has ours. Strange indeed would it be if with the marvelous achievements in electricity as evidenced by wireless telegraphy, telephony, etc., no particular advancement should be made in the treatment of the human body, which is the most wonderful electrical instrument on earth. It is true that the average length of human life has statistically increased from 33 to 36 years within the present generation, and medical fraternities have pointed to this encouraging evidence with just pride. But the fact is that this increase does not represent any remarkable prolongation of adult life, but rather of that of infants. Improved conditions for childbirth, maternity hospitals, etc, have aided in keeping babies alive for a few years who otherwise would have died at birth or shortly thereafter. This, of course, boosts the per capita average for the entire race, yet we cannot say that medical science has succeeded in materially lengthening the life of adult men and women in general.

When Dr. Richard C. Cabot, professor of medicine in Harvard Medical School and chief of staff of the Massachusetts General Hospital declares before the assembled American Medical Association that 47 per cent of diagnoses and treatment in his own hospital have been proven by autopsies to be wrong (not to mention the percentage of errors committed on those who managed to escape an autopsy), the rest of us certainly cannot look with

enthusiasm upon present medical procedure. Considering, then, that the various drug and drugless methods of the past (with due credit to their accomplishments) have singly failed to produce any startling improvement in the health of the world, the public cannot be blamed for its present tendency to turn away from the old school methods of treating disease and to look with favor upon any new cult that may arise. Indeed, the rapid growth of cults today is an argument against the efficiency and accuracy of modern medical (and science) practice. Science of an unquestionable and solid basis leaves no room for cults.

It is not unreasonable to anticipate new discoveries in therapeutics which may completely revolutionize scientific thought in that field. Considering the recent strides along other lines why should we not now expect the dawn of a new era in which man shall not only be conqueror of the forces of nature about him but master of himself as well, and of disease to which the race has long been heir? The day should come when the diagnosis of human ills shall no longer be largely guesswork as it has been in the past, but shall be as easy and as unerring as the reading of hours and minutes by a watch dial. When that time shall come it should then be possible to quickly destroy evil germ and infallibly cure every dread disease by a process almost as simple as the turning of an ordinary electric switch. Such results must of necessity involve not merely the cells but the molecules and atoms from which they are formed. Whether the vibrations of Abrahm's Oscilloclast, after the machine is more fully developed, will be found to do the trick unfailingly remains for time to determine. But the idea upon which he is working, together with the results already accomplished, are well worthy of scientific interest and not ridicule.

Guglielmo Marconi, inventor of the wireless telegraph, speaking of the new era now at hand said recently to a Hearst correspondent: "We are just entering what may be called the field of vibrations, a field in which we may find more wonders than the mind can now conceive. Most of the great inventions of the fifty years have been in this field. The telephone, the electric light, the dynamo, the electric motor, the phonograph, the moving picture and the radio are all based upon vibrations. Science is turning from what primitive man considered to be the great forces of nature to explore the infinitely little. Scientists are now beginning to realize that the really great forces with which we may deal are locked up in vibrations so gentle that we cannot feel them, though we may feel a summer zephyr as it blown upon our cheeks. Nobody has enough imagination even to suggest all that we may yet find in this great field."

Answering a question as to what progress may be expected along this line in the near future, Marconi replied, "The age of scientific miracles is not in danger of coming to a pause; It has only just begun. The speed that will be attained during the next fifty years will vastly excel that of the past half century. Since 1872 we have witnessed the invention of the electric light, dynamo, motor, telephone, phonograph, moving picture, automobile, X-ray, wireless communication, the discovery of radioactivity and the invention of the airplane. These are great achievements for so short a period, unexampled in the history of the world. But they will seem almost if not quite insignificant in comparison with what will be brought about during the coming half-century. It is inevitable that this should be so; we have more knowledge of natural laws than ever before and are therefore searching more intelligently in all directions throughout the civilized world. The field of vibrations

seems almost exhaustless in its possibilities." It is to this great field of vibration, referred to by M. Marconi, that Dr. Albert Abrahms has turned in his study of the diagnosis, treatment and pathology of disease, while the world awaits with interest the outcome of his researches.

Part V

The Electron Theory

When mention is made of "The Electron theory" some people imagine the phrase implies that the very existence of electrons is theoretical; that nobody really knows for a certainty whether such elemental particles of electricity constitute the structure of material atoms, but that the proposition is a scientific hypothesis. The following pages should dissipate that popular misconception. The theory does not concern the existence of electrons, for that has been experimentally established beyond question, but rather their arrangement and activity within the atom in an endeavor to account for hitherto unexplained phenomena. It is the purpose of this essay to depict in an orderly way the progress which modern scientists have made in their exploration of the intricacies of atomic structures by naming the discoveries that have been made and describing the experiments and apparatus employed. A line of demarcation will accordingly be drawn between fact and theory at every point.

Modern knowledge of the constitution of matter properly dates from the discovery of X-rays by Roentgen in 1895. Like many other important discoveries this one was an accident. While experimenting in a darkened room with an electric current and a Crookes tube, with no definite object in mind (so the story goes), Prof. Roentgen was amazed to discover the outline of his hand recorded upon a photographic plate which had been lying beneath a book on the working table. The impinging of the current upon the sides of the tube had generated certain peculiar light rays, invisible to the eye, but of strange, penetrating power before which the human hand and the book had appeared as porous. He called them X (that is, Unknown) rays. Roentgen's discovery stimulated scientists everywhere to undertake experiments along similar lines, and these investigations led almost immediately to the discovery by Becquerel of radioactive emanations from the mineral uranium. Both discoveries owe their inception to the development of photography, because each of them was revealed by their radiochemical actions on photographic plates.

When in 1896 Prof. Becquerel found uranium possessed of this peculiar power to emit radiant energy continuously, Pierre and Mme. Curie and others began a series of investigations to account for the strange phenomenon. It did not at first occur to them that this emanation of energy, which seemed to controvert the law of the conservation of energy, really originated within the structure of the atom itself. They attempted to explain it on the theory that uranium is so constructed as to be able to store up within its molecules a quantity of energy which it receives from some outside source like the sun and that it in turn radiates this energy exactly as the earth radiates solar heat. Experiments were then made to ascertain if the radiation from uranium would be less at midnight than

at high noon, due to the interposition of the earth's thickness between the radioactive substance and its supposed source of energy. No difference was detected.

The negative result of the last mentioned experiment led inevitably to the conclusion that these energy emanations must originate within the structure of the substance and are independent of any outside source. But the idea that radioactivity is a purely atomic phenomenon was a revolutionary one for chemists and physicists who had long regarded the atom as having no mechanical structure whatsoever. To them it was the ultimate division of the known elements and incapable of further structural analysis. The discovery of radioactivity, therefore, marked the beginning of a new era in the progress of physical science.

Other substances were then examined to ascertain if radioactivity is a property common to all matter or if uranium is unique in this respect. Thus it was that the Curies in 1897, while experimenting with mineral pitchblende, discovered therein an element which when isolated was found to give out radiant energy 4,000,000 times more intense, gram for gram, than that which emanates from uranium. This element they appropriately named radium. Other substances possessing radioactivity in varying degrees were shortly thereafter discovered, such as polonium, actinium, and thorium, but none that displays it so abundantly as does radium. Curies' discovery, therefore, opened wide the door to the investigation of radioactive phenomena and of the constitution of matter in general. Evidence now points to the fact that all matter possesses the quality of radioactivity to some extent, although only certain elements of high atomic weight display it sufficiently to produce effects on photographic plates.

No particular progress could be made in the field of physics so long as the atom was regarded as an indivisible elementary particle, incapable of further analysis. Chemists were, of course, familiar with the innumerable combinations of the various elementary atoms which constitute the endless variety of substances that go to make up a world or a universe. But why there are eighty or ninety different kinds of atoms, and just what constitutes the difference between them, were questions which were regarded as unanswerable. Scientists had contented themselves with quantitative rather than qualitative research into the basis of things. They were devoted to the problem of how much could be accomplished with the material in hand rather than with the intricacies of the mechanism itself.

But with the discovery of the strange property of radioactivity it became manifest that something more than the mere chemical combination of atoms into molecules was involved. Chemists knew these chemical combinations from A to Z, but that knowledge was incompetent to explain the source of these remarkable emanations of radiant energy. They realized that these chemical combinations have nothing to do with the problem; that the phenomenon is wholly elementary and must emanate from within the atoms. This was demonstrated when it was found that radioactivity continues unabated even after the molecules or atomic combinations of the radioactive substance are disintegrated. This being so there could be no other conclusion than that the atom is a complex structure

possessing internal activity and energy instead of being a lifeless elementary particle of matter incapable of divisibility or dissection.

If the atom is thus an active, composite structure, how is it made and from what kind of matter is it formed? May it not be that all types of atoms are made from the same original stuff, but simply put together according to different patterns? May not the hitherto "unsolvable" problem of the basic difference between elements really be solved after all? These and many similar questions now filled the minds of earnest investigators and daily clamored for solution. Numerous experiments were undertaken and much scientific data was amassed during the years immediately following the discovery of radium. Thus by 1903 Prof. Ernest Rutherford, in collaboration with Prof. F. Soddy and others, was able to propose a concrete theory of atomic structure which fully accounted for the phenomena exhibited by radioactive substances and plausibly explained the fundamental differences, between the various known elements. So carefully was their theory constructed that twenty years of most critical research since that time has not shaken but has strengthened their hypothesis by adding thereto certain interesting details which make this now accepted Electron Theory of Matter unique in its completeness. The following pages will set forth in simple language the details of the theory and the discovered facts upon which it rests, giving also a brief explanation of the apparatus and methods of experimentation.

WHAT ARE ELECTRONS ?

The modern confirmed hypothesis of the constitution of matter declared that all atoms consist entirely of elemental charges of electricity. These charges are called electrons, a name suggested by Dr. G. Johnstone Stoney as "the natural unit of electricity" several years before anybody knew anything about the structural nature of atoms. Both positive and negative electrons reside together within the atom, and are complementary to one another. Recently the name proton has been suggested for the positive electron, so as to distinguish it from the negative electron. We will so refer to it in this essay, and will apply the word electron only to the negative particle.

Electricity is not a fluid like ethereal nothing as many people indefinitely imagine. It is tangible matter in its basic form, and is granular in nature. But these grains (electrons and protons) are so infinitesimal that untold billions of them would be required to make a mass large enough to be observed through a powerful microscope. Yet they have been measured and analyzed, not directly but indirectly, by means of the effects which they produce. Their diameter is one hundred-thousandths that of an atom of hydrogen (the smallest atom known); and the hydrogen atom's diameter is known to be one fiftieth of a millionth of a centimeter. A centimeter is less than two fifths of a British inch. In our school days we were correctly told that if an orange were magnified until it became as large as the moon even then its atoms would be no larger than ordinary marbles. But in that event the electrons which compose the atoms would still be invisible to the naked eye.

The layman is not to be blamed for skeptically asking "How do scientists know so much about electrons and atoms inasmuch as both are invisible even with the most powerful

microscope?" And "Isn't it mostly guesswork anyway, with one guess about as good as another concerning such infinitesimal things?" These queries are legitimate and require an answer. It is the purpose of this treatise to give to the reader, in nontechnical terms a history of the research work in this field up to the present moment, that he may reasonably determine what is theory and what is actual discovery.

Literally speaking, all conclusions which are arrived at by deduction are theoretical; but when theory has been corroborated by independent modes of calculation it is then elevated from the realm of fancy to the plane of reasonable fact. It is true that no human being has seen or can see an atom of matter, much less to look within it and observe its complex electronic mechanism. Nevertheless these minute particles, when emitted by highly radioactive substances like radium, can be made to produce visible effects in a gaseous medium through which they may pass, cause phosphorescent screens to become luminous, and make impressions upon sensitized photographic plates. These and many other producable effects are capable of analysis and logically lead to certain definite conclusions. Any effect must have a competent cause, and from an aggregation of effects that have been produced by the same factor much definite knowledge may often be gained concerning that factor.

We have already seen how that early experiments demonstrated the fact that radioactive substance emit the same amount of energy at midnight as at high noon thereby proving that the action of the sun's rays has nothing to do with radioactive phenomena. The next experiment undertaken was to ascertain if temperature of the substance would increase or decrease its radioactivity. This experiment likewise gave negative results. Radium was also found to be equally active whether in the solid or in the dissolved state. These results show that the emission of these particles is not only independent of outside force but that it is likewise independent of the molecular constitution of the substance. Here, then, we have laboratory proof, not theory, that the radiation emanates from within the atom. Therefore the atom must have activity within it, revolving or vibrating parts; and the energy of these moving parts must be enormous since they impart such high velocities to the emitted particles. Thus the first step was taken on the scientific exploring expedition into the unknown depths and structural complexities of the atom.

Part VI

Radium Analysis

Next, an analysis was made of the radium emanations themselves to ascertain their exact nature. Although these radiations are invisible to the eye nevertheless they were made to appear visible by various ingenious contrivances. By placing a small quantity of radium into a prepared cavity in a solid lead block, the rays were then permitted to pass through a tiny aperture in the lid and made to graze along a wall which had been covered with a phosphorescent substance such as zinc sulphide. The radium rays brushing against this wall produced a faintly illuminated streak. Now a magnet of known strength was held against the wall a few inches to one side of the streak. Immediately the streak divided into three parts, one portion bending toward the magnet another portion bending away

from the magnet, while a third portion retained the original position, being neither attracted or repelled. This proved that three distinct streams are emitted, one of which consists of positively charged particles, another consists of negative particles, while another is of such a nature as to absolutely defy the magnetic field. The positive stream they called Alpha rays, the negative stream Beta rays and the independent stream Gamma rays, after the first three letters of the Greek alphabet. These are usually referred to by the Greek characters themselves, as a, b and y rays.

By letting these rays fall squarely upon a phosphorescent target held at variable distances from their source, minute sparks, plainly visible through a telescope were produced by the a and b streams thereby proving that they consist of infinitesimal particles like leaden shot from a shotgun. The y rays were found to be of the nature of X-rays but far more penetrating.

After determining the existence of the three different kinds of emissions from radium various experiments were then undertaken to determine their exact nature. First their respective velocities were ascertained. This was accomplished by noting the amount of deflection that could be produced by magnets of known strength acting upon the charged particles. Prof. Schuster proposed a mathematical formula by which velocity may be computed where the amount of curvature and the strength of the magnetic field are known. But his equations required certain assumptions and were therefore not entirely satisfactory until later experiments supplied the missing data. Accordingly Profs. Thomson, Wilson and others experimentally determined the velocity; energy and charge of both the a and b particles without indulging in any assumptions whatsoever.

It was found that an electric current flowing from negative to positive possesses all the properties of the b rays from radium, except velocity; hence it was possible to make a very close study of b particles under most favorable circumstances in vacuum tubes. Such currents are called Cathode rays, because they flow the negative pole (or cathode) to the positive pole (or anode). By boring a hole through the center of the anode some of the current or ray would pass directly through it because of its velocity, and when it thus fell upon a phosphorescent screen behind the anode the same scintillations were produced as in the case of the radium emanations, thereby showing that the cathode current or stream actually consists of multitudes of individual particles (electrons) which were found to be identical with those which comprise the b rays from radium.

It was arranged that the negative particles (electrons) which pass through the anode would be deflected by a magnet and caused to fall into an insulated hollow vessel. An electrometer connected to the vessel was therefore able to record the aggregate charge of the particles collected within a given time. By a similar arrangement their aggregate energy was measured by means of a galvanometer. With these quantities known, together with the amount of curvature produced by a given force, a simple algebraic equation then yielded the information sought, viz., the velocity. In like manner the velocity of any current or any radioactive emanation may be definitely ascertained. This experiment, and various others of a more elaborate nature, enabled scientists to determine the following facts about radioactive radiations: a rays are almost identical with helium atoms, having a

mass 7,000 times greater than b particles. An a particle is not, therefore, an individual proton, but is an aggregation of protons and electrons in which the protons predominate and thus give it a positive charge. These a particles, because of their relatively larger size, are far less penetrating than are the b particles. They are unable to pass through an ordinary sheet of paper. Their velocity is about 20,000 miles a second.

b rays consist of individual electrons which are, of course, negatively charged. They have a mass of about 1/1700th of an atom of hydrogen (the smallest atom known) and can easily penetrate thin sheets of aluminum or iron. They have a maximum velocity of 170,000 miles a second, which is over nine-tenths the speed of light itself.

y rays consist in nature to X-rays but have greater penetrating powers, and like the latter they possess the same velocity as ordinary light, viz., 186,000 miles a second. They carry no electric charge and therefore cannot be deflected by a magnetic or electrostatic field. They are emitted only by those radioactive substances which also emit b rays (some substances emit only a particles). They do not consist of particles such as make up the a and b streams, but are pulsations of energy evidently produced by the atomic "explosion" when the b particles are shot forth. Owing to the unusual penetrabillity of the y rays it is difficult to utilize them efficiently in the study of radio-chemical effects. There remains much yet to be determined regarding these powerful y rays.

Prof. Thomson's apparatus, mentioned above, proved that b particles carry a considerable charge; yet their mass was so excessively minute that it could not be measured by any means then employed. He estimated that it would take a century to collect a weighable amount of electrons in his insulated vessel, viz., one-thirtieth of a milligram. Of course the mass, and consequently the size, of these electrons could have been mathematically computed from their aggregate charge, energy and known speed, provided the number of particles constituting the aggregation were known. Being unable to determine this by means of the aforementioned apparatus, he undertook an entirely different experiment and was happily rewarded with success. The details of this brilliant experiment are quite interesting.

MEASURING AN ELECTRON

By means of a vacuum pump the residual gas in a glass jar was rarefied, and then a stream of electrons (cathode rays or beta rays) was passed through it. The bombardment of the swiftly traveling electrons against the gaseous atoms caused the latter to be deprived of some of their planetary electrons, thus leaving them out of balance. Such atoms are then said to be charged, because they will react either negatively or positively depending upon whether they have too many protons for the remaining electrons, or vice versa. Charged atoms are called ions , and the process of disrupting the atoms by a bombarding current is called ionization. An ion, in other words, is an atom or molecule which is charged by virtue of an inequality in the number of positive and negative electrons which compose it.

The apparatus was so arranged that a known amount of vapor could then be forced into the jar containing the ionized gaseous atoms. Immediately this was done the vapor began to condense around each ion, thereby forming tiny globules of mist or fog. Now it is well known that vapor cannot condense into droplets without a nucleus upon which to form. An uncharged atom or molecule will not permit of condensation around it, but ions readily attract the vapor and cause condensation upon their surfaces, in much the same way that dust does. It is generally because of minute particles of dust in the atmosphere, acting as nuclei for condensation, that we have cloud formations, resulting in fog, mist, rain, rail, etc., upon the earth. These nuclei are frequently so infinitesimal that they cannot, be seen through a microscope, yet in a test tube they may be filtered out with cotton wool to such extent that no condensation can take place when the temperature is lowered to the dew point, even though the air in the tube be supersaturated with vapor. But immediately dust particles are introduced condensation into fog begins. The uncharged molecules of air in the tube are too small to act as condensation centres; something larger like a dust particle, which consists of millions or billions of atoms, is necessary. But the electric tension within an ion seems to compensate for the minuteness of its circumference; hence ions will permit mist to form around them even though the tube be free of dust.

COUNTING FOG-DROPS AND ATOMS

The purpose of the experiment was to ascertain the number of ions present, which, together with their known aggregate charge would enable the mathematician to determine their individual charge, inertia, mass and size. Then, by deduction, the mass and size of the missing electron (which caused the ion to become charged) could be ascertained. But how was the number of ions to be arrived at? Was this done by simply counting the globules of fog in the jar? Exactly; but it was not so simple as it might at first appear. While the ions were present in great number the resulting for appeared as a dense cloud, and the individual globules were of course indistinguishable. But by first rarefying the gas in the jar and then, repeating the ionization and condensation processes the nuclei were fewer in number and the globules were correspondingly larger. They were still too small, however, to count in an ordinary manner, being about 30,000 to the cubic centimeter in the most successful experiment undertaken; and a further rarefying of the ions was found not to aid but really to hinder the success of the experiment.

It was therefore necessary to determine the amount of water in each fog-drop and divide it into the total quantity of water that had been introduced into the jar in vapor form, all of which had now been condensed into fog. The result gave the number of individual globules in the cloud. But how could the amount of water in each tiny fog-drop be ascertained? Even if one of them could be isolated it would certainly be too minute to be measured or weighed by any ordinary process. Nevertheless these tiny droplets have weight and are acted upon by gravitation the same as anything else. Therefore, by noting the rate of their fall their size could be determined mathematically inasmuch as the density of the medium through which they were falling was known.

All clouds are acted upon by gravity; and the larger the globules which compose the cloud the faster the cloud will fall. Sometimes a cloud condenses sufficiently to cause the globules to fall quickly in the form of rain. If the globules have not condensed so as to be as large as raindrops then their fall is slower, in the form of a fine mist; or possibly they settle down still more slowly, in the form of a thick fog. But if the globules are excessively minute they will remain on high as cloud; yet they are not beyond the force of gravity. Contrariwise each globule, no matter how infinitesimal, is slowly but surely falling through the resisting air. Air currents may carry the cloud upward more quickly than the globules are falling downward; but no matter how high and how rapidly the cloud is elevated by the wind, the globules continue to trickle down through it as fast as the resisting medium will permit.

Since, therefore, the size of the globules affects the rate of their fall, large drops falling more rapidly than smaller ones through the same resistance, it has been possible to work out a formula by which the size of any drop or globule may be determined by taking into consideration its velocity of fall and the density of the air through which it falls. In the experiment in question the gradual descent of the cloud in the jar could be easily observed and timed by illuminating the top surface of it with a transverse beam of light and then noting how long it took for it to fall an inch, which was about ten minutes. Then by a simple computation the size of each globule, and the total number of globules was ascertained. This gave the number of ions present, because each globule had an ion as its central nucleus.

Before the vapor was introduced into the jar all the positive ions had been electrically eliminated so that only the negative ions were utilized as nuclei for the vapor. The number of globules therefore gave the number of negative ions only. These were now attracted to an anode which was introduced into the side of the jar, and their aggregate charge and energy measured. Then by dividing the number into the total, the charge and energy of each ion was established. This gave the charge for an individual electron because the ions were charged by virtue of having lost one electron by bombardment. Another simple calculation gave the mass and inertia of an electron. It is important to note that the same value was obtained for the mass of an electron, no matter whether the bombarding stream consisted of beta rays or cathode rays or electronic streams set up by X-rays or ultra-violet light falling upon negatively electrified plates. The ions behaved identically regardless of how they were produced, thus justifying the conclusion that each of the methods accomplished the same thing, viz., shaking lose one electron from each ionized system.

The mass, inertia and charge of an electron now having been mathematically determined, another equally simple calculation established its size, because it is known that a given amount of electric charge, having a given inertia, must exist on a sphere of certain radius and could not occupy a sphere of any other size without doing violence to proven and established electromagnetic laws. The diameter of an electron was thus found to be one-fifth of a trillionth of a centimeter. It would thus take 13 trillion electrons, laying side by side in close formation, to make a row one inch long. Our minds can scarcely comprehend the magnitude of such a number. If we had a book containing 13 trillion

pages, and each leaf was as thin as the paper used in this pamphlet, our volume would be 400,000 miles thick -- nearly twice the distance from the earth to the moon.

Inasmuch as the sizes and masses of electrons, atoms, etc., are so excessively small when considered in terms of the customary scientific units such as the centimeter and the gram, the scientist finds it necessary to make a modification in our decimal system; otherwise his figures would become unwieldy. The exigency is easily met, however, by simply using successive products of 10 (for all numbers above 1) and indicating these products by a small figure in the upper right-hand corner, called an exponent, thus:

10^1 means 1 x 10 or 10

10^2 " 10 x 10 " 100

10^3 " 10 x 10 x 10 " 1000

10^4 " 10 x 10 x 10 x 10 " 10000

10^5 " one million

10^12 " one million billion

10^18 " one billion billion

For numbers smaller than 1 it is equally simple. Any fraction may be expressed in negative power of 10 by placing a minus sign before the exponent, thus:

10^-1 means .1 or one tenth

10^-2 " .01 or one hundredth

10^-3 " .001 or one thousandth

10^-6 means .000001 or one millionth

10^-9 " .000000001 or one billionth

10^-12 " .000000000001 or one trillionth

Any desired quantity, large or small, may easily by expressed by this system. If, for example, we wish to set down one fortieth of a millionth, instead of writing it .00000025 we would express it as 2.5 x 10-3 (i.e., two and a half times a hundred millionth). Accordingly, instead of specifying the diameter of an electron as one fifth of a trillionth of a centimeter we would designate it as 2 x 10-18 cm. (i.e., two times a tenth-trillionth). Likewise the diameter of the hydrogen atom is written as 10-8 cm. With this method of numerical expression it is as feasible to work out a problem involving excessively minute

or excessively large quantities as it is to calculate the number of square yards in a city block. To the mathematician it is but a step from the infinitesimal radius of an electron (10-18 cm.) to the illimitable distance from earth to the farthest nebulae (1024 cm.); yet when these figures are converted into the units of everyday usage they are of such proportions as to appear to the layman as but a fantasy of scientific imagination, and he hastily concludes that they signify nothing more than an elaborated bit of arbitrary guesswork.

The diameter of an atom is exceedingly large in comparison to the diameter of an electron. We would therefore suppose that an atom is made up of billions or trillions of electrons, were it not for the fact that experiments have shown that such is not the case. If all the electrons in any atom were crowded close together they would comprise only a small fraction of the atom's bulk. The hydrogen atom, for instance, contains but one electron and one proton. This was demonstrated by Profs. Thomson, Aston and others in a set of brilliant experiments in which they actually succeeded in isolating the proton from the electron and measuring it. They bombarded hydrogen gas with positive rays, causing the electron to be separated from its nucleus. The nucleus was then deflected by a magnetic field of known strength and the amount of deflection from a straight line was registered upon a photographic plate. From the amount of deflection produced by the magnet, the mass and inertia of the particle were computed. Its inertia was found to be 1845 times that of an electron, and thus its mass is almost equal to the entire atom itself; although it is evident that its size is identical with that of an electron. Inasmuch as they are elemental charges of electricity, the one positive and the other negative, and the two are complementary to each other. Equality in size does not signify equality in mass. Various other experiments have corroborated the fact that greater portion of the mass of all atoms resides in the nucleus.

Part VII

Empty Space in Atoms

MUCH EMPTY SPACE IN ATOMS

If the diameter of an atom of hydrogen is 10-8 cm. and it is composed of only one proton and one electron, each of which has a diameter of only 2 x 10-13 cm. how is its bulk made up, seeing that the two electrons, even if laid side by side would have a combined diameter which would be insignificant in comparison to the diameter of the atom which they form? The only conclusion to be reached is that the negative electron revolves around its proton nucleus at a distance, just as the moon revolves around the earth 240,000 miles away; or else the two revolve around each other in dumbbell in fashion at relatively great distances apart. Thus the greater portion of the bulk of the atom consists of empty space. Various experiments corroborate the conclusion that the negative electrons in all atoms revolve about their positive nucleus at considerable distances therefrom, and from each other, even as the planets of our solar system have large orbits about the sun.

The proof that the one electron and one proton which compose the hydrogen atom, for instance, are not welded together into one united solid sphere, rests not merely upon the mathematical variance between electronic and atomic sizes, but upon the hydrogen spectrum in the spectroscope which indicates an orbital motion on the part of the electrons of the atom. When an electron and a proton do combine into one granule, however, experiments have shown that they then, in their united state, actually occupy a space eight tenths of one percent smaller than either did originally! Prof. Aston has demonstrated that even two protons and one electron may have a combined size which is smaller than one electron alone. Here is a real paradox in nature. An explanation which has been offered is that an individual isolated electron or proton suffers internal repulsion between its parts (if it may be said to have parts), thereby swelling its size; but when the two come in contact their spontaneous attraction for each other is so intense that they immediately merge into the closest possible union, there being no longer any repulsive swell in either particle because each has found its complement. Thus the two united can occupy a smaller space than either of them did in its individual, unsatisfied condition. It is the inertia of the electron and proton in the hydrogen atom that keeps them apart. For the same reason the moon does not fall upon the earth , nor the earth upon the sun, although there is strong mutual attraction.

The size of any atom is marked by the orbit of its outermost electron, just as the size of our solar system is determined by the orbit of our distant sister Neptune. Now a comet may pass through our solar system without colliding with any planet in it, traveling through free space between the planets. But if the comet continues its journey through a vast number of solar systems the chances are that sooner or later it would find some planet in its path and a collision would result, unless a guiding Providenced. If the comet were larger than the planet which it struck, or if it were moving at an enormous velocity, it would either knock the obstructing planet to one side or else it would drive it on ahead as it continues its journey through the heavens. The comet might thus collide with several planets before its energy was sufficiently expended to cause its own deflection and ultimate stoppage.

In a similar manner the gaseous atoms in a testing tube may be subjected to bombardment of electrons (cathode rays or beta rays) or by alpha particles, in which event it is found that some of the atomic systems suffer collision while others escape unharmed by reason of the flying particles passing successfully through the open spaces between the planetary electrons. When a collision occurs in any atomic system, that system is immediately charged, because the bombarding particles have deprived it of one of its satellites, or else has struck the nucleus and knocked out some protons. If an electron is struck, the atom is then deficient in negative electricity by one electron and is said to be charged positively. But if the nucleus is struck, and protons are thrown out, then the atom is charged negatively. In either event the wrecked atom is called an ion, and their presence is experimentally discernible.

The path of the alpha or beta particles may be traced through the gas, and the collisions made visible by introducing water vapor into the tub and noting the points of condensation. It is simply a variation of the Thomson/Wilson cloud experiment already

described. Every atom is ionized becomes a nucleus for a small drop of water, whereas the atoms which escape collision will not cause any condensation. The water globules are easily discernible. If alpha particles are shot through the gas, the resulting globules are so numerous that they appear as white streaks throughout the length of the tube. If the tube is sufficiently long the white streaks suddenly stop before the end of the tube is reached, thus indicating that the alpha particles have spent their energy and are unable to travel further through the gaseous atoms.

If beta or cathode rays are used for the bombardment a very different effect is observed. Instead of there being a continuous streak of drops throughout the length of the tube only an occasional drop of water is formed. This shows that the beta particles are much smaller than the alpha particles, because they are able to pass through more of the atomic systems without colliding with anything. Alpha particles, as already mentioned, are aggregations of protons and electrons, whereas beta rays consist of individual electrons. While the former do not possess the enormous velocity of the latter, nevertheless they are capable of ionizing millions of molecules in each centimeter of their path and are rarely deflected from a straight line until their energy becomes largely spent near the end of their course. The beta particles, on the contrary, ionize only about one mercury molecule in 10,000. Their size is so minute that they can pass through the free spaces in that number of systems without striking any obstruction. In ordinary air they will ionize on an average about one molecule in every four inches, or the equivalent of one collision in each 100,000,000 molecules. It is not surprising, therefore, that ordinary solids, like metal sheets, appear porous before these infinitesimal particles. And no better proof than this could be had of the enormous relative spaces existing between electrons within the atom.

Spectrum analysis has contributed much to our present knowledge of electrons, particularly concerning their orbital motion in the atomic systems. The spectroscope, as the reader probably knows, consists in its simplest form of two telescopic lenses placed on opposite sides of a glass prism, together with a screen or photographic plate upon which the light under examination may fall. When light rays from any substance pass through the first lens they emerge parallel and thus pass into the triangular prism. When they emerge from the prism, however, they are broken up or separated according to frequency so that each wave length takes a different direction, being spread out like a wedge upon the spectral screen. Every line upon the screen or plate has its meaning, and spectrum analysis has become one of the most fruitful fields of physical research.

The spectral lines are manifestly due to the frequency of rotation of the planetary electrons in the atoms under examination. If this is so, then any change in their rate of rotation should cause a shifting of these lines to a slightly different position on the screen. But how can the frequency of their rotation be affected? This can be done by the introduction of a magnetic field near the radiating substance. Its lines interweaving with the circular currents of the revolving electrons of the substance should either increase or retard their orbital frequency. The experiment was early undertaken by Larmor with unsatisfactory results; but in 1897 Prof. Zeeman of Amsterdam succeeded in demonstrating that a strong electromagnet does produce a definite shift of the spectral lines, thereby establishing the revolving state of electrons within the atom.

We might hastily conclude that the immediate effect of a strong magnet would be to overpower the revolving electrons, or at least to cause their orbits to face round parallel to the lines of force instead of maintaining their accustomed positions. But experiments prove otherwise, the only perceptible effect being a slight change in velocity. No doubt the tendency of these circular currents is to adjust themselves normal to the magnetic lines of force; but they are prevented from actually doing so because of their great inertia, just as the inertia of a spinning top is able to resist the influence of gravity. The constant tendency of the top is to fall over, but so long as it is spinning at the proper speed it will defy gravitation sufficiently to remain erect. As soon as friction reduces the speed, however, the top yields more and more to gravity's force, resulting in a wobbling motion until eventually its inertia is overpowered completely and it falls motionless to the floor. But neither gravity nor any known magnetic or electrostatic field can compel the electrons of any atom to come to a standstill. This proves their velocity and inertia to be enormous. The spectroscope thus confirms the previously calculated inertia of electrons as determined from the Thomson/Wilson cloud experiment already described.

Every frequency of rotation will produce its definite line in the spectrum. Planetary electrons may revolve many billions of times per second without impairing the stability of the atom, although there is, of course, a limit beyond which all atoms would radiate themselves to destruction. Theoretically, an aggregation of electrons would produce a red glow if they traverse their orbits at a speed of 400 billion times per second, and light of higher refrangibility would be emitted for velocities in excess of that. Obviously, therefore, the electrons in a normal atom do not possess such velocities as this, nevertheless their frequency of rotation is enormous when compared with any man-made machine. The armature of the highest speed modern type motor revolves less than fifty times a second. Electrons revolving even one billion times a second would thus rotate twenty million times faster than the most rapid electric motor. It is this enormous rotating motion of the electrons in the atom that gives the expelled particles of radioactive substances their exceedingly high velocities.

We have already mentioned that alpha particles emitted by radium, polonium, etc., if permitted to fall upon a target covered with zinc-sulphide, will produce luminous flashes which are plainly visible through a small telescope. Inasmuch as the mass, velocity and inertia of these particles are known, it is therefore possible to compute the amount of power that is generated when they are suddenly stopped. If the stoppage is sufficiently quick, say within the diameter of a molecule, there is actually involved the expenditure of nearly 80 horse-power for an exceedingly minute fraction of time. There can be little doubt but that a way will eventually be found to harness some of the enormous energy now locked within the atoms of particles of matter around us, making it generally available for the benefits of humanity.

WHY ATOMS DIFFER

We have now considered experimental evidence:

(1) that atoms are composed of aggregations of minute particles known as electrons;

(2) that some are negative and some are positive (the latter being called protons)

(3) that they have definite size with determinable mass, inertia and charge;

(4) that there is no characteristic difference between the electron (or protons) of one type of atom and those of any other type;

(5) that some of the electrons of atoms rotate in planetary fashion around a central nucleus at enormous velocities;

(6) that there are great spaces between the planetary electrons in all atomic systems, similar to the arrangement of the planets of a solar system.

These established facts bring us to the consideration of the precise arrangement of the electronic orbits of the various atoms and of the elemental difference between the ninety-two types of atoms known to science. The Rutherford-Soddy atomic models have lately been improved by Prof. Bohr, who was awarded the 1922 Nobel Prize in Physics by the Swedish Academy of Sciences (Einstein having received this prize for the preceding year). We shall accordingly endeavor to follow the reasoning of these eminent physicists and see how their theoretical structures account for known phenomena.

If electrons revolve there must be some stabilizing force that holds them in bounds. There is no reason for supposing that their infinitesimal size works a reversal in the tried and proven laws of electromagnetics; therefore any and all atomic systems must be so arranged as to neutralize the characteristic repulsion of one electron for another of the same sign. How, then, does an atom hold itself together? The reasonable conclusion is that each atom must have a central nucleus which is of opposite charge to that of the electrons which rotate around it and having sufficient attractive power to hold all the orbital electrons in bounds even as our sun holds in check the various planets which revolve around it. This would necessitate there being at least as many protons in the nucleus as there are planetary electrons.

The nucleus, however, could not consist entirely of protons; for positive charges are mutually repulsive even as negative charges are mutually repulsive. Hence the nucleus would be unstable if it were composed of protons alone. The Rutherford-Soddy atomic model, therefore, proposes that the nucleus of an atom consists of both positive and negative electrons, but not in equal number, probably arranged in blocks of four protons, with two negative electrons on each side as a binder. This would make the nucleus stable and would always result in an excess of protons for the purpose of stabilizing the remainder of the atom.

The foregoing deduction has been confirmed by experiment. As early as 1911 Prof. Rutherford succeeded in isolating the nucleus of an atom and ascertained the number of elemental charges which it carried. This he found to be in each case approximately equal to half the atomic weight. He first determined the mass of an alpha particle, which turned out to be identical with that of the helium atom minus two elemental negative charges.

Helium is the second lightest atom known and, as will be seen presently, it has two planetary electrons. The alpha particle is therefore one and the same thing as the nucleus of the helium atom with the two revolving electrons missing.

If alpha rays from radium are intermingled with ordinary electric sparks the spectrum will show helium lines in the discharge path, although no such lines are observed before the discharge is subjected to the radium emanations. Now if these alpha particles (helium nuclei) are permitted to bombard the nuclei of other types of atoms thus ionizing them and causing them to condense vapor in the manner heretofore described, they may be deflected by a magnet of known strength; and from the amount of their deflection the quantitative charge on these nuclei may be calculated. The experiment was repeated for various types of atoms and the respective results compared. Moseley, in 1914, shortly before his untimely death in the world war, fully corroborated Rutherford's findings as to the character of the nuclei of various atomic types, although he followed an entirely different experimental method. His results are believed to be very accurate and are relied upon by chemists for the establishment of atomic weights.

With the exception of hydrogen, which is the lightest atom known and which contains only one electron and one proton, the nuclei of all types of atoms are found to consist of aggregations of both protons and electrons, the protons of course always predominating Helium, the second lightest atom, has a nucleus consisting of a "block" of four protons and two binding electrons, the same as the alpha particle. Then for all other types up to and including uranium, which is the heaviest known atom, these nuclei are composed of increasingly numerous blocks. The more massive the nucleus the greater will be the number of planetary electrons. In other words, whatever number of excess protons there are in the nucleus there will be just that many negative "satellites" revolving around it. Thus the stability of the atom is maintained. The atomic weight of any element is therefore governed by the excess protons in the nucleus. Here then for the first time in the history of chemistry we have a reasonable explanation of why one type of atom differs from another.

Part VIII

List of Atoms

Variations of the "cloud" experiment and certain other methods heretofore mentioned have enabled scientists to determine the mass, size, etc., all known types of atoms -- ninety-two in number. These have been classified according to their atomic weight, ranging from hydrogen (the lightest) to uranium (the heaviest), and the tabulation discloses a remarkable even graduation throughout the list with only six gaps or breaks in the progression. These gaps evidently signify that there are six corresponding atomic types somewhere in nature about us which have not yet been discovered. A complete list of all known atoms is given below in the order of their weight. The number preceding the name of each element represents the number of excess protons in the nucleus (and consequently the number of electrons rotating around the nucleus), while the abbreviation which follows in parenthesis is the symbol by which the atom is known in chemistry:

1 Hydrogen (H)

32 Germanium (Ge)

2 HELIUM (He)

33 Arsenic (As)

3 Lithium (Li)

34 Selenium (Se)

4 Beryllium (Be)

35 Bromine (Br)

5 Boron (B)

36 KRYPTON (Kr)

6 Carbon (C)

37 Rubidium (Rb)

7 Nitrogen (N)

38 Strontium (Sr)

8 Oxygen (O)

39 Yttrium (Y)

9 Fluorine (Fl)

40 Zirconium (Zr)

10 NEON (Ne)

41 Niobium (Nb)

11 Sodium (Na)

42 Molybdenum (Mo)

12 Magnesium (Mg)

43 .....

13 Aluminum (Al)

44 Ruthenium (Ru)

14 Silicon (Si)

45 Rhodium (Rh)

15 Phosphorus (P)

46 Palladium (Pd)

16 Sulphur (S)

47 Silver (Ag)

17 Chlorine (Cl)

48 Cadmium (Cd)

18 Argon (A)

49 Indium (In)

19 Potassium (K)

50 Tin (Sn)

20 Calcium (Ca)

51 Antimony (Sb)

21 Scandium (Sc)

52 Tellurium (Te)

22 Titanium (Ti)

53 Iodine (I)

23 Vanadium (V)

54 Xenon (X)

24 Chromium (Cr)

55 Caesium (Cs)

25 Manganese (Mn)

56 Barium (Ba)

26 Iron (Fe)

57 Lanthanum (La)

27 Cobalt (Co)

58 Cerium (Ce)

28 Nickel (Ni)

59 Praseodymium (Pr)

29 Copper (Cu)

60 Neodymium (Nd)

30 Zinc (Zn)

61 .....

31 Gallium (Ga)

62 Samarium (Sa)

63 Europium (Eu)

78 Platinum (Pt)

64 Gadolinium (Ga)

79 Gold (Au)

65 Terbium (Tb)

80 Mercury (Hg)

66 Dysprosium (Ds)

81 Thallium (Tl)

67 Holmium (Ho)

82 Lead (Pb)

69 Erbium (Er)

83 Bismuth (Bi)

69 Thulium (Tu)

84 Polonium (Po)

70 Ytterbium (Yb)

85 .....

71 Lutetium (Lu)

86 Niton (Nt)

72 .....

87.....

73 Tantalum (Ta)

88 Radium (Ra)

74 Tungsten (W)

89 Actinium (Ac)

75 .....

90 Thorium (Th)

76 Osmium (Os)

92 Uranium Xii (Ur Xii)

77 Iridium (Ir)

92 Uranium (Ur)

It is from these ninety two kinds of atoms that all matter of which we have any knowledge is formed. It is a comparatively easy task to chemically analyze a substance and find out exactly what combinations of these known atomic "elements" go to form its molecules. The molecules of pure water, as every schoolboy knows, consist of two atoms of hydrogen and one of oxygen. Common salt, chemically known as Sodium Chloride, is composed of sodium and chlorine atoms in equal parts. That is, one each of these two kinds of atoms is found in each salt molecule. Nearly every substance with which we to do in daily life is a combination of different types of atoms; yet some common substances are wholly elementary, as for instance, gold, silver, copper, nickel, iron, tin, lead, etc., as will be observed from the foregoing atomic list. Even these, however, are seldom seen in their pure state, unmixed with alloy of some kind.

Although there are ninety-two places in the aforementioned tabulation of atoms, it will be noted that six of these are blank, viz., Nos. 43, 61, 72, 75, 85, and 87. This means there are actually only eighty-six "elements" thus far discovered; although if nature preserves the perfect graduation in atomic weights, from the lightest to the heaviest, she must have produced atomic types corresponding to these six missing numbers. No doubt such atoms do exist somewhere in the earth, and eventually they may be discovered.* Like some others which have more recently come to light, they doubtless will be found to belong to some very rare substances, probably buried far below the earth's surface where man has not yet penetrated. Certain other types of atoms were discovered subsequent to their theoretical classification and were found to fill the positions assigned to them in the chemical table. As soon as these six missing types are located another chapter in the great book of nature may then be closed.

It is within the realm of possibility, of course, that some atomic type or types heavier than uranium may yet be discovered, although many physicists consider this very unlikely even as they do not expect to ever find an atom lighter than hydrogen. The hydrogen atom, consisting as it undoubtedly does of only one electron and one proton, has ever maintained its position at unity in the atomic family, and still maintains it in this day of the most extended and thorough physical research work of the world's history. Uranium likewise defies all competition at the other end of the scale.

Uranium was the first radioactive substance ever discovered, and that epoch-making revelation happened only three years before the dawn of the twentieth century. There is evidence that it is in fact the parent of all the highly radioactive atoms; that is, that all the "elements" from 91 back to 82 in the foregoing atomic table are really uranium disintegrations. It is therefore believed that in the course of time all uranium, thorium, actinium, radium, niton, polonium and bismuth (as well as the two missing types which precede and follow niton) will disintegrate into lead, and that these seven atomic types are but characteristic steps in the slow, disintegrating process. Absolute proof of this, however, is admittedly lacking.

With the exception of hydrogen and helium it is not definitely known what the total number of protons and electrons in the nucleus of any given atomic system might be; but as we have seen, it is the excess protons in the nucleus that determine the number of

planetary electrons in a system (and therefore the atomic weight), and this knowledge we do possess. Furthermore, the affinity which certain types of atoms have for those of other types, which results in the formation of molecules, furnishes the modern chemist with much valuable information as to the arrangement of the planetary electrons around the nuclei of their respective systems. Some atoms are electropositive, some are electronegative, while others are self satisfied having neither positive or negative valence. Such atoms are said to be inert. There are altogether six inert atomic systems, and these we have distinguished in the foregoing tabulation by setting them in caps, viz.,

(2) HELIUM having 2 planetary electrons

(10) NEON " 10 " "

(18) ARGON " 18 " "

(36) KRYPTON " 36 " "

(54) XENON " 54 " "

(86) NITON " 86 " "

What causes one atomic type to react negatively and another positively? Why are the six inert atoms different from all others in this respect, being in what may be called a self-satisfied condition? Any theory that furnishes a plausible answer to these questions without conflicting with any known fact is worthy of consideration. The Rutherford-Soddy atomic models do provide a reasonable explanation of such phenomena. Their hypothesis arranges the planetary electrons in concentric rings, or rather concentric shells, inasmuch as they are distributed on all sides of the nucleus like the cover of a baseball instead of having orbits parallel to each other like the successive bands of Saturn. These "shells" of electrons revolve at relatively great distances from the nucleus and also from each other (with certain exceptions hereinafter described). Except for hydrogen, all atomic systems have at least one ring or shell of planetary electrons around the nuclei. The hydrogen atom, being composed of one electron and one proton, might be said to have no nucleus, each charge being in planetary rotation around the other like a swinging dumbbell. This unsymmetrical configuration of the atom is believed to account for the extreme activity of hydrogen gas in chemistry.

Helium, the second lightest atom, is an inert system. Why? This is accounted for by the natural assumption that its two planetary electrons revolve on diametrically opposite sides of the nucleus which would insure perfect balance and electrical stability. Its nucleus consists of four protons and two electrons, being identically the same formation as an alpha particle emitted by radium and other highly radioactive substances. Even as the two nuclear electrons serve to stabilize the four protons, so do the two external electrons, pulling against each other on opposite sides of the nucleus, tend to perfect the stability of the entire system. Hence the helium atom is inert.

It is believed that there are never more than two planetary electrons in the first shell of any system, and that for all atoms which possess more than two external electrons there must be additional shells. The six-inert atoms, therefore, are those which have all of their shells exactly filled, whereas all other atoms have their outer shell only partially filled and consequently they react positively or negatively depending upon how nearly filled or how nearly empty this outer shell my be. When each shell is symmetrically filled with electrons the atom is then in a satisfied or inert state and will not seek to join in molecular union with any other atom for the purpose of attaining further satisfaction, although an unsatisfied system may seize an inert atom and hold it in a molecular embrace in its craving for one or more of the electrons with which the inert system is so abundantly blessed.

Neon, with its ten planetary electrons, is the second inert system. It must, therefore, possess two completely filled shells. If it has two electrons in its first shell, then its second shell must have a capacity of eight. This is entirely reasonable; because if the second shell is the same distance from the first one as the first is from the nucleus, then it would have exactly four times the area of the first and could consequently accommodate four times as many electrons, namely eight. Thus the inertness of this ten-planetary system is accounted for. Atoms possessing over ten external electrons must have more than two shells.

Argon is the third inert atomic system. It has eighteen planetary electrons, i e., two in the first shell, eight in the second and also eight in the third. Hence the third cannot be situated at a distance from the first, otherwise its area would be greater and its capacity more. The fact that it contains the same number of electrons as does the second shell suggest the logical conclusion that it must be practically coincident with the second, or superimposed upon it in lock-joint fashion with no spatial partition between the two.

Krypton, the fourth inert atom, possesses thirty-six planetary electrons. If it has two in its first shell, eight in the second and eight in the third, then it must have eighteen in its fourth shell. This would indicate that it is located exactly as far from the second and third shells as they are from the first. In other words, its diameter is three times that of the first shell, which gives it nine times the area and consequently nine times the number of electrons of the first shell, which would be eighteen. This makes a total of thirty-six for the fourth shell, the location, area and capacity of the first three being identical with that of the preceding inert system (argon), while the fourth shell is also spaced in perfect symmetry with the other three.

The fifth inert atom is xenon. It has fifty-four planetary electrons, which is just eighteen more than is possessed by krypton, the fourth inert system. Thus the outer upon the fourth because they each contain eighteen electrons. The arrangement of the fourth and fifth shells is therefore evidently identical with that of the second and third already considered, the electrons being paired or interlocked in each case. The sixth shell, however, is a little distance removed from the fifth, because niton (the sixth inert atom) possesses eighty-six external electrons, which is thirty-two more than the fifth inert type. Inasmuch as niton's sixth or outer shell, therefore, has a capacity for thirty-two electrons while the fifth shell

contains only eighteen, it must have a somewhat larger diameter in order to possess the necessary area.

As for the systems above niton, which possess more than eighty-six electrons; these atoms must have a seventh shell which is superimposed upon the sixth. There is no atomic system which has this seventh shell filled, however, because that would require at least as many electrons as there are in the sixth shell, viz., thirty-two. This would make a total of 118 external electrons for such an atom, whereas the heaviest atom known is uranium, and it possesses only 92. This leaves only six electrons for its seventh or final shell, and it is therefore an unsatisfied system.

From the foregoing descriptions of the inert systems it is seen that more than mere quantitative balance between protons and electrons is necessary in order to make an atom "satisfied." Each of the ninety-two types of atoms is numerically balanced in positive and negative charges, having exactly as many planetary electrons as there are excess protons in the nucleus. But if their configuration around the nucleus is such as to leave an outer shell only partially filled, then the system is in an unsatisfied condition so far as valence is concerned and will seek satisfaction by embracing certain other atoms with which it may come in contact; thus molecules are formed. Now if such molecular systems are later broken up, as may be done by various laboratory methods, the atom of the aggregation which is the least satisfied often deliberately steals an electron from one of its erstwhile partners which is better able to part with it. This is easily demonstrated by laboratory experiments.

The atomic systems just below and just above an inert system have, respectively, a positive and a negative valence of one; as, for instance, fluorine and sodium, which occupy positions on opposite sides of the inert atom neon. Fluorine lacks one negative electron in its outer shell and therefore craves one negative charge, while sodium has one electron more than enough to fill its second shell and has therefore started a third shell with only one electron therein. Now there are two methods open to the sodium atom to obtain satisfaction: (1) by gaining seven additional electrons so as to complete its third shell, or (2) by relinquishing its one extra electrons and thus leaving it with only two full shells, same as neon. It is at once apparent that the latter method would be the easier of the two. Accordingly it is found by experiment that the sodium atom will readily part with one electron, and because of this disposition on its part it is said to have a positive valence of one. Magnesium is found to have a positive valence of two, and aluminium three. That is, they have this many electrons in their outer shells which they will readily part with in order to attain a satisfied state.

Part IX

Valence

Silicon, next to aluminum, has four electrons in its outer shell; that is the shell is exactly half full. Therefore there are two equally feasible ways for this atom to secure satisfaction. It may either take on four electrons and thus fill its outer shell, or it may

relinquish four and thus drop back to a two-shell system like neon. And, singularly enough, silicon is found by experiment to be in just such a quandary; it will react either electropositively or electronegatively with equal ease. It is therefore said to be an amphoteric system. As for the next three types however (phosphorus, sulphur and chlorine), the valence changes from positive to negative, and they are found to have a negative valence of three, two and one respectively. Inasmuch as they are approaching completion of their outer shell it is obvious that the easiest way for them to become satisfied is to take on rather than to give away, electrons Thus the behavior of all atoms is accounted for by the concentric shell arrangement of the planetary electrons. This same graduation of valence that exists in the systems between neon and argon, just considered, is also found to exist between every two consecutive inert systems.

WHAT CAUSES RADIOACTIVITY?

Having examined into the internal structure of the atom we are now prepared to understand the underlying causes of radioactivity and of radiant energy in general. What is this strange phenomenon so manifest in radium and certain other heavy atoms? And is all matter radioactive? Answering the latter question first: there can be little doubt but that all matter is radioactive to some extent although it is more pronounced in those "elements" of high atomic weight. It is only in the latter atomic systems that we find the radiations sufficiently intense to make visible impressions on photographic plates or on phosphorescent screens, yet there are other experiments that do reveal the emanation of energy from ordinary matter. This is well demonstrated by Abrahams' reactions.

It was discovered many years ago that the "leakage" from a charged electroscope is more rapid than can be accounted for by allowance for imperfections of the apparatus and other known causes. It is therefore believed that fully 70 percent of this leakage is due to radioactivity from the ordinary materials used in the construction of the instrument itself, which tends to neutralize the outside charge upon the electroscope proper. By screening the electroscope from stray radiations from the outside about 30 percent of the neutralization is eliminated. But no amount of screening seems to further reduce it, thereby indicating that the major cause lies within rather than without the instrument. Furthermore it is found that different degrees of neutralization or "leakage" are produced by different substances used in the lining of the electroscope.

Metals of all kinds are found to ionize the air molecules in their immediate neighborhood, each in a characteristic or specific amount. This is a further experimental corroboration of the theory that radioactivity is a property common to all matter; that it is as likely to be displayed by one type of atom as another if the conditions are similar, but as already noted it will differ in amount or intensity according to the massiveness of the atom and certain other internal peculiarities. While one gram of radium emits about 37 billion alpha particles per second, it is probable that an equal quantity of some lighter substance would emit only a few thousand or a few hundred per second, and would therefore be unobservable by any ordinary methods. Yet Dr. W. H. Russell, while experimenting with radium emanations, also noted faint photographic influences produced by common materials; again suggesting that radioactivity is a general property of matter. Although

this latter experiment is otherwise explained, it is nevertheless admitted that this spontaneous photographic power of ordinary substances has puzzling aspects about it so long as actual radioactive emanations from their atoms is denied.

Why should any substance continuously emit energy? What mechanism is there in matter that produces this phenomenon? Radioactivity, especially in those atoms of high atomic weight, is explained as being the result of internal convulsions in certain of its atoms. In the crowding of the electronic orbits, due to molecular contractions and other causes, dissatisfaction and consequently instability of certain atoms must of necessity occur. If an atomic system becomes dissatisfied in its nucleus then eruption of alpha particles and electrons forthwith takes place in the effort of the atom to regain its equilibrium. Often these eruptions are such as to cause the explosion of the entire atom.

This disintegrating process is what is constantly taking place in any highly radioactive substance such as radium which emits billions of particles per second from each gram. However enormous this number of atomic explosions per second appears, yet when we consider the total number of atoms in a gram then the number that erupt are actually few, so few in fact that it would take nearly two thousand years for all of them to explode, even if they kept up this rate constantly. Numerically speaking, therefore, the eruption of a dissatisfied atom is a "rare" occurrence, analogous to an occasional shooting comet among a thousand million heavenly spheres, yet we are accustomed to thinking of them as excessively numerous simply because we forget to view them relative to their setting. If only ten drops of water should ooze out every minute from a reservoir which contains millions of barrels we could consider the leakage insignificant. The outflow per minute of positive and negative particles from a single gram of radium as likewise insignificant when considered in relation to the grand total in the "reservoir." The experiments of Rutherford and Gelber with alpha emanations from polonium demonstrated that those eruptions, both in respect to time and place, simply obey the law of chance. Nevertheless they are sufficiently constant to appear to the ordinary observer as though they were governed by some inner economy which doles them out forever at a given rate.

When convulsive ejections of the swiftly moving electrons or beta particles occur, a disturbance is caused in the surrounding atoms and in the atomic and molecular systems through which they pass as they make their exit. The result is, as maintained by Prof. Bohr, that various atoms suffer a temporary change in the dimensions of their electronic orbits. Now as these disturbed orbits move back to normal, energy is necessarily given out. Gamma rays are an example of this form of radiant energy. They carry no charge and are therefore not composed of electrons or protons, yet they carry definite quanta of energy in exact ratio to the disturbance which generates them. Similarly when an outside disturbance such as an electric current or a beam of light falls upon any substance, the electrons orbits of the surface atoms of that substance are affected; and in the adjusting process there is an expenditure and outflow of energy which we specify by the general term radiation.

Planck, in 1901, found that all radiation, whether light, heat or otherwise, is given out in quanta, i. e., in amounts which are invariably proportional to the "wave length" or

frequency of the disturbing cause. He put the matter upon a definite mathematical basis, and the universal numerical ratio which he discovered to exist is called "Planck's Constant". It is found to hold good for all cases irrespective of the wave length causing the radiation. Some radiations of energy are so small in quanta that they escape experimental detection. Nevertheless such a faint radiation as that caused by an ordinary candle three miles away will produce a visible effect upon a photographic plate.

Gama rays, X-rays, radio waves and any light or heat rays are all related phenomena, being kindred manifestations of energy emissions from disturbed electronic orbits. The only difference between them is in the frequency of vibration. The frequency of the radiation is determined by the frequency (not the amount) of the disturbing factor. Thus if we permit a strong light, then a dim light, both of the same frequency, to fall upon any given surface, the electronic orbits of the surface atoms will be affected to the same extent in each case. The strong light will affect more atoms than will the dim light, but it will not disturb any individual atom any more than will the dim ray of the same frequency. Each atom will radiate the same quantum of energy in both instances.

If the frequency is increased, however, then the quantum of radiant energy will be larger, although the ratio between the two remains constant. Thus a dim light of high frequency will produce a greater amount of radiation per atom than will a strong light of lower frequency, although the sum total of radiation in the latter case may be greater due to the fact that more atoms are engaged in the radiating process. It is like fifty 25-watt incandescent lamps as against a thousand 10-watt lights. The latter aggregation will give more illumination, but no individual lamp in it shines as brightly as does a single 25-watt bulb. It is not the quantity but the quality (i.e., the frequency) of the disturbing element that determines the amount of contraction or expansion of the orbits of the planetary electrons in any atomic system, as Planck clearly demonstrated. His "quantum theory" was not readily embraced by scientists in 1901 due to the generally limited knowledge of atomic structures at that early date. The Plank constant, however, was later resurrected by Einstein and employed by him in calculating the specific heat of solids with such remarkable success that its accuracy is now no longer questioned.

The acceptance of the quantum theory of energy, however, necessitates a radical reconstruction, if not a complete repudiation of the ether theory. Instead of radiation being regarded as pulsations or wave motion in an ethereal medium, similar to waves in water, Planck holds that it consists of infinitesimal bundles of energy which are shot out in all directions, each carrying exactly the same amount so long as the source is being excited at a definite frequency. There are, of course, difficulties involved with the theory, even as there are many unsolved problems confronting the champions of the older ether theory; yet the former has so satisfactory accounted for the hitherto inexplainable phenomena of radiations that modern scientific consensus of opinion is leaning rapidly toward the quantum and away from the ether hypothesis. There is no doubt, of course that radiant energy travels in a wave-like manner, because interference can be produced in the same manner as interference of waves in water. But this wave motion may be confined to the quantum itself rather than being a phenomenon of the hypothetical ether. Certainly no experiment thus far undertaken has actually demonstrated that "ether" exists, and if all

known phenomena can be accounted for apart from it, then we are probably on safer ground when we ignore it altogether.

CONCLUSION

Having now examined into the fundamental basis of material atoms, and seeing how completely wonderful are their electronic mechanisms, we are the better prepared to appreciate the electronic reactions of Abrahms as outlined in the first part of this book. That which at first may have appeared fantastically well founded.

It must also be remembered that while our present treatise on the electron theory has been confined to atoms of inorganic matter, Dr. Abrahms ' researches concern the still more intricate problem of living organism. There is a difference between the atoms of organic and inorganic matter, but just what that difference consists of no scientist yet knows. He must content himself with the mere descriptive distinction that the one has life while the other has not.

What is life? That is the great problem that is still unsolved. To declare that life is energy is entirely too indefinite, because all kinds of atoms, organic or inorganic, possess energy, as we have seen. The chemist can analyze living organism; he can determine the elements of which it is composed, and can specify the atomic proportion of each to the molecule. Yet when they are put together by the hand of man the combination, -- though chemically correct, lacks life; it is but inorganic. Considering, then, the electronic intricacies of living organism, who can afford to blindly contend that the electronic reactions of Abrahms are the products of imagination? It is inexcusable folly to say "it can't be done" when it has been done and is being done every day by a thousand physicians.

Nearly every, advance in knowledge has been brought about by the sheer aggressiveness of somebody who has dared to depart from the beaten path of ages and plunge deteminedly into the wilderness of the unknown. Dr. Albert Abrahms has enlarged the horizon of physical science; he has thrown new light upon the subject of atomic mechanism; he has broken entirely new ground in the field of nature and has opened wide a door to undreamed of possibilities. It is plainly the duty of every true scientist to now find in further uncovering the long hidden treasures of this infinitesimal world of electrons of which we are made and which he has brought into prominent view.

FINIS

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