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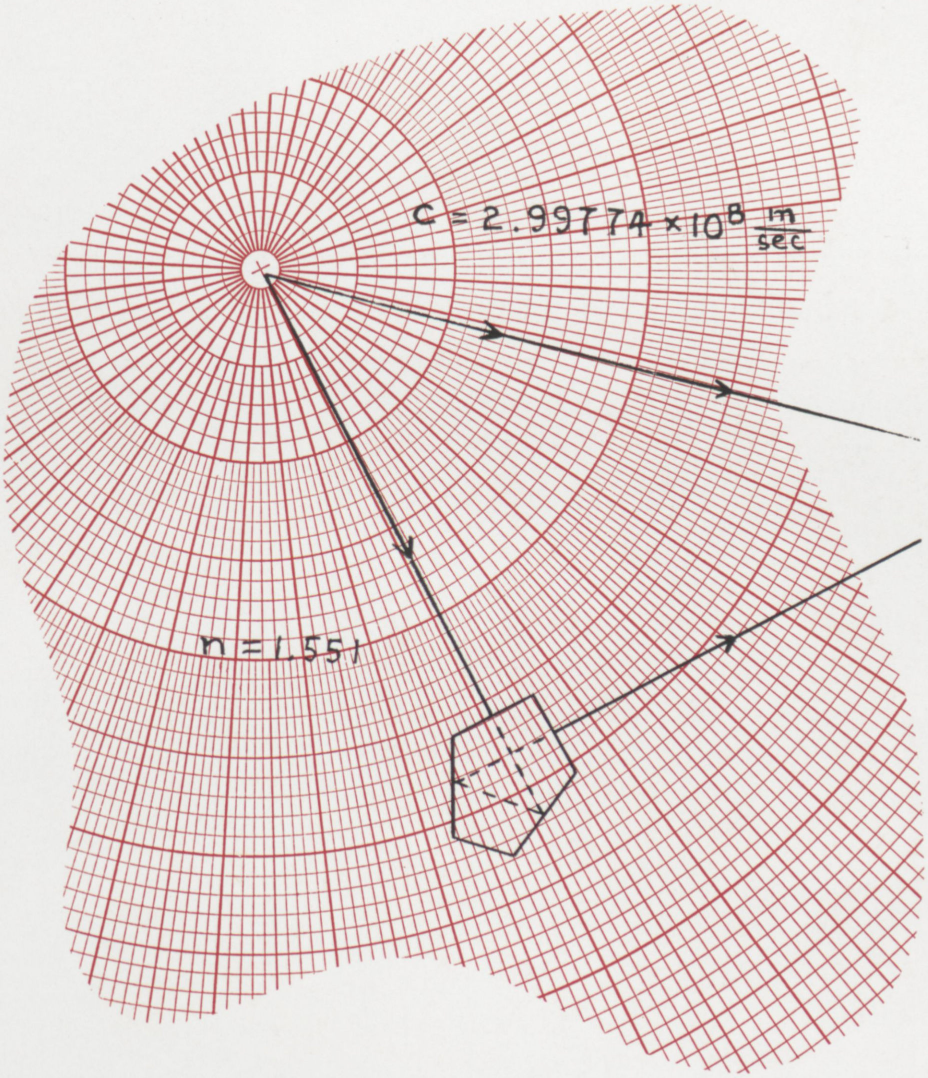
Rose Technic

November 1964



RIEMANN AND PHYSICAL SPACE

DEVELOPMENT OF THE PERIODIC TABLE

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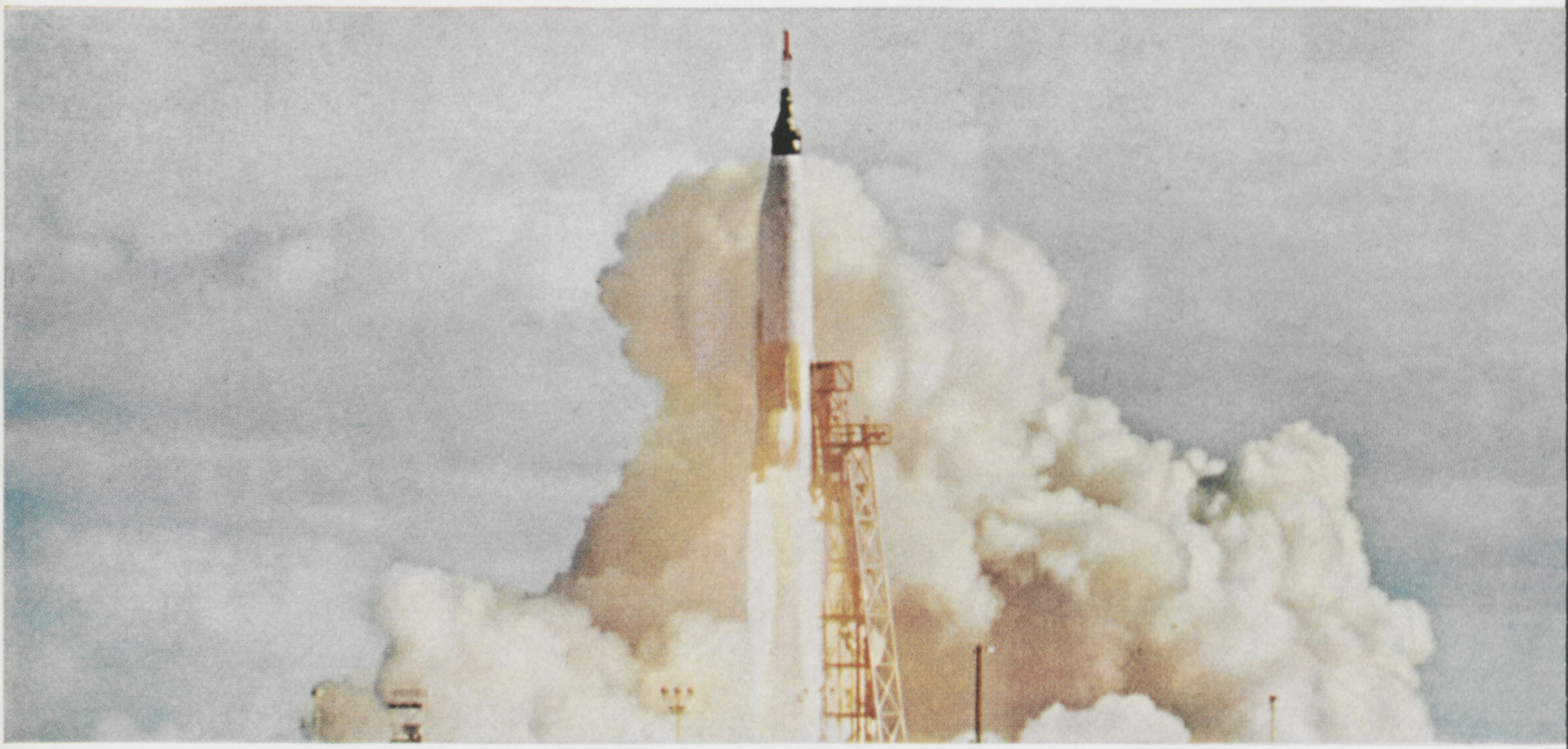

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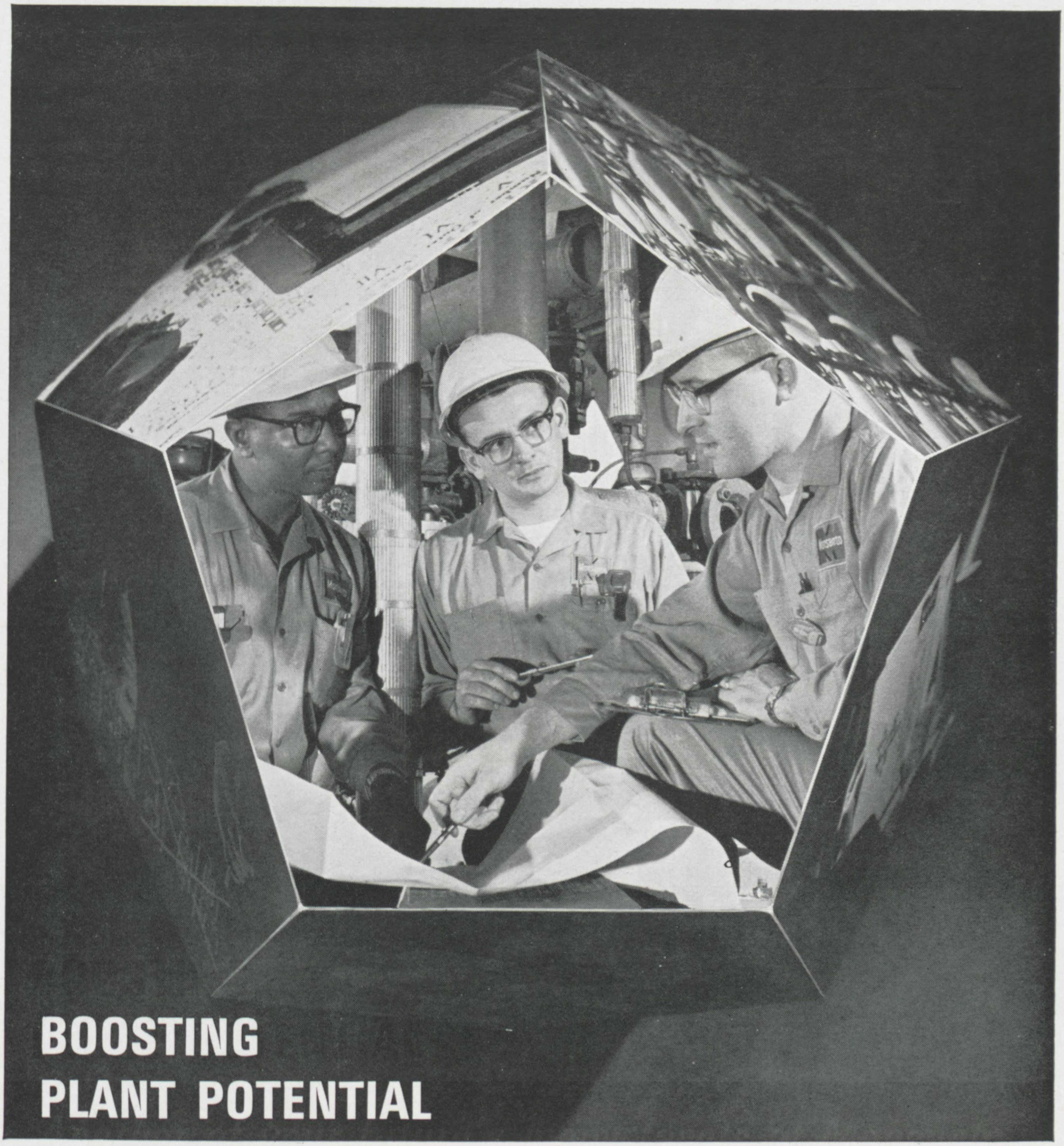

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IN THIS ISSUE

The contributions of Riemann to the concept of physical space are depicted in Bob Wattleworth's "Riemann and Physical Space."

In "Development of the periodic Table", John Diefenbaugh discusses the theories and discoveries of Greek philosophers, alchemist, and early scientists which led to the development of the Mendeleeff periodic table.

Prof. John W. Rhee describes detection of matter in outer space in "Concentration of Interplanetary Dust Particles."

An account of research pertaining to the dual nature of the corpuscular-wave theory of light and matter is presented by Bob Allen in "The Dualistic Theory of Light and Matter since Dalton."

P. O. STATEMENT

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COVER NOTE

This month's cover is entitled "Point Source." It is an original work by Associate Editor Bob Finney, a senior in mechanical engineering.

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The Office of the Dean of Students

By RALPH M. ROSS, Dean of Students

Ed. Note—This is the second of a series on the various offices of the administration, written to acquaint students and alumni with the functions assigned to them.

Student personnel services is an area of concern on college campuses that, in most cases, has come into being in the past 10 years. Increased enrollments in colleges and universities together with the increasing complexity of society itself have necessitated comprehensive programs of personnel administration.

The Rose Board of Managers, in the spring of 1961, made provisions in the administrative structure of Rose for an office of Dean of Students. This is not to infer that through the years prior to this, no attention was given to the areas now served through this office but rather that the administration of the various functions were shared by a number of faculty members as administrative assignments to be performed in addition to regular teaching duties. The chief areas of concern now coordinated in this office are counseling, housing, food service, student activities, financial aid, parent relations, special programs and general school discipline.

In the area of counseling, the Dean of Students office coordinates the efforts of the faculty advisers, instructors, the guidance counselor and chaplain in order to care for the academic and personal concerns of the student. Interest tests are administered and interpreted for those students seeking advice in making professional choice. Remedial programs are prescribed where certain deficiencies become evident. Grade studies and grade analysis are made to strengthen our overall program.

Housing and food service is becoming an ever increasing area of concern. Adequate housing is provided for Rose students whether it be on-campus housing in our dormitories or in our fraternities and private homes in the city of Terre Haute. Housing standards are established and maintained and an approved list of private homes is available to those students renting off-campus rooms. Plans now well underway for additional dormitories will greatly relieve our housing shortage. Although food service is on a contract basis with Saga Foods, Inc., the coordination and school supervision of this program is the responsibility of the Dean of Students.

This office serves as a coordinating agency for all extracurricular functions, club and social activities. All student events are calendared and school facilities for these functions scheduled in this office. It is the responsibility of the Dean of Students to administer the faculty rules on chaperonage and serve as chairman of the Student Activities Committee which recommends to the faculty any changes in the current rulings governing student organizations and activities.

Student financial aid programs are coordinated and administered in the office of the Dean of Students

(*Continued on Page* 34)

editorial

TIME FOR ACTION ON FRATERNITY HOUSING

Although President Logan is not the sort of man who usually allows the channels of communication between himself and the students to become clogged, his red-tape-snipping scissors seem to disappear at the mention of the two words, "fraternity housing." This problem has not arisen just recently—it has been floating around for several years. At least one fraternity even went so far as to obtain plans for a new house about five years ago. Yet, if one were to ask a fraternity man about the housing situation now, he would probably reply with a sarcastic laugh and say, "We're moving into 'our' fifty-man dormitory as soon as it's built." This is a reference to one plan offered as a solution to the problem.

It is not the purpose here to analyze the various plans presented thus far and advocate one as best. This is, from a practical view, nearly impossible, because no plan yet offered has been specific enough, particularly in the matter of financing, to permit such an analysis.

The big problem now is simply this: the fraternities do not know the attitude of the administration and, more important, the Board of Managers, toward the matter of fraternity housing. The efforts for communication which were made last year resulted mostly in the raising of the question, "Will fraternities be part of Rose in ten or twenty years?" Apparently the policy of the Board will hinge on the answer to this question.

No one can answer this question for the Board of Managers. It is time they took a business-like guess at the answer, so that they can establish a policy toward fraternity housing and incorporate this policy into the over-all development plan. Also, the fraternities have the right to know if they are to be expected to relocate on campus, and if so, under what sort of conditions.

The fraternities have a large responsibility in this area also. They must decide first exactly what they want to do, and second, exactly what aspects of the plans presented in the last few years are totally unacceptable and why. They must, furthermore, determine their financial capabilities and the financial requirements of any alternative considered. Finally, they must make known to the administration and Board what they want, what they consider unacceptable, and why.

The problem of fraternity housing can be summed up in the following questions:

Do the fraternities want to move onto campus?

Can the fraternities handle the obtaining of new houses off campus without financial aid from the school?

Is there any on-campus plan which does not require forfeiture of the independence and responsibility for their own problems that the fraternities have now and wish to retain?

If the fraternities, or any one of them, take the off-campus course, can they be assured that they will not be required by the administration at some future time to move on campus?

Only a systematic attack on these questions by co-operating administration and Inter-Fraternity Council can produce any progress in the area of new fraternity houses, progress which is becoming increasingly necessary with each year that passes.

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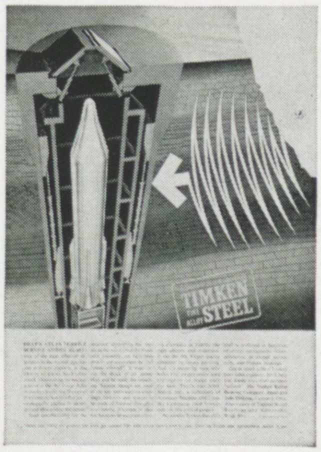
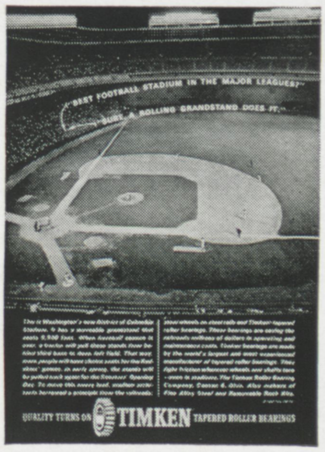
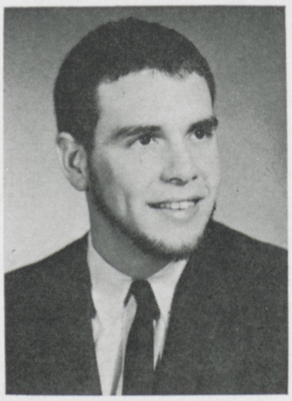




THE DEVELOPMENT OF THE PERIODIC TABLE

By
John
Diefenbaugh,
Sr. Ch. E



John Diefenbaugh is a senior majoring in chemical engineering. He comes from near Elkhart, Indiana. He is serving this year as President of his class, Vice-President of Blue Key, and President of the A.I.Ch.E. John also is a member of Lambda Chi Alpha fraternity and the varsity baseball team.

Chemistry had its beginning with the Greek philosophers who tried to determine the basic elements of the world. They felt that fire, earth, water and air were the four basic elements of the universe. They also had a knowledge of such elements as gold, silver, tin, iron, and sulphur. However, they made no attempt to classify these elements. Their value in the development of the periodic tables lies in the fact that they gave chemistry the necessary push it needed to bring about the classification of the elements.

The earliest classification, due to the work of many men, resulted in the recognition that the metals were elementary in character. They were divided into two classes: noble metals (gold and silver) and base metals (copper, tin, iron, lead, and mercury).

Up until 1802, the various attempts at classification were vague and showed no relationship among the elements. All modern effort at classification began with John Dalton (1766-1844) and his atomic theory of 1802-1803. This theory contained no systematic classification but it provoked thought as to whether atoms of various elements, although apparently different in properties, might be composed of some fundamental substance and whether the marked similarities among certain elements might be traceable to their atoms.

Dalton's idea that all elements might be composed of some fundamental substance was used by William Prout (1785-1850) in his hypothesis of 1815. His hypothesis stated that all elements were compounds of hydrogen and oxygen and that hydrogen was the fundamental material out of which all elements (including oxygen) were constructed. He calculated the atomic weights of some of the known elements and found some of them to be the same. For instance, nitrogen and phosphorus had an atomic weight of fourteen; iron, cobalt, and nickel were twenty eight; sulphur and oxygen were sixteen. From these similarities in weights, he concluded that substances having the same atomic weight resemble one another in properties and can combine more readily with one another. His assumption that the properties of elements with the same atomic weight resemble one another is important because, for example, the properties of sulphur and oxygen are very similar indeed. However, their atomic weights are not the same so in this respect he was wrong. The most important effect of Prout's hypothesis was that it was the first attempt to recognize any relationship between the atomic weight of the elements and their characteristic properties.

In Prout's values of atomic weights, none of them contained any fractions. This idea of whole number atomic weights prevailed up to the time of Mendeleeff, and beyond, even though much was accomplished in atomic weight values by Jons Berzelius (1779-1848) from 1807 to 1818. He set out upon the task of determining the combining weights of the elements and in these eleven years found forty-three of them. The importance of his atomic weight values was the fact that they were fractional atomic weights. His atomic weight value for sulphur was 32.18, today it is 32.064. Obviously his experiments were extremely accurate but his values for atomic weights were not quickly adopted by his followers. However, Berzelius' atomic weight values were different from those of Prout which is important because the question of whose values were correct had to be answered before a true classification of the elements could be found.

The next man to enter the scene of classification was J. W. Dobereiner (1780-1849). In 1839 he published a paper in which he noted that similar elements usually existed in groups of three which he called triads and also that the sum of the atomic weights of the lightest and heaviest elements divided by two equaled the atomic weight of the middle one. For example,

$$\frac{\text{chlorine } (34.470) + \text{iodine } (126.470)}{2} = \text{bromine } (80.470).$$

Berzelius, in his experiments, determined the atomic weight of bromine to be 78.383. Note the use of fractional atomic weights instead of whole atomic weights as Prout had used. Dobereiner's triads were the first reported attempt at classification. Prout had only recognized the similarities among the elements on the basis of atomic weights and made no attempt to classify them.

The next attempt at classification was made in 1850 by Max Pettenkofer (1818-1901). He suggested that among chemically similar elements such successive differences in atomic weight differed by a constant or some multiple of this constant. Pettenkofer used examples like the following as the basis for his assumption: lithium 7; sodium 23 (7 + 16); potassium 39 (23 + 16) and calcium 20 (12 + 8); strontium 44 (20 + 24); barium 68 (44 +24). It can be seen that these atomic weights can be broken up into a sum in which one of the addends is some multiple of eight. Pettenkofer felt that this relationship was more than a mere coincidence and he was thus led to believe that the possibility existed that all compound bodies were made up of the same simple body. In Pettenkofer's belief we can see Dalton's idea of all elements being composed of a single fundamental substance and also Prout's idea of using whole number atomic weights.

Two years after Pettenkofer's attempted classification came the attempted classification of Jean Dumas (1800-1884). Dumas felt that there existed a simple formula of two or three terms which would account for the composition of a group of similar elements. For example, in the nitrogen group, Dumas found the relationship in Figure 1.

This led Dumas to observe that these series showed the same kind of relationship as existed in many of the organic compounds which were composed of hydrogen and carbon. But we have already seen that Prout's hypothesis stated that the fundamental element was hydrogen. If hydrogen was not present in the above nitrogen series, then Dalton's theory still said that there might exist some fundamental substance common to this series. Once again, whole number atomic weights were used instead of fractional atomic weights in expressing this relationship.

In 1853 J. H. Gladstone (1827-1902) stated that the atomic weights of similar elements might be related in one of three ways: (1) the weights may be the same; (2) the weights may be in multiple proportion; or (3) the weights may differ by certain definite increments. To illustrate his first possible choice, Gladstone used chromium 26.7, manganese 27.6, iron 28.0, cobalt 29.5, and nickel 29.6 as well as other examples. These five metals are of similar properties and exist in nature associated together. Gladstone felt that a careful determination of the atomic weights would prove them equal. To illustrate his second choice, Gladstone used boron 10.9 and silicon 21.3; and oxygen 8.0 and sulphur 16.0. Also, the platinum group (99) is nearly double the palladium group (53) and gold (197) double the platinum group. To illustrate his third choice, Gladstone used the same examples as those of Pettenkofer and Dumas. In his attempted classification, Gladstone made use of fractional atomic weights. However, most of them were wrong, such as sulphur, even though the values of atomic weights determined by Berzelius were available. As had happened with Pettenkofer and Dumas, Gladstone made no use of Berzelius' work.

Immediately upon the heels of Gladstone was J. P. Cooke (1827-1894). In 1854 Cooke published a classification more detailed and complete than any before it. He divided the elements into six series, each characterized by a special numerical relationship and published a series of tables bringing out these relationships. Like Dumas, he observed that these relationships exhibited something similar to the series of organic compounds. His tables are too long

(*Continued on Page* 16)

Figure 1

a			14			Nitrogen	14
a	d		14	17		Phosphorus	31
a	d	d^1	14	17	44	Arsenic	75
a	d	$2d^1$	14	17	88	Antimony	119
a	d	$4d^1$	14	17	176	Bismuth	207

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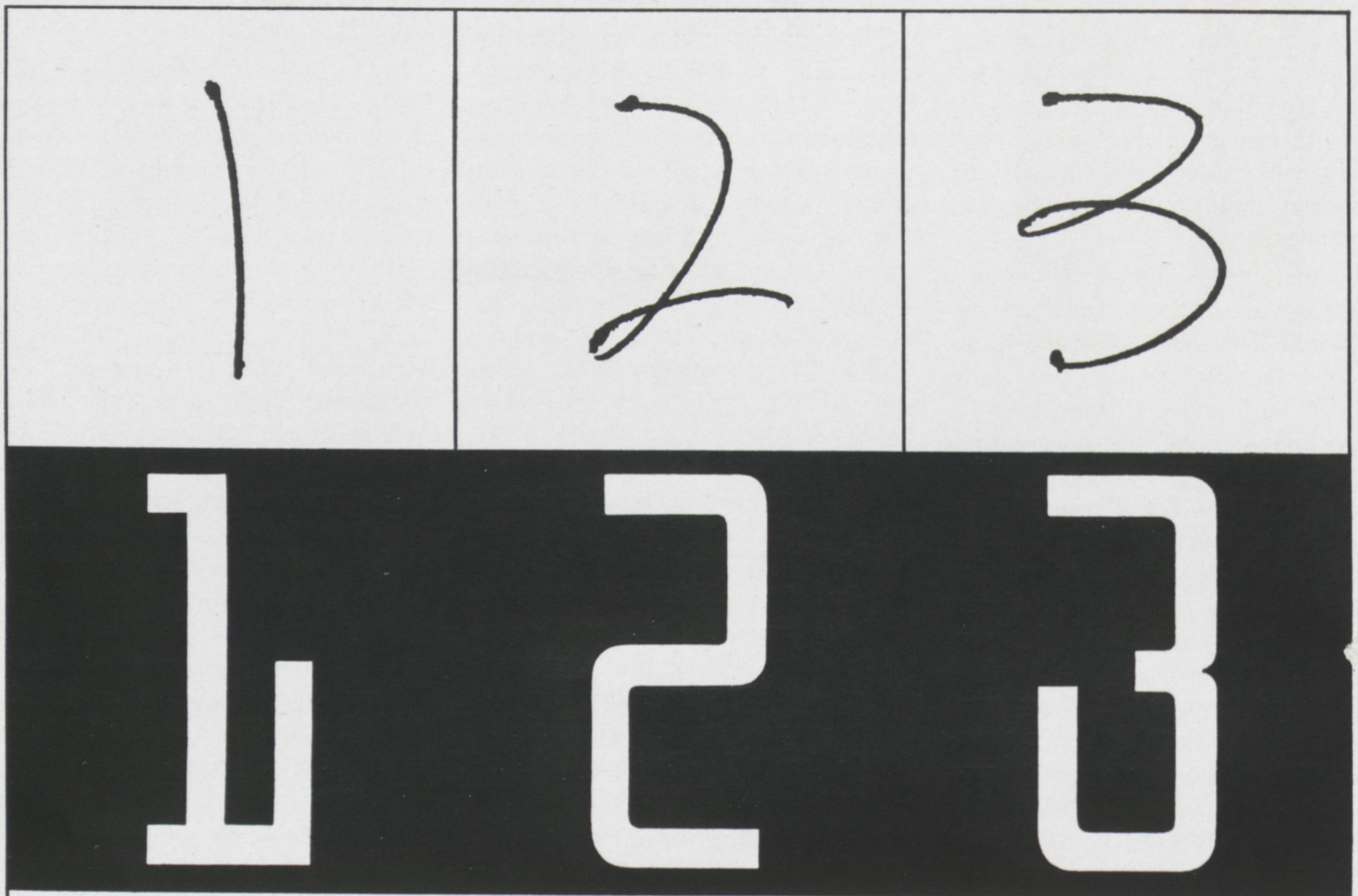

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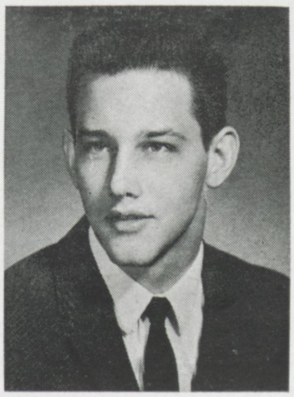


Bob Wattleworth is a junior and is majoring in mathematics. He comes from Olney, Illinois. He is active in school affairs and is a member of Theta Xi fraternity and the Interfraternity Council.

Riemann AND PHYSICAL SPACE

By Robert Wattleworth, Jr. Math

At the time of the emergence of non-Euclidean geometries the view of physical space had been for centuries one in which Euclidean propositions held, and the metrical form of space had been defined by the analytical counterpart of Euclidean geometry. Even philosophical doctrine had been closely related to the idea of Euclidean space, the case in point being the academic philosophers who adhered to the Kantian contention that the axioms of Euclidean geometry were a *priori judgements* transcending reason and experience.

The definition of congruence, which had been irresistibly suggested by the mere existence of rigid bodies, seemed to demand that our physical space be Euclidean, and all manner of measurements that had thus far been made seemed to completely justify this.

By varying the parallel postulate of Euclidean geometry, Riemann and Lobatchewsky each found a geometry different from Euclid's, although they were entirely consistent within themselves. Riemann found, in addition, that in either of the two non-Euclidean geometries congruence could be defined by rigid bodies, although a rigid body in one geometry would not be identical to a rigid body in the other geometry. In fact, a rigid body in any of the three mentioned geometries would appear to squirm when moved, in comparison to a rigid body of the other geometries. Which geometry then, if indeed any of the three, was the physicist to accept as valid in our physical space?

Poincare' maintained that there was no *a priori* metrics associated with space, and that the definition of congruence is entirely a convention, as long as no assumptions are made contradictory to the geometry we employ, regarding the behavor of rigid bodies.

The type of space physicists are discussing, then, "reduces to a relational synthesis of physical results. Space itself remains amorphous." The geometry the physicist credits to space is based on his acceptance of a number of physical laws; however, by varying these laws in an appropriate way he could still account for observed facts and credit corresponding types of geometry to space.

This view of Poincare', that of a pure mathematician, is not necessarily the most practical. If we consider space and its physical content jointly, the geometry we select to describe space is that one which permits the simplest coordination of the facts. In the words of Riemann:

> Nevertheless it remains conceivable that the measured relations of space in the infinitely small are not in accordance with the assumptions of our geometry (Euclidean geometry), and in fact we have to assume they are not if, by doing so, we should ever be able to explain phenomena in a more simple way.

Newton, however, did not start with an abstract mathematical space and then impose a geometry on it, but rather looked for the metrics of real space within the structure of space itself. The apparent uniqueness of the geometry of physical space is emphasized, he said, by the fact that we are led to the same Euclidean geometry (experimentally) whether we start with rigid bodies and define congruence, or start with light rays and define geodesics. (It had not been shown yet that light rays do not follow Euclidean straight lines.) This coincidence seems rather strange if the geometry credited to space were not independent of the physical method of exploration used for defining our metrics.

Also the effects of moving bodies in space cannot be neglected. If space were of the amorphous mathematical variety, we should expect all paths through space to be amorphous, and yet we find that the various forces of inertia are experienced for certain paths through space and not for others. Newton concluded that these forces must arise from the structure of space itself, and that the structure was, in the light of experiment, Euclidean.

Since the requirements of mathematical empty space demand the lack of an inherent metrics, the structure of space was said by some physicists of this time to be contained in a mysterious "ether" filling space. Real space then became the combination of empty mathematical space and its ether content.

Riemann, however, did not accept as did most of his contemporaries this mysterious ether theory. If the existing physical laws were to retain their simplicity, then, he said, we must associate with space an inherent metric, although the source of the metrical field was to be sought elsewhere. He pictured this field as analogous to the magnetic field surrounding a magnet, and in turn searched for its source in the physical world of real objects. "With characteristic boldness, he found it in the matter of the universe; the metrical field thus became a species of material field." The development of the general theory of relativity by Einstein has since shown that "what appeared to Riemann as a geometrical hypothesis, as a mere possibility of thought, was an organ for the knowledge of reality."

The mathematical analysis of the structure of space had already been started, in a sense, by Gauss through his work on the theory of surfaces. He investigated the properties of curvature of surfaces in space; his greatest contribution (in space geometry) rests in his proof that the properties of curvature of a surface at a point may be expressed in terms of the intrinsic properties of the surface.

For this purpose Gauss assumed two families of curves drawn on the surface. These curves were to be used for defining position on the surface and had the advantage that the position description was not dependent upon observation from a point not on the surface, as would be the case with the familiar cartesian coordinates of three-space. (To see the utility of this, consider the problem of trying to discover the nature of the earth's surface without leaving the surface. His proof thus gained in generality of application.)

Along each curve of one family one of the coordinates specifying position is constant, and along the other set, the other coordinate is constant.

These curves are to cover the whole surface such that any point on the surface may be specified by specifying its "Gaussian" coordinates, (x_1, x_2). (As a familiar case, note that the latitude and longitude lines on the earth's surface are a Gaussian coordinate system.)

Now considering a small element of arc, ds, on the surface and the corresponding elements of arc dx_1 and dx_2 in the direction of the x and x curves respectively, it can be shown using the Pythagorean theorem in cartesian coordinates that

$$ds^2 = g_{11}dx_1^2 + 2g_{12}dx_1dx_2 + g_{22}dx_2^2$$

where g_{11}, g_{12}, and g_{22} are magnitudes which can be determined by making physical measurements on the surface and are different in general for different locations on the surface — an expression without reference to a submergence of the surface under consideration into the space of next higher dimension, three-space.

Riemann, the student of Gauss, saw in this expression a generalized statement for infintesimal length in any continuous manifold of n dimensions, and one in which ds would be invariant under transformation. Thus for a geodesic element in a manifold of n dimensions with general coordinates $(x_1, x_2, x_3, \ldots, x_n)$, he asserted the formula

$$ds^2 = g_{uv}dx_u dx_v$$

with u and v to be summed over 1, 2, 3, ..., n.

The g_{uv} functions were to specify the curvature at each point, and in the case of physical space, they would be the result of the gravitational field at the point. From these functions could be calculated lengths of arc, angle magnitudes, areas, and volumes of pieces of a three dimensional solid.

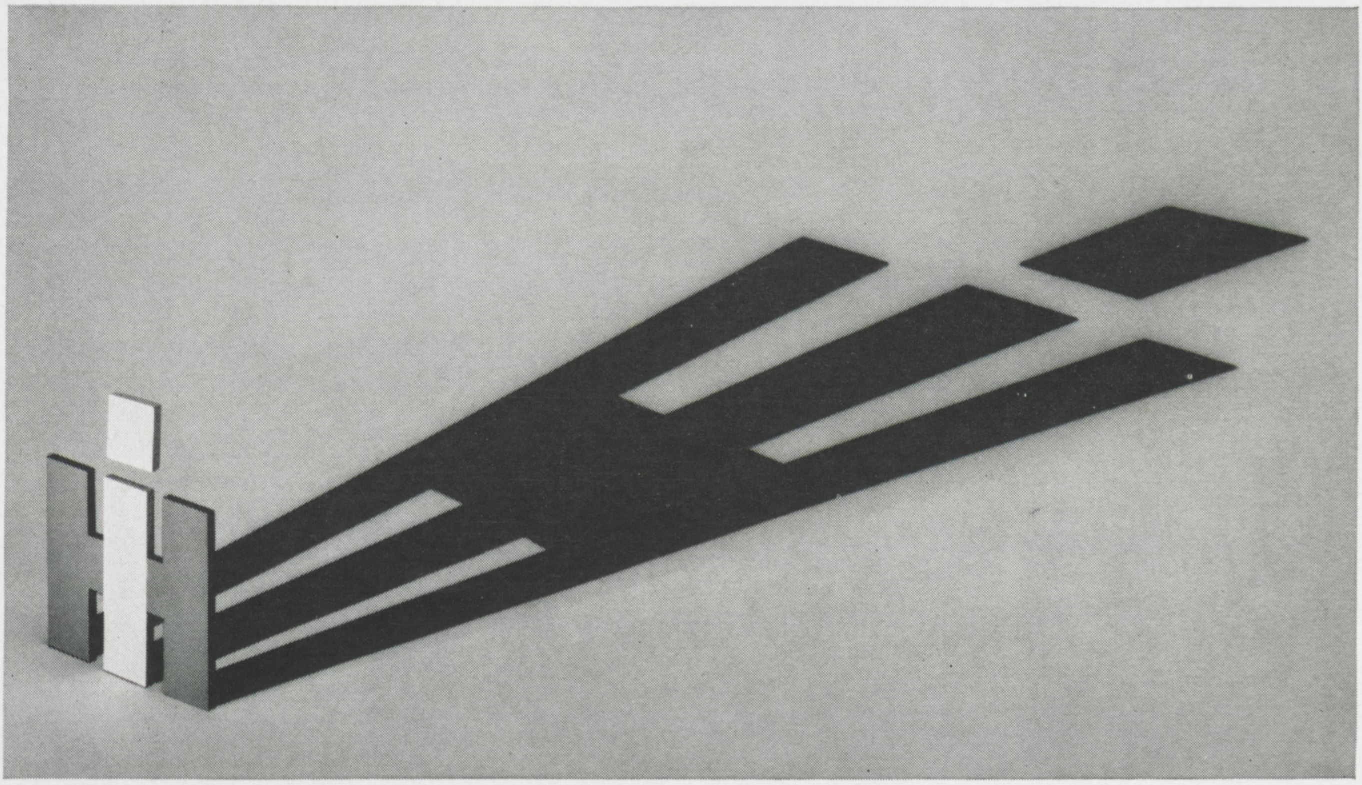
Straight lines of Euclidean geometry are generalized in Riemannian space to "geodesic lines," or simply "geodesics." These geodesics, whose equations form a natural network throughout the n-dimensional manifold, can be used as a basis for the determination of its curvature. If, at a given point in space, two infinitesimal line segments are drawn and then also all the other infinitesmal line segments "in the same plane" at the point, geodesics can be drawn from the point with these line segments as initial elements which will generate a two dimensional "geodesic surface", S^{uv}, with its normal N. Riemann now defined the general curvature K_n of the n-dimensional manifold at the given point with respect to the normal N as the Gaussian curvature of this geodesic surface. It is obvious that the Riemannian curvature K_n depends on the orientation N of the geodesic surface and varies also from point to point. In other words it is a measure of both the anisotropy and heterogeneity of space.

If the Riemannian curvature is independent of the orientation N of the geodesic surface element S^{uv} at every point in the manifold, which would be the case if the manifold were isotropic, it can be shown that the curvature is constant, i.e. the manifold is homogeneous. If this curvature is zero, then the space is Euclidean; if it is +1, the space is Riemannian (or spherical); if it is —1, the space is Lobatchewskian (or hyperbolic).

The contention of non-homogeneity of physical space was revolutionary for the time. Of the limitless possibilities of types of geometries created by Riemann (today known as differential geometries), only the homogenous varieties in which the curvature of space is constant were given any credit by his contemporaries. Riemann, however, claimed that the assumption of homogenous space did not take into account the existence of matter; "just as a strictly homogenous magnetic or electrostatic field is never encountered in reality, so a homogenous metrical field of space is only an idealization."

The modern ideas of quantum mechanics and the respective pur-

(Continued on Page 32)



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Concentration of Interplanetary Dust Particles In The Vicinity Of Earth

By
JOHN W. RHEE, Asst. Prof. of Physics
M.A., Ph.D., Temple University

Prior to joining the Rose faculty in 1964 Dr. Rhee was Assistant Professor of Physics and Acting Chairman of the Department at College of South Jersey, Rutgers—The State University. At Rose he is in charge of courses in theoretical mechanics and optics. His current research interest concerns the distribution of cosmic dust particles in the vicinity of the earth. He is the author of a number of articles on the subject including one based on data collected by the Mariner II Venus space probe.

An important component of the solar system is the cloud of dust particles surrounding the sun. Knowledge concerning the origin, composition, and physical characteristics of the dust particles is fundamental to the consideration of the solar system. The techniques used in these investigations have been as follows: (1) Visual, photographic, and radar observations of meteors; (2) Photometric observations of zodiacal light and solar Fraunhofer corona; and (3) Direct measurements of dust particles. The zodiacal light observed in the night sky forms a tapered band stretching up from the horizon into the sky and is attributed to sunlight reflecting from vast numbers of small dust particles in space. Other evidence of the concentration of particles in space results from the shape of the sun's Fraunhofer corona. The Fraunhofer corona is shaped by the absorbing medium through which the sunlight passes. The medium through which it passes, in this case, is a zodiacal dust cloud that results in the F corona of the sun (other media through which the sunlight passes account for other components of the corona).

Since the visual, photographic, and radar techniques used in observing meteoric processes produced by meteoroidal dust particles are limited to the study of particles of masses greater than 10^{-4} gram, they are of little value in studying the size, mass, and spatial distribution of the dust particles. Optical observations of the solar F corona and zodiacal light have led to some useful but inconclusive ideas about the physical properties of dust particles, and their spatial distribution as well as the shape and extent of the dust cloud. The direct measurement technique is the most adequate for the purpose of these studies since it can include the study of collection of dust particles coming to the earth from outer space as well as the measurement of selected physical parameters of dust particles (mass, velocity, and density).

The first direct measurement of dust particles was made in 1949 using sounding rockets instrumented by Professors J. L. Bohn and F. H. Nadig of Temple University. Since the successful launching of U. S. Explorer I, data have been obtained from experiments carried out on more than two dozen satellites, rockets, and space probes sponsored by the United States and the Soviet Union. This direct measurement technique represents a unique way of studying small particulate aggregates of matter in selected regions of the solar system as well as in the vicinity of the earth's orbit. The earliest direct measurements that were of quantitative value were obtained with microphone systems in a series of seven successful high altitude rockets instrumented by the Temple University under the supervision of Professor J. L. Bohn. Explorer I, Explorer III, Explorer VI, Explorer VIII, Explorer XIII, Explorer XVI, Midas II, Pioneer I, Ranger I, Samos II, and Vanguard III have carried dust particle detectors and fairly good data have been obtained from these space experiments. Direct measurements carried out by the Russian space scientists have also been reported by T. N. Nazarova. Sputnik III, Lunik I, Lunik II, Interplanetary Station, and three geophysical rockets carried dust particle detection systems. An interplanetary dust particle experiment was carried out on Mariner II

(*Continued on Page* 32)


TOWMOTOR

PERIODIC TABLE

(*Continued from Page* 9)

and detailed to consider in this paper, but his idea of dividing the elements into distinct series was the first of its kind and was used by most of the men who followed him.

We have seen how several men in their classifications have used Prout's hypothesis of whole number atomic weights. But in 1860, J. S. Stas (1813-1891), by tremendous patience and extremely accurate equipment for his time, was able to determine accurately values for atomic weights. His atomic weights deviated from whole numbers, as had the values of Berzelius and, because of his work, Prout's hypothesis was proven to be false. The question of fractional atomic weights (Berzelius' values) versus whole number atomic weights (Prout's values) was answered.

The attempted classifications up to 1863 were necessary steps to final periodic classification but none of them were truly periodic arrangements. They were more on the line of group classifications but they showed no connection between the various groups. But in 1863 M. de Chancourtois (1820-1886) came out with the first truly periodic arrangement of the elements. He plotted the values of atomic weights on a vertical curve described on a vertical cylinder. The surface of the cylinder was divided into sixteen equal parts with lines drawn parallel to the axis of the cylinder. The number sixteen was chosen because it represented the atomic weight of oxygen. A curve was drawn by starting at the base of the cylinder and drawing a line at forty-five degrees. Each intersection of this spiral curve with a generatrix (one of the sixteen lines parallel to the axis of the cylinder) was a unit of atomic weight and each point of intersection on the same generatrix was sixteen atomic weight units more than the one above it or sixteen atomic weight units less than the one below it. In other words, the atomic weights on the same generatrix differed by a multiple of sixteen. This curve, which de Chancourtois called the telluric screw, produced an arrangement whereby the related elements fell upon the same vertical line. This led de Chancourtois to suggest that the properties of substances were properties of number. Figure 2 is an unfolded portion of de Chancourtois' telluric screw. From this table one can see, for example, that oxygen and sulphur, which have similar chemical properties, are on the same generatrix and differ by sixteen atomic weight units. This idea of similar elements differing by a certain multiple used by de Chancourtois is similar to the ideas expressed by Pettenkofer and Dumas. Also notice the use of whole number atomic weights by de Chancourtois even though Stas had proved beyond a doubt that atomic weight values were fractional.

Without any knowledge of de

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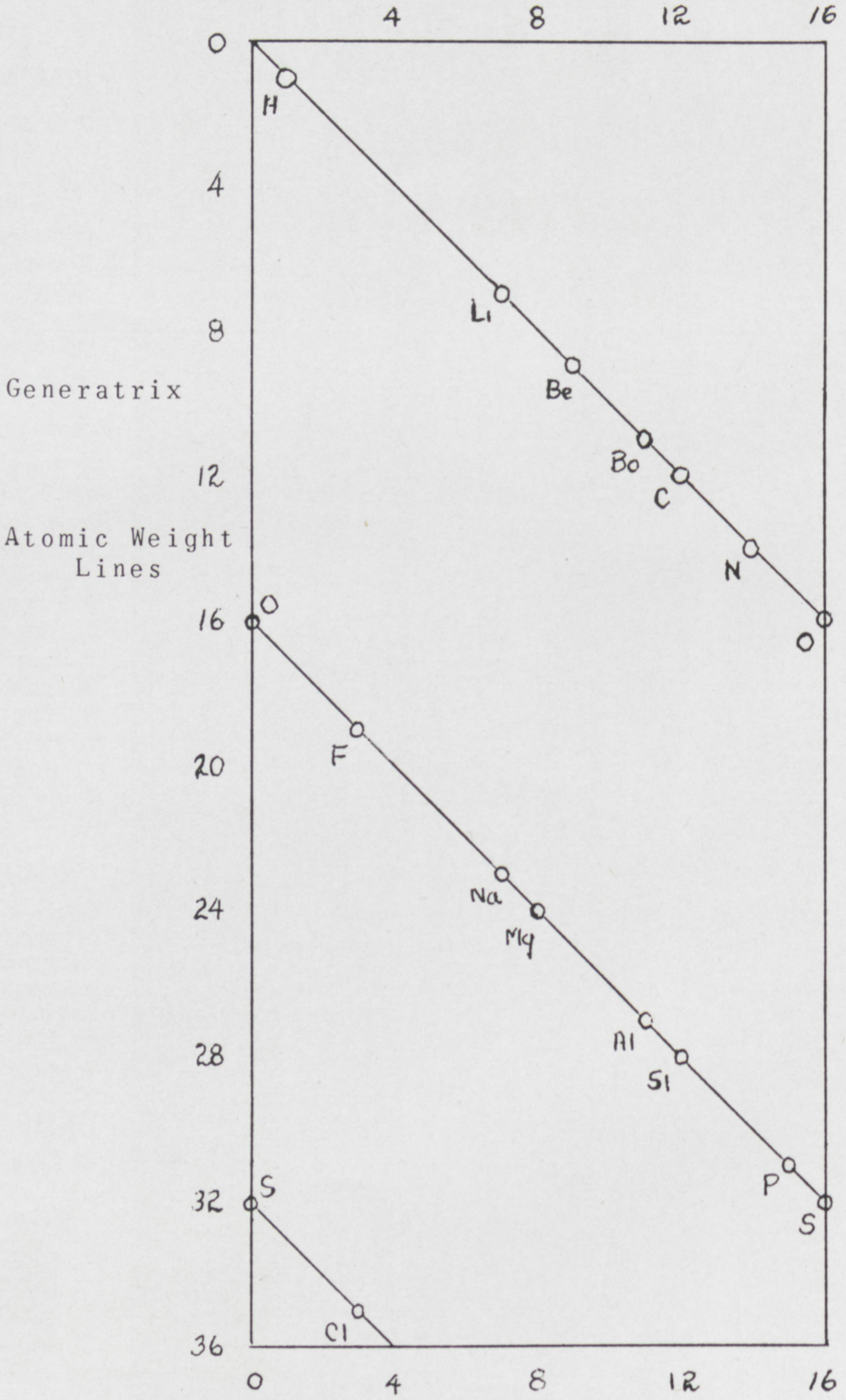

Fig. 2. De Chancourtois' Telluric Screw

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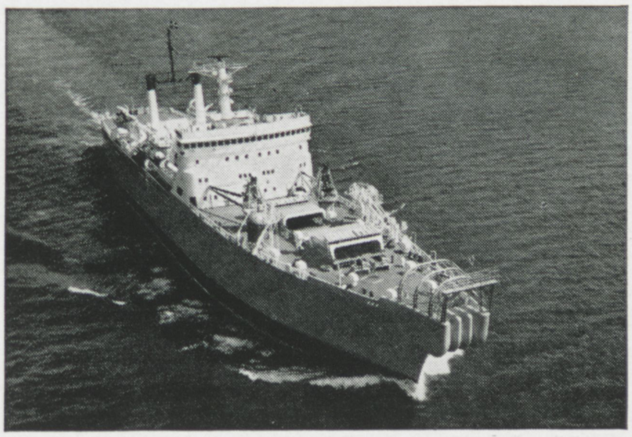

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The *DUALISTIC THEORY OF LIGHT AND*

DUALISTIC THEORY OF LIGHT AND

Noted scientists of Dalton's day were already thinking in terms of a corpuscular structure of matter at the time the atomic theory was presented. Although Dalton was a crude experimenter and many of his results have since been disproved, his description of the atomic nature of matter remains as the starting point of a modern investigation of the composition of matter. For a hundred years after its postulation the existence of the atom remained to be proved.

Dalton's Predcessors

The atomic view of matter was enunciated in 1803 by John Dalton. It is important to realize that the Quaker school teacher's theory did not appear as a stroke of genius out of thin air. Dalton had access to the kinetic theory of gases that was begun by Daniel Bernoulli in the latter part of the eighteenth century. The foundations of Dalton's theory were established by Lavoisier and Proust. Lavoisier presented evidence of conservation of matter in chemical reactions and a concept of chemically discrete elements in 1789. Another Frenchman, Joseph Proust, added that every pure substance composed of two or more elements may be decomposed to its elements and always decomposes in the same way and in the same proportions by weight. From these theories and the study of absorption of gases by liquids Dalton published his papers introducing atomic weights and the law of multiple proportions on which he founded his atomic view of matter.

The work of Avagadro and Proust in 1815 set the stage for the system of atomic weights. This early progress in atomic theory led the Russian chemist, Mendeleef to propose the periodic table of elements in 1869. In a very few years about ninety of the elements had been isolated and their characteristics compared with Mendeleef's predictions.

Electric Charge and the Atom

Faradays's electrolysis established the idea that electric charge was in some manner intimately associated with the atom and its structure. This was in 1833 — a very early time in the history of atomic physics. Some sixty years later Faraday's work helped J. J. Thomson in his discovery of the electron and positively charged particles.

Existence of the atom was attacked by the French chemist, Joseph Perrin. Perrin's classic experiment stands as a tribute to man's creative genius and skill. He was able to prepare colloids of amazing uniformity and make microscopic measurements of the settling of the particles of the colloid. From these tedious observations he was able to determine the molecular weight of the liquid used to suspend the colloidal particles and determine the number of liquid molecules per unit volume. Perrin's work is important because it was confirmation of the corpuscular theory of matter by direct experimental observation.

The ground work for the Modern Corpuscular Theory

The study of blackbody radiation eventually led to the development of the quantum theory of radiation, which is now an integral part of the atomic theory. A great deal of work in thermal radiation and electrodynamics was done in the latter half of the nineteenth century. Stephan and Boltzmann began investigation of blackbody radiation in hope of being able to give radiation quantitative explanations. But they were only moderately successful in obtaining an empirical expression for the intensities of radiant energy. Maxwell had given an expression for the distribution of speeds of gas molecules being thermally agitated. It was found by Wien that the Maxwellian speed distribution curve held a remarkable similarity to the wavelength distribution of energies obtained in blackbody radiation experiments. Wien attempted to write an empirical equation similar to the Maxwellian distribution that would fit the radiation curve. His approach was well justified if blackbody radiation is regarded as a result of thermally agitated molecules of the solid. After arduous calculation and curve fitting Wien was able to obtain an equation which fit the radiation phenomena rather well. However, there was a slight deviation of Wien's Law from the experimental data for long wavelengths.

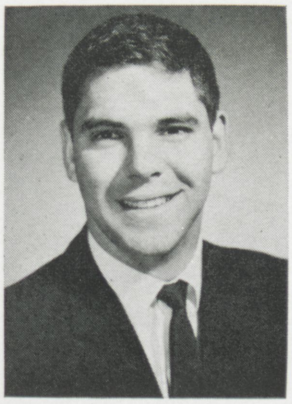
Confrontation of Classical Theory and the embryo Corpuscular Theory

Shortly after Wien's empirical work in 1893, Lord Rayleigh at the Royal Society in London attempted to derive from classical thermodynamics an equation which would explain radiation emitted from a blackbody cavity. Rayleigh's approach was from classical thermodynamic considerations of modes of vibration of the thermally agitated atomic particles. Rayleigh's equation presented science with a crisis, because it predicted that radiation emitted from a blackbody would possess an infinite amount of energy at the extremely short wavelengths. This meant there could be no living thing on earth, because of the intense ultraviolet radiation being emitted. The scientific community had regarded Wien's failure as "too bad," but it could not overlook a contra-

MATTER MATTER

Since Dalton

Bob Allen is a senior majoring in electrical engineering. He is from Arlington Heights, Illinois. He came to Rose after one year at the University of Wichita. Bob is an officer of the IEEE and a member of Lambda Chi Alpha fraternity



diction to the classical thermodynamics that had worked so well. Max Planck set out to try to resolve the contradiction.

Planck began by careful examination of Rayleigh's derivation and reasoning in search of error. Finding none he turned to the equation itself in an attempt to discover what caused the discrepancy. By bandying the numbers of Rayleigh's equation, Planck was able to bring it into exact agreement with experimental data. He then turned to Rayleigh's first considerations of the modes of vibration of the agitated atoms. Rayleigh had allowed the atomic vibrations to have an infinite range of harmonics, which produced the "ultraviolet catastrophy." By placing additional restrictions on the energy associated with these atomic oscillators, Planck could again arrive at the exact equation for thermal radiation. The restriction Planck placed on the system was that the energy associated with atomic vibration could not vary continuously, but must take on discrete integral multiples of a constant, h, times the frequency of vibration, f. This is his famous quantum equation of energy association with radiation $E=nhf$.

Planck's Genius

Planck was hesitant to make this break with classical physics even though it appeared to be correct. During the time of development of the theory of discrete energy emission or quantum he believed that Wien had arrived at the correct equation and improved instruments would soon prove Wien's Law was correct. But in 1900 new measurements by Lummer and Pringshlim and Rubens and Kurlbaum led Planck to conclude that Wien's Law could not possibly be correct. Planck's quantum theory was the first break with classical physics and the beginning of a new form of physics whose full power is not yet known. For this concept Planck was awarded the Nobel prize in 1918.

Improvements in Apparatus

Meanwhile notable work was being done with gas discharge tubes by Crookes, J. J. Thomson, Perrin, Lenard, and many others. These experiments led to the discovery of charged particles of the atom. The work was slow, because it had to wait for technological development of vacuum pumps which were capable of producing very low pressures. This technological breakthrough came in 1862 with the development of the first mercury vacuum pump by Heinrich Geissler. An improved pump of this type was used by Sir William Crookes in 1877 in the early investigation of cathode ray discharge in rarefied gases.

Perrin discovered that a metal plate acquired a negative charge when placed in the path of a cathode ray. From this Perrin believed the beam of cathode rays to be a stream of negatively charged particles similar to Faraday's ions. Perrin's views were criticized by Lenard, who observed cathode rays passing through various screens without making "holes." He contended this was a property of waves alone (i.e. light waves passing through glass).

The Significance e/m

J. J. Thomson reasoned that if it were possible to measure the charge to mass ratio of the cathode rays he could conclude that the rays were in fact a stream of charged particles; for waves do not possess the property of mass. Thomson was able to calculate the charge to mass ratio of the electron by means of measuring the deflections of the beam caused by electric and magnetic fields. The values he obtained are very close to the values obtained by Millikan in 1909. The stage for Thomson's discovery was set by twenty years of scientific study of gas discharges and the technological developments of effective evacuating equipment.

Thomson later postulated that the atom was like a watermelon of positive charge with negative electrons embedded in it like seeds. His reasoning was on the basis of matter being homogeneous; then the charge must be distributed in the same way. The next step in atomic theory is Rutherford's resolution of the problem of how the mass and charge are distributed in the atom.

The Atomic Structure takes Familiar Share

For at least ten years Rutherford had been working on radio-active decay and transmutations of elements undergoing radioactive decay, when he began an experiment in 1911 to verify Thomson's model of the atom. Rutherford bombarded a thin gold foil with alpha particles (doubly ionized helium atoms) emitted from a radium source. He then measured the scattering angles with a small phosphorescent screen. Much to his surprise he found that the Thomson model could not produce such a scattering as he observed. If Thomson's model was correct most of the alpha particles would pass straight through the foil. Many of the alpha particles did pass through undeviated, but some were scattered at unusually large angles and a few were deflected back

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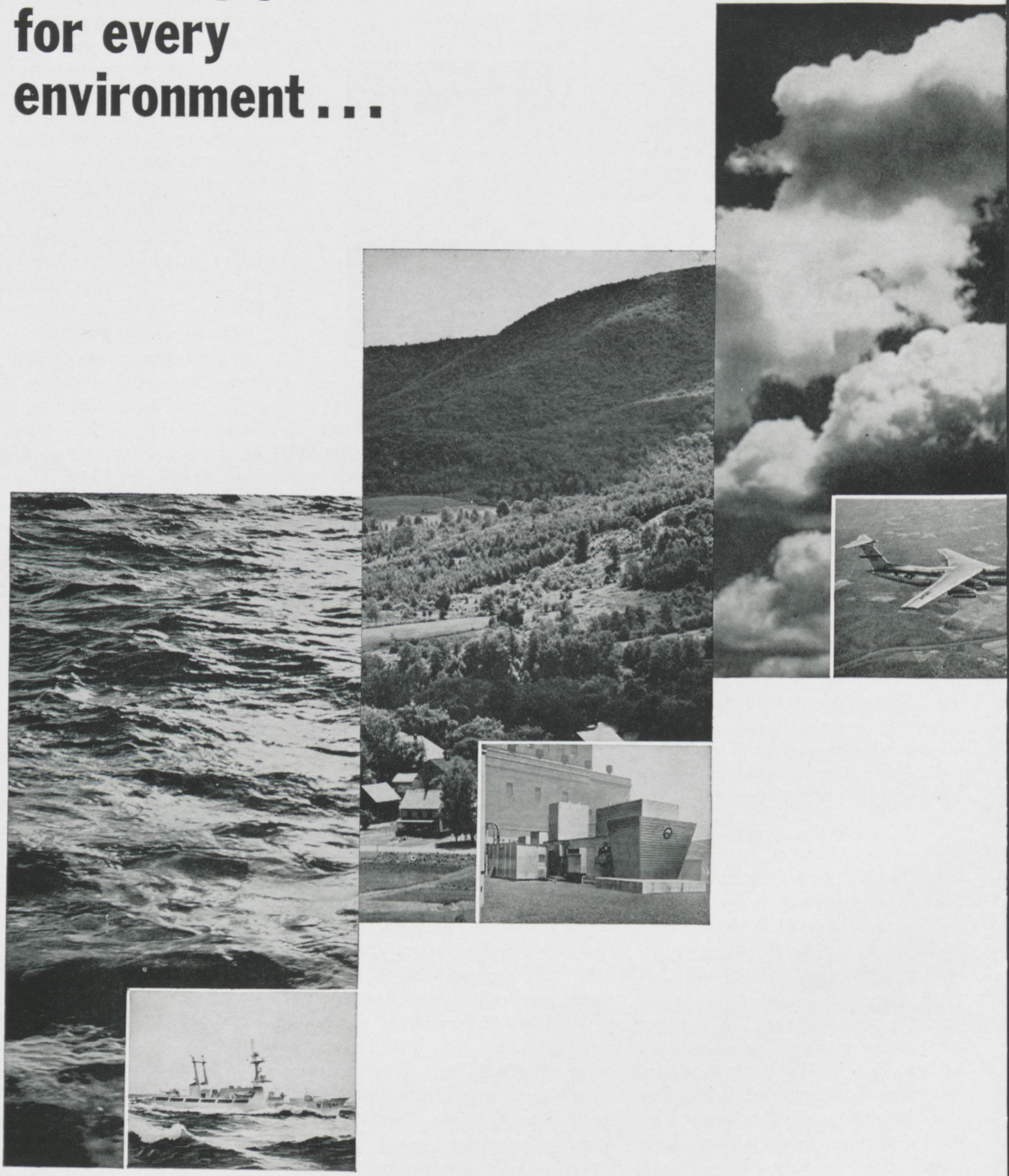

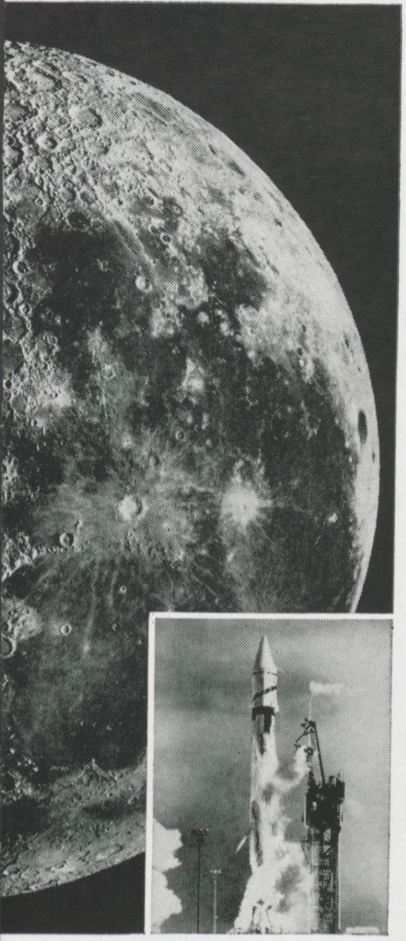

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Miss Technic for November

Our eyecatching Miss Technic for November is Miss Carol Hall. Miss Hall is a freshman at Indiana State College where she is majoring in elementary education.

Carol's home is in Morristown, Indiana, a small town 100 miles to the east of Terre Haute. Maybe this is where she acquired that "pretty girl back home" look.

Outdoor sports appeal to Carol. She participates in such as swimming, hiking, and tennis. Her fellow participants are entranced by her 35-24-35 figure.

Carol's other important measurements are 5'4" tall, and 120 lbs., making her a great lass to have close on those cold November evenings.

Miss Carol Hall

Figure 3 MEYER'S TABLE OF THE ELEMENTS

I	II	III	IV	V	VI	VII	VIII	IX
	B=11.0	Al=27.3				In=113.4?		Tl=202.7
	C=11.97	Si=28				Sn=117.8		Pb=206.4
			Ti=48		Zr=89.7			
	N=14.01	P=30.9		As=74.9		Sb=122.1		Bi=207.5
			V=51.2		Nb=93.7		Ta=182.2	
	O=15.96	S=31.98		Se=78		Te=128?		
			Cr=52.4		Mo=95.6		W=183.5	
	F=19.1	Cl=35.38		Br=79.75		I=126.5		
			Mn=54.8		Ru=103.5		Os=198.6?	
			Fe=55.9		Rh=104.1		Ir=196.7	
			CoNi=58.6		Pd=106.2		Pt=196.7	
Li=7.01	Na=22.99	K=39.04		Rb=85.2		Cs=132.7		
			Cu=63.3		Ag=107.66		Au=196.2	
?Be=9.3	Mg=23.9	Ca=39.9		Sr=87.0		Ba=136.8		
			Zn=64.9		Cd=111.6		Hg=199.8	

Figure 4 **NEWLAND'S LAW OF OCTAVES**

H	F	Cl	Co,Ni	Br	I	Pt,Ir
Li	Na	K	Cu	Rb	Cs	Os
G(Be)	Mg	Ca	Zn	Sr	Ba,V	Hg
Bo(B)	Al	Cr	Y	Ce,La	Ta	Tl
C	Si	Ti	In	Zr	W	Pb
N	P	Mn	As	Di,Mo	Nb	Bi
O	S	Fe	Se	Ro(Rh),Ru	Au	Th

PERIODIC TABLE

(*Continued from Page* 16)

Chancourtois' work, J. Newlands (1837-1898), between 1863-1865, came up with a classification somewhat similar to that of de Chancourtois. Newlands noticed that upon arranging the known elements in the order of increasing atomic weight there was, in many cases, a repetition of chemical properties in each eighth element. He called this relationship the law of octaves because of the repetition of the eighth note of an octave in music as shown in Figure 4.

From this table we can see that the arrangement amounts to seven horizontal series, each containing eight members, and eight vertical groups. According to Newlands' law, hydrogen, fluorine, chlorine, cobalt, nickel, bromine, iodine, platinum, and iridium should be similar in properties. Fluorine, chlorine, bromine, and iodine are similar and so are cobalt and nickel and platinum and iridium, but these three groups exhibit no similarity with each other. Discrepancies like these existed in Newlands' table because of undiscovered elements and his lack of accurate atomic weight values. However, his arrangement is recognizable in those used today. It should be noticed that in Newlands' law of octaves we can see the idea of using a series of elements as had been done for the first time by Cooke in 1854 and also the addition of vertical groups.

De Chancourtois and Newlands provided the link between all previous attempts at classification and the final evolution of the periodic table by Lothar Meyer (1830-1895) and Dimitri Mendeleeff (1834-1907) in 1869. Meyer and Mendeleeff each devised a table without knowledge of the other's work, yet both tabulations were similar and both men stressed the law of periodicity of properties with atomic weight. Mendeleeff's table was based upon the chemical properties of the elements while Meyer's was based upon the physical properties of the elements. As a consequence of periodic variations noted when such properties as atomic volume, melting point, boiling point, etc., were plotted against the atomic weight, Meyer arrived at the following tabulation of the elements, which appears in Figure 3.

In Meyer's table we see the use of horizontal series and vertical groups, with the idea of a series coming from Cooke's work in 1854 and the idea of groups coming from Newlands. The elements which exhibited similar properties were arranged in horizontal series and if these various series are arranged in a vertical series, the similarity with our modern day periodic table is evident. Also, it is worthwhile to

Figure 5 **MENDELEEFF'S TABLE OF 1869**

I	II	III	IV	V	VI
			Ti=50	Zr=90	?=180
			V=51	Nb=94	Ta=182
			Cr=52	Mo=96	W=186
			Mn=55	Rh=104.4	Pt=197.4
			Fe=56	Ru=104.4	Ir=198
			NiCo=59	Pd=106.6	Os=199
H=1			Cu=53.4	Ag=108	Hg=200
	Be=9.4	Mg=24	Zn=65.2	Cd=112	
	B=11	Al=27.4	?=68	Ur=116	Au=197?
	C=12	Si=28	?=70	Sn=118	
	N=14	P=31	As=75	Sb=122	Bi=210
	O=16	S=32	Se=79.4	Te=128	
	F=19	Cl=35.5	Br=80	I=127	
Li=7	Na=23	K=39	Rb=85.4	Cs=133	Tl=204
		Ca=40	Sr=87.6	Ba=137	Pb=207
		?=45	Ce=92		
		Er=56?	La=94		
		Yt=60?	Di=95		
		In=75.6?	Th=118?		

Figure 6 **MENDELEEFF'S TABLE OF 1872**

Series	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
1	H 1							
2	Li 7	Be 9.4	B 11	C 12	N 14	O 16	F 19	
3	Na 23	Mg 24	Al 27.3	Si 28	P 31	S 32	Cl 35.5	
4	K 39	Ca 40	—* 44	Ti 48	V 51	Cr 52	Mn 55	Fe 56, Co 59 Ni 59, Cu 63
5	(Cu 63)	Zn 65	— 68	— 72	As 75	Se 78	Br 80	
6	Rb 85	Sr 87	?Y 88	Zr 90	Nb 94	Mo 96	— 100	Ru 194, Rh 104 Pd 106, Ag 108
7	(Ag 108)	Cd 112	In 113	Sn 118	Sb 122	Te 125	I 127	
8	Cs 133	Ba 137	?Di 138	?Ce 140	. . . *	. . .	. . .	
9	. . .	. . .	. . .	. . .	. . .	. . .		
10	. . .	. . .	?Er 178	?La 180	Ta 182	W 184	. . . . . .	Os 195, In 197 Pt 198, Au 199
11	(Au 199)	Hg 200	Tl 204	Pb 207	Bi 108	. . .	. . .	
12	. . .	. . .	. . .	Th 231	. . .	U 240	. . .	

*Dashes indicate predicted elements, dots signify missing elements

note the use of fractional atomic weights by Meyer.

Mendeleeff is usually given more credit for the classification of the elements than Meyer, for Meyer made no predictions whatsoever concerning his table while Mendeleeff made several predictions which clearly showed his grasp of the existence of certain relationships among the elements. Figure 5 is the original table of elements proposed by Mendeleeff in 1869.

The similarity between this table and that of Meyer is evident. Also, Mendeleeff's table contained six verticle groups and it will be remembered that Cooke's table also contained six series of the elements. Mendeleeff's table also has a striking resemblance to that of Newlands.

In 1872, Mendeleeff published a table in which, for the first time, the main groups were divided into subgroups with the division being based largely upon whether the members of the subclasses belonged to series with odd or even numbers. Figure 6 is Mendeleeff's table of 1872. For instance, Group I is composed of two subgroups, even (Li,K,Rb,Cs) and odd (H,Na,Cu,Ag,Au). In both of Mendeleeff's tables he used fractional atomic weights sparingly.

The most striking phase of Mendeleeff's work was his prediction of elements then undiscovered and the properties they would exhibit, all on the basis of the unoccupied positions of his table of 1872. Figure 7 is a table of the properties predicted for an element Mendeleeff called ekasilicon and the actual properties observed for it when it was discovered and named germanium.

The agreement of these properties in this case was scarcely observed in other cases, but such predictions made a striking appeal to popular attention and hastened the adoption of the periodic law as one of the fundamental chemical generalizations. Mendeleeff's table of 1872 is the forerunner of our periodic table of today.

The values of the atomic weights played the dominant role in the development of the periodic table. From the time of Prout's hypothesis in 1815 until the atomic weight values determined by Stas in 1860, the use of whole number atomic weights versus fractional atomic weights was a personal matter, depending upon the type of classification each man was trying to develop. For instance, the use of whole number atomic weights made the relationships of Pettenkofer, Dumas, and de Chancourtois much easier than if fractional atomic weights had been used. But Dobereiner, Cooke, Newlands, Meyer, and Mendeleeff were able to use fractional atomic weights because their classifications were not based upon any proportion or were not required to fall upon a certain line as in the case of de Chancourtois. The proportional relationships suggested by Pettenkofer, Dumas and de Chancourtois would have been very messy if fractional atomic weights had been used. In Gladstone's case, he made use of both fractional and whole number atomic weights. Perhaps if the fractional atomic weights determined by Berzelius had been used, the periodic table might have been developed before 1869, but this is a question which can never be answered.

The lack of undiscovered elements and accurate atomic weights of the known elements also had an effect upon the development of the periodic law. The combination of these two factors resulted in all of the men mentioned in this paper placing some of the elements in the wrong places in their tables.

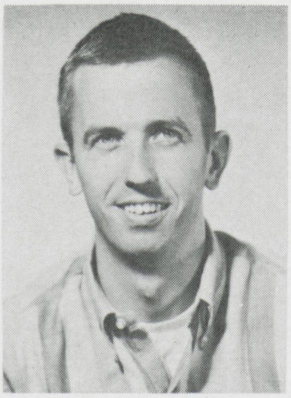
(*Continued on Page* 36)

Figure 7

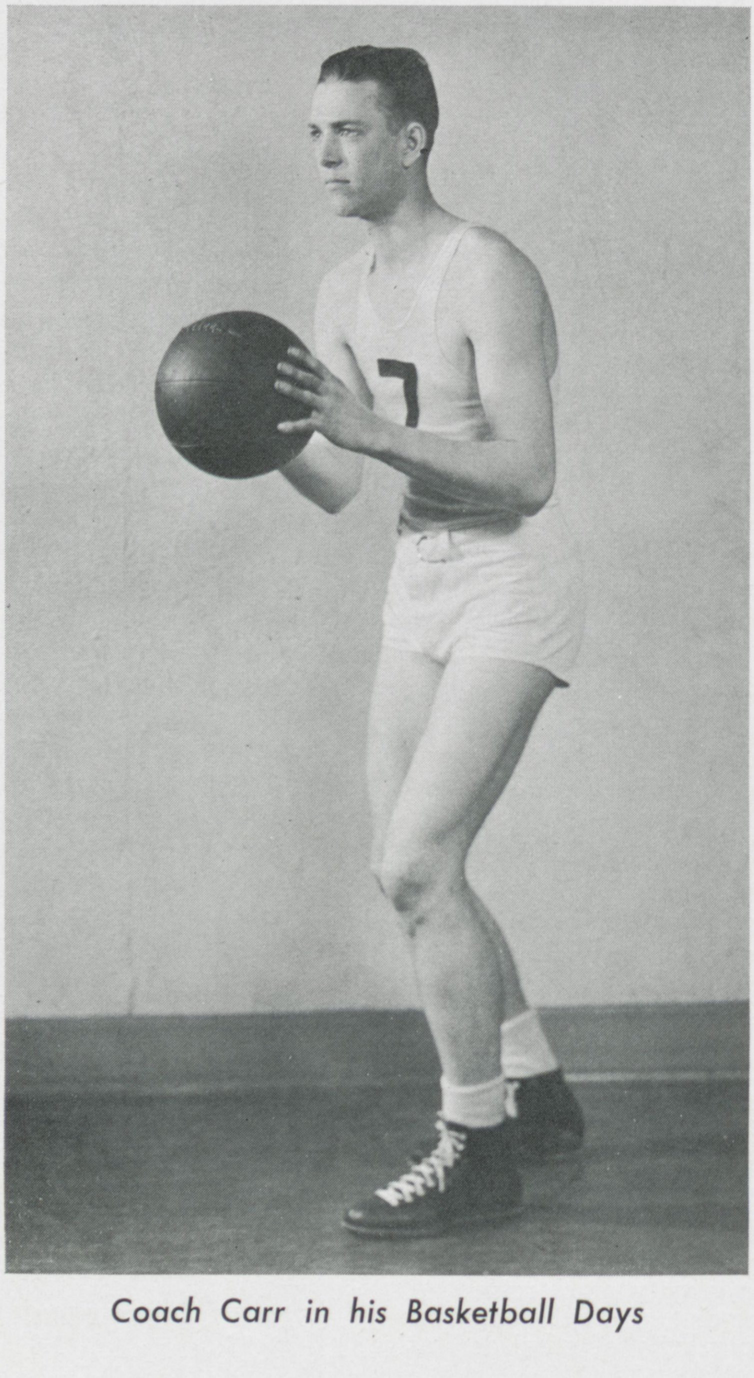
Property	**Predicted for ekasilicon 1871**	**Observed for germanium 1886**
Atomic weight	72.0	72.3
Specific gravity	5.5	5.469
Atomic volume	13.0 cc	13.22 cc
Color	Dark gray	Grayish white
Specific gravity of oxide	4.7	4.703
Boiling point of chloride	100°C	86°C
Specific gravity of chloride	1.9	1.887
Boiling point of ethyl compound	160°C	160°C
Specific gravity of ethyl derivative	0.96	1.0

SPORTS

(Not) Unillustrated



Denny Lind is a junior majoring in mathematics. He comes from Brooklyn, Indiana. He is a member of the Rose cross-country team and of Lambda Chi Alpha fraternity.



Coach Carr in his Basketball Days

This is the first of three profiles on Rose's three coaches.

This month Mr. Jim Carr is introduced to the readers.

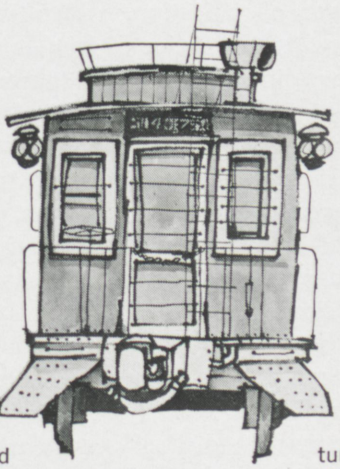
Mr. Carr was born in Terre Haute and attended Wiley High School. There he starred in basketball and played football until a knee injury halted his gridiron days. In his junior year, 1931, Wiley went all the way to the semi-final game. The next year with Mr. Carr as captain they advanced to the Sweet Sixteen at Indianapolis. He also played semi-pro baseball.

At Indiana State Teachers College, Mr. Carr excelled in athletics. In basketball, he lettered three years and was named team captain his senior year. In 1936, Indiana State participated in the tryouts for the first United States Olympic basketball team. In that tourney they were defeated by the University of DePaul at Chicago 29-28. On the baseball field, Coach Carr played five positions: all three outfield positions, third base, and pitcher. His senior year he achieved the pitcher's dream, a no-hit game against Ball State. He was also recipient of the Bigwood Award in baseball (most valuable player). Beside his three letters each in baseball and basketball Mr. Carr found time to win one letter in track. His event was the javelin; his best throw — 168 feet. However, he gave up track, because his chief interest was in baseball.

Mr. Carr distinguished himself in

(*Continued on Page* 33)

OUR ENGINEERS NEVER RIDE THE CABOOSE



Sometimes an engineer can get so sidetracked in the course of a project that he forgets where it was going in the first place. This is calamitous. The engineer loses interest, and the wheels start to slow down in a dozen different places. ☐ Hamilton Standard follows the project management concept, which enables the engineer to keep sight of the entire program, providing the "what and when" direction, establishing and maintaining responsibility for the "how" and excellence of work required to accomplish the programs. Specifically, the engineer will have the opportunity to participate in and pursue a program from the beginning to final production, including phases of ☐1) Precontract — prepare R&D proposals, defining the tasks, technical as well as costs and schedules. 2) Planning — developing complete detailed plans covering each element of the contract. 3) Design & Analysis — creating the hardware ideas — applying the state-of-the-art, and assuming responsibility for the basic structure of the final product. 4) Development & Qualification — preparing development and qualification test programs to determine and demonstrate product performance, conducting these tests, evaluating results, solving the problem areas to assure complete product development and technical integrity, serve as technical consultant to manufacturing and maintain customer coordination, analyzing in-service or field product performance. ☐ Some of the present projects involve *space and life support systems, environmental conditioning systems, v/stol propulsion systems, micro-electronics, ground support equipment, turbine and rocket engine controls, industrial valves, electron beam machines, air induction and special controls.* ☐ Hamilton engineers are encouraged to broaden their personal capabilities by taking advantage of in-plant technical courses lectures and seminars. Enrollment in useful short courses at various colleges and universities is also authorized. Engineers may also qualify for the company's rotational program. This provides opportunities for assignments in several departments to broaden the individual's knowledge of the company's scope of operations. ☐ In summary: an engineer's future with Hamilton Standard is limited only by his ability and desire to make a contribution to the team effort — and his capacity to shoulder responsibility. He's got a wide-open track to personal progress. ☐ *We invite you to climb aboard for an immediate interview and to submit a resume of your qualifications to this equal opportunity employer — write to Mr. Timothy K. Bye, Supervisor of College Relations, Windsor Locks, Conn., or see your Placement Office for an appointment with our representative when he visits your campus.*

Hamilton Standard DIVISION OF **United Aircraft**

DUALISTIC THEORY

(*Continued from Page* 19)

toward the source. This indicated that the alpha particles encountered something very small and massive. Geiger and Marsden, two of Rutherford's students were able to conclude, from a careful study of scattering patterns and considering the scattering due mainly to electrostatic forces, that an atomic charge proportional to the atomic weight existed in the massive atomic core. From experiments on a fairly wide range of elements they found that the atomic charge was approximately half the atomic weight. It is not unreasonable to believe this today since it has been found that heavy elements contain approximately as many neutrons as protons in the nucleus. Rutherford's experimental evidence prompted him to postulate an atomic model similar to a tiny solar system with a massive, positively charged nucleus and electrons orbiting about it.

After Rutherford's proposal of the structure of the atom, physics was left in a quandary. Until now the atomic theory had emerged along classical lines of electric and magnetic field theory, but a serious contradiction had presented itself. Rutherford's model fit the experimental facts, but if electrons are allowed to orbit the nucleus classical physics says they will radiate energy. Classical electric and magnetic field theory shows that any charged particle will radiate energy if it is accelerated. Centripetal electrical forces of attraction of the electron and the nucleus will accelerate the electron. If radiation occurs the electron will lose some of its energy, it will be slowed in its orbit and very rapidly fall into the nucleus. This is the paradox that faced the young Danish physicist, Neils Bohr.

The Quantum Theory and Neils Bohr

Bohr began his study by considering the simplest atom, hydrogen, as having a one-proton nucleus and a single electron in a circular orbit. Since there is no radiation emitted from a stable atom Bohr's first postulate was that there must be certain non-radiating orbits for the electron. If this is true the angular momentum of the electron must be constant in these orbits. In addition, he postulated, the angular momentum for a non-radiating orbit was equal to an integer times Planck's constant. Here Bohr borrowed Planck's concept of quanta.

This first postulate did not appear in some magic way. Bohr had access to the excellent work of J. W. Nicholson. From Rutherford's suggestion of nuclear structure of the atom, Nicholson set out to calculate the frequencies of vibration of the electrons in orbital rings. His calculation gave frequencies of vibration of electrons in the plane of the orbits and perpendicular to the orbital plane. Strangely enough Nicholson's mathematical procedures followed very closely the methods of James Maxwell's theoretical investigation of Saturn's rings. Nicholson's equations could give only the ratio of possible frequencies of vibration, which were identical to the ratios of frequencies obtained in spectroscopic observations of radiation from excited hydrogen atoms. But if one frequency was assumed or obtained from spectrographic observation he was able to predict precisely the frequencies of other spectral lines. Nicholson's most important contribution was that the angular momentum of the hydrogen atom was an integral multiple of Planck's constant. This work was undoubtedly of considerable value to Bohr. Unfortunately, Nicholson's work is often overshadowed by Bohr's most successful theory of the hydrogen atom.

From the non-radiating orbits of his first postulate Bohr extended his theory with a second postulate. Bohr's second postulate says that radiation occurs when the electron is excited to a higher energy state and returns to a lower energy state. The quantum of radiation is equal to the change in energy levels.

Bohr's second postulate does not seem to be an obvious assumption to make. It was prompted by Planck's quantum theory which so successfully described thermal radiation. Equally impressive is that Rydberg's empirical equation for wavelengths in the hydrogen spectrum was derivable from Bohr's theory, giving Bohr's theory strong experimental support. Physicists are overjoyed when empirical constants and equations can be arrived at from theoretical derivation. The modern atomic theory was off the ground and moving with increased speed. Bohr had surmounted a very perplexing problem that had temporarily halted progress. This second major break with classical physics was by no means immediately acceptable to the scientific community any more than the failure of Michelson and Morley's experiment to produce the ether to support the classical wave theory of light. But Bohr's theory soon gained wide acceptance and other men began to expand it.

Shortcomings in Bohr's Theories

Bohr's theory explained a good share of the phenomena of the hydrogen spectrum, but some effects were still unexplained. Bohr's theory rapidly broke down for heavier elements. In 1915 Sommerfeld improved Bohr's model by considering elliptical orbits which added two more quantum states. However, this was not enough to bring the model into complete agreement with physical observation. It was the brilliant, but arrogant, French theoretical physicist, Dirac, whose magnetic electron theory finally set Sommerfeld's work straight. The year 1925 added still another important principle to quantum theory. Wolfang Pauli published his exclusion principle, which states that no two electrons may simultaneously occupy the same quantum state. This addition greatly strengthened the quantum theory.

The Improved Position of the Corpuscular Theory

By the 1920's the corpuscular nature of radiant energy and matter was generally accepted because of the success of Planck's quantum theory and Einstein's explanation of the photoelectric effect. Einstein's explanation of the photoelectric effect was a rebirth of the Newtonian corpuscular theory of light with some new implications thrown in. The success of Bohr and Sommerfeld in extending the quantum theory and quantum mechanics led the scientific world to have little doubt that matter was corpuscular in nature.

In 1924 another young French theoretical physicist was hard at work. Louis de Broglie presented his doctoral thesis to the University of Paris in that year. In this year paper he presented ideas that were the beginnings of the wave theory of matter and present day wave mechanics. De Broglie assumed that the motion of Bohr's electrons propagated pilot waves which traveled through space with them. He reasoned that if this was the case, there would necessarily be an integral number of wave lengths of these waves in a Bohr orbit, and for any intermediate orbit the waves could not trace the orbit in an integral number of wave lengths.

DeBroglie and the Dualistic Problem

De Broglie's wave theory presented a startling suggestion that told of possible undulatory characteristics of electrons. This suggestion furnished a new basis for the quantum theory. This idea is not as new and revolutionary as one might suppose. It was Planck's successful theory that presented us with the paradoxical situation of the dualistic nature of light and energy. His formula $E = hf$, where E is energy emitted, h is Planck's constant and f is the frequency of oscillation gives a relation between the two contradictory hypothese. The very foundation of de Broglie's argument was that of symmetry in nature.

In 1927 Davisson and Germer of the Bell Telephone Laboratories were successful in diffracting electrons with a thin metallic film, thus showing a wave-like behavior of electrons. The electron behavior was similar to the behavior of light in Fresnel diffraction. G. P. Thomson, son of J. J. Thomson, discoverer of the electron, preformed electron diffraction with crystals in an apparatus similar to Bragg's X-ray diffraction apparatus. These experiments present evidence for existence of electron waves which is as good as any existing evidence of I-ray waves or visible light waves. In addition electron waves, while exhibiting properties of waves, retain their characteristic electrical charge and may be deflected in magnetic and electrical fields. So at this point it is necessary to accept electrons in a dual nature of waves and particles.

The Basis for Schrodinger's Equation

Energy and matter are intimately related as Einstein has shown us. If we accept the dual nature of radiant energy we are directed to accept a dual nature of matter. De Broglie's qualitative statement of the nature of matter gave Schrodinger the clue to attempt a precise mathematical development of de Broglie's ideas. With additions by Born, Heisenberg and others we arrive at the highly successful present day quantum mechanics.

Heisenberg's uncertainty principle has presented philosophers and physicists alike with much food for thought. The uncertainty principle stems from statistical methods used in mechanics and a critical discussion of causality. According to wave mechanics, a particle does not have a precisely defined position and velocity or momentum and cannot be known simultaneously because of the statistical methods used. The principle states that the range of uncertainty of position of a particle, multiplied by the range of uncertainty of the momentum of the particle, is always on the order of magnitude of Planck's constant divided by 2 pi.

Heisenberg's Principle Illustrated

An analogy to some of the implications of the uncertainty principle may be seen if we consider a rifle bullet travelling through space. From two simultaneous measurements of two quantities, such as position and time, the bullet's velocity and momentum may be fixed with certainty. This may be done only because minute experimental errors are insignificant with respect to the size of the bullet and magnitude of the properties measured. But a small packet of waves does not have a unique position at a given time nor does it have a well defined momentum. Here we see that experimental errors are tremendous on the atomic scale if we try to represent a particle by a wave. If you prefer to cling to the particle concept it can be reasoned that it is impossible to observe this minute particle without interrupting its natural state. Then it is impossible to measure its true position, momentum or velocity even if one could visually observe it. It appears we cannot assign to a small particle, in terms of actual or possible observation, a definite position, momentum or velocity in a simultaneously precise set of values. Since 1900 it has become increasingly popular as a principle of physics that only those magnitudes which can be observed, either directly or indirectly, have physical meaning. Therefore we say that these small bits of matter may be considered as having properties of particles and waves and are neither true particles nor true waves in the classical sense of the words.

Heisenberg's Principle Applied to this Case

Even though we cannot say with precise certainty that we will know the location of an electron at a given time, it is possible to predict the probability that it will be present in a narrow region at a given time. The uncertainty principle tells us that we cannot know for sure a particle's position. This in no way destroys the truth of the guiding wave function. The wave function guiding a particle's path exists in the same sense as the trajectories of macroscopic bodies exist. The earth's orbit around the sun exists in the mathematical sense by representing a continuum of points on the path;

(*Continued on Page* 36)

R & D

Edited by
Larry Buchanan,
Frosh

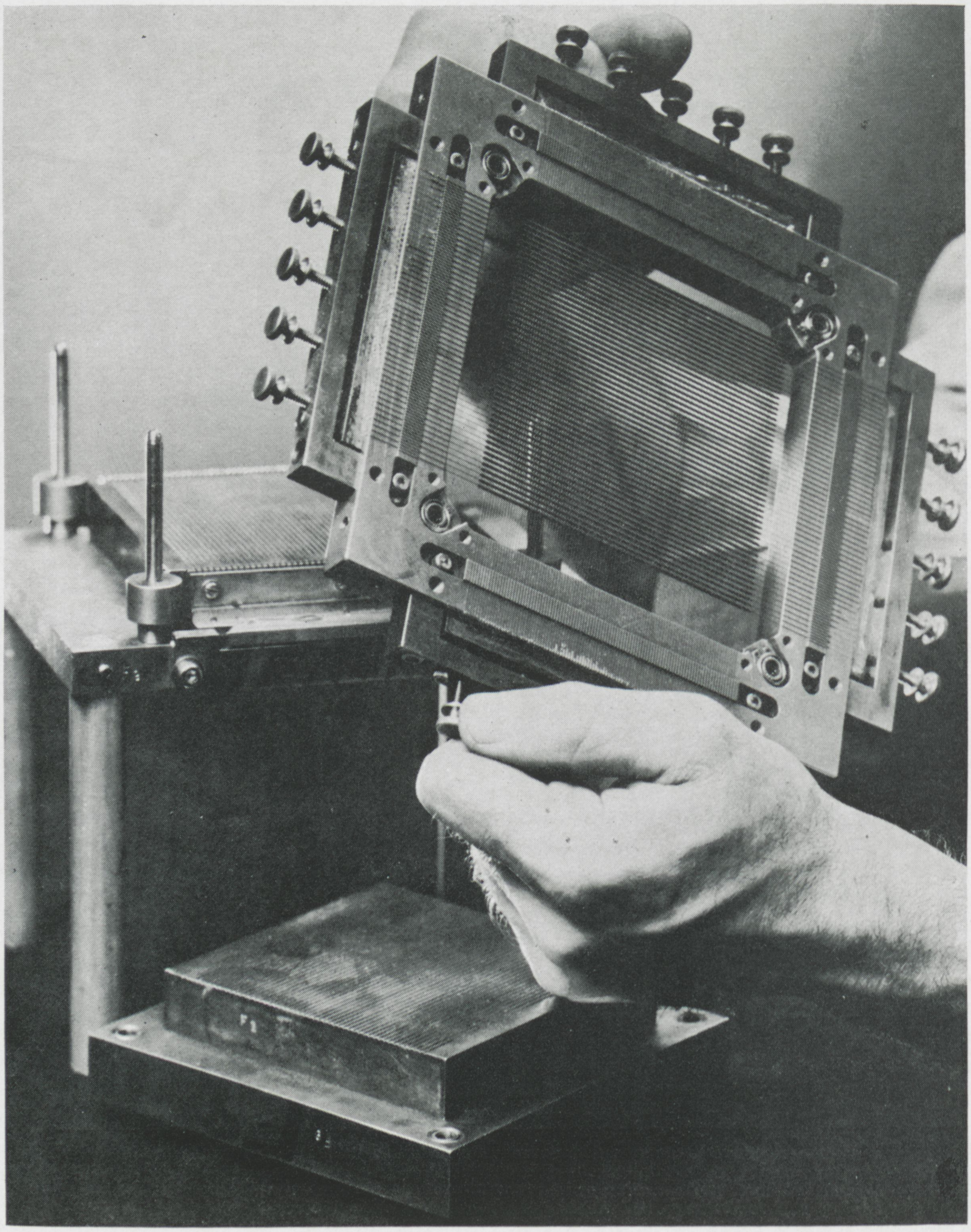


Photo shows experimental Flute memory array being removed from a mold in a new fabrication process developed at IBM. Prior to the molding step, grooves in each mold half are filled with a fluid mixture of magnetic ferrite material and thermosetting binder. After a curing cycle, the pre-wired memory array is removed from the mold and sintered.

A new molding process, which can form a miniature memory plane containing thousands of storage cells, has been developed on an experimental basis by scientists of International Business Machines Corporation.

Using the new molding process, IBM scientists have fabricated an experimental memory array, called Flute, which incorporates advances in speed and miniaturization. The name of the array is derived from the flute-like appearance of the individual memory elements.

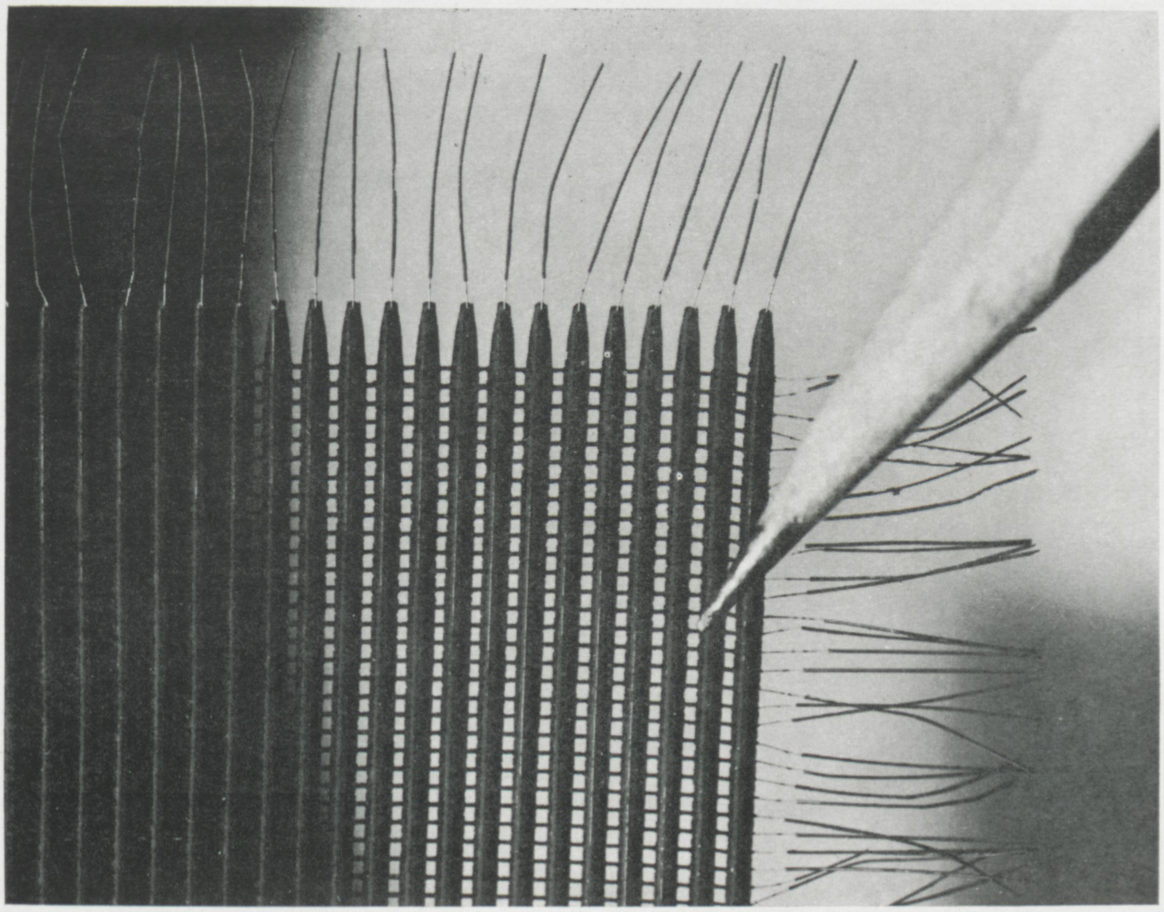


Photo shows close-up view of experimental Flute memory array developed at IBM. The highly compact device is made by molding tiny magnetic ferrite "tubes" over a mesh of fine wires. This experimental array can store 5000 bts of information. A bit, either a "1" or a "0," can be stored by changing the magnetization direction of the ferrite material at the intersection of any two wires.

Each storage cell in the Flute memory can store or release information in 100 billionths of a second. This is an important factor in determining the overall speed of a memory system. In addition, a density of 2000 storage cells per square inch has been achieved in an experimental Flute array containing a total of 15,000 storage cells. IBM scientists believe much higher densities could be obtained with this technique.

A molding process is a natural approach to fabrication of memory arrays, since each array consists of thousands of identical storage cells. Presently, Computer memories are usually composed of arrays of tiny doughnut-shaped magnetic cores—each one constituting a memory cell. Thousands of these cores are assembled in any array and threaded with a series of wires, so the magnetization (or information state) of each core can be switched from one state to another.

Molding the magnetic material onto a set of wires has heretofore been considered a very difficult operation because of problems associated with handling and processing the materials. IBM scientists have overcome many of the problems by development of new magnetic ferrite material and a number of processing innovations, which insure a high fabrication yield.

In the Flute memory, a magnetic ferrite material is molded in the form of many tiny "tubes" over a mesh of fine wires in a single step. The finished memory array consists of a set of parallel ferrite tubes held together by a set of wires, called bit lines, intersecting the tubes at right angles. Each tube contains a wire, called a word line, running along its axis.

The array is fabricated by sandwiching a grid of word and bit lines between halves of a matching grooved mold, pre-filled with a mixture of ferrite and thermosetting binder. After a curing cycle, the array is self-supporting and can be removed from the mold and sintered. During the sintering process, the organic binder is burned away, leaving a binder-free ceramic ferrite structure.

The Flute array is particularly well adapted to batch fabrication since imperfections in individual elements, which may arise in the molding or sintering process, can be compensated for by including a number of spare elements in each array. Faulty elements can easily be disconnected from the memory circuitry and the spare tubes wired in as replacements. IBM scientists believe high fabrication yield could be achieved in this fashion.

DUST PARTICLES

(*Continued from Page* 14)

Venus Probe. One objective of the experiments on the Mariner II was to make a determination of the flux of dust particles in interplanetary space. The experiment consisted of a metallic sensor plate with an acoustical transducer attached to it such that when a dust particle hit the plate, the impact generated an electrical signal which was telemetered to the earth. The Mariner II data shows that during a portion of the flight, the detector was approximately perpendicular to the ecliptic plane and facing in the direction of the flight. Thus it was sensitive to particles in retrograde heliocentric orbits, even though impacts from particles in direct heliocentric orbits with low relative velocities were possible. The Mariner II Venus Probe detected two particles in the interplanetary space and the mass of the detected particles turned out to be 1.85 x 10-^{10} gram.

There are a few mechanisms which can lead to a concentration of interplanetary dust particles near the earth. They are as follows: (1) gravitational accretion of dust particles by the earth; (2) capture of dust particles by electromagnetic processes; (3) electrostatic breakup to fluffy "dust ball" meteoroids near the earth; (4) ejection of lunar material by meteoroidal impacts on the lunar surface; (5) atmospheric drag at very high altitude; and (6) solar radiation pressure and solar wind. The data from the Mariner II Venus Probe apparently indicate that interplanetary space seems to be almost devoid of any dust particles. This might be explained by saying that all the dust particles are swept away from interplanetary space to the vicinity of the planets and its satellites by the solar radiation pressure and solar wind. This solar wind is caused by hydromagnetic expansion of the solar corona. If this is so, then the only place where interplanetary dust particles can stay "alive" temporarily is in the vicinity of the planets and its

(*Continued on Page* 38)

REIMANN

(*Continued from Page* 12)

suit of a finite geometry of discrete space structure had also been envisioned by Riemann. In a remarkable passage he stated:

> If in a case of discrete manifold the basis for its metrical determination is contained in the very idea of this manifold, then for a continuous one it should come from without. The reality which lies at the basis of space, therefore, either constitutes a discrete manifold, or the basis of metrical determination must be sought outside the manifold in the binding forces which act on it.

If the homogeneity of physical space is accepted on the macroscopic scale as it is today by some, Riemann's contentions have another important aspect. If space is Riemannian, i.e. its curvature is $+1$, then the universe must be spherical. (Not to be confused with a spherical solid in three-space.) In spherical space light rays must return to their starting point, and the total volume of the universe is given at any time t as $2\pi^2R^3$, where R, the radius of the universe, depends in some way upon time. (R is again not to be confused with the radius of a three-dimensional solid sphere.)

Though it is generally accepted that Einstein did not start with Riemannian ideas in his development of the general theory of relativity, but rather traveled a separate path, the ideas he arrived at concerning space-time are in very close harmony with Riemann's concept of space. A very great difference is Einstein's assertion that the curvature of space is due to not only mass, but also energy. However, Riemann's initiation of the differential geometary created the tool without which Einstein's genius could not have expressed its concepts of space-time mathematically.

SPORTS

(*Continued from Page* 26)

other activities at Indiana State. They were: President of his Freshman class, member of Blue Key National Honor Fraternity, Student Council, a member of Delta Lambda Sigma fraternity. Mr. Carr has a Bachelor of Science and a Master of Science degree from Indiana State. At Indiana University he earned his Director degree which is halfway between a Master and a Doctor degree.

After college, Mr. Carr was varsity basketball coach at Ottercreek High School for six years. In that time his teams achieved a fine 78-31 record. Mr. Carr then became assistant basketball coach at Terre Haute State under Mr. Paul Wolf (now baseball coach at I.S.C.)

Mr. Carr was then elevated to the head basketball and baseball coach at Rose. In his sixteen years as coach, his basketball teams have won 45% of their games. Mr. Carr is now Director of Intramurals, golf, cross country. This year's cross country team finished with a 2-4 record. Late in the season the team was hampered by injuries to four of their seven men. The schedule included Indiana State, Valpo, Franklin, and Wabash. Since no member will be lost via graduation, next year's outlook is bright.

Mr. Carr regards the following as some of the high lights of his career. He rated playing in the Indiana high school semi-finals as his most enjoyable experience. He also remembers his senior year at Indiana State when they defeated Phillips Diamond Oilers of Oklahoma, 26-22. The Oilers were a touring team made up of amateurs, one step below professional caliber. The Oilers featured Chuck Hyatt, an All-American from Pittsburgh. This was a relatively high scoring game in the days when playing time was cut due to a center jump following each basket.

Much of Coach Carr's relaxation time is also devoted to physical activities. He is an ardent golfer and enjoys taking camping trips during the summer vacation period.

DEAN OF STUDENTS

(Continued from Page 5)

with a faculty committee on scholarships and loans, chaired by the Dean of Students, approving all school sponsored grants and loans. With the increase in enrollment and school costs, the financial aid program at Rose in the past 10 years has risen from a $20,000 per year assistance to a current total scholarship and loan assistance of $240,000. During the 1964-65 school year, 275 students of a total enrollment of 655 undergraduates will receive some form of financial aid through scholarship, loan, or student labor. Loan collection is also the responsibility of this office and some 250 outstanding loans are now in the repayment stage and the number increases with each graduating class.

In the spring of 1961, the Rose Parents' Association was organized in order Rose might better acknowledge the parents' interest and solicit their support in behalf of the Rose Family. This organization assists in a Parents' Orientation program in the fall and Parents' Day week-end in the spring. It has standing committees for recruitment, development, public relations and programs. The responsibility of coordinating the efforts of the Rose Parents' Association with the overall school program rests with the Dean of Students office.

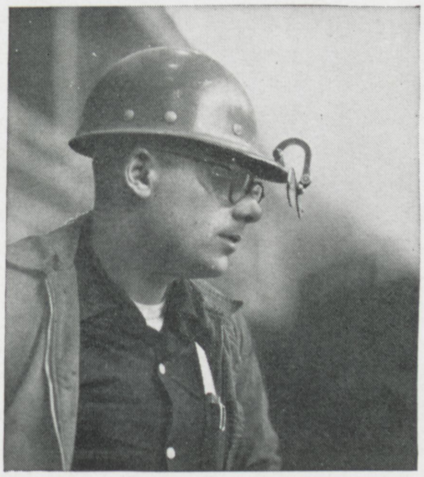
In today's educational planning there are many special programs which go to make up the entire educational picture. Foreign student programs, prefreshman Summer Institute, automobile registration and identification cards are only a few. The primary responsibility for these lies with the Office of Dean of Students.

The last area of concern is the general student decorum — to encourage and cooperate through student committees standards of behavior that will reflect favorably on the student body and enhance the total educational process. Where, in the opinion of the Dean, it is necessary, he will refer appropriate cases to the Judicial Council of the Student Body Government for initial action with review and approval being reserved by the faculty discipline committee.

To assist in the discharge of these duties, the office staff in addition to the Dean, includes Mr. John A. Heetderks, Guidance Counselor and Mrs. Barbara Butts, secretary. Assisting in the dormitories is Mrs. Ralph M. Ross, Dormitory Director and Resident Director for Baur-Sames-Bogart Hall; Mrs. Walter B. Smith, Resident Director of Speed Hall, and Mrs. Barbara Butts, Social Hostess for Deming Hall. Also serving as student counselors in the dormitories under the appointment and direction of the Dean of Students are thirteen junior and senior student counselors.

Although this is a brief summary of the activities coordinated in the office of Dean of Students and the personnel who carry out the program, it is hoped this will help acquaint one with this area of administration.

Men on the move at Bethlehem Steel



DON YOUNG, MET.E., DREXEL '62— Don is General Turn Foreman in our Bethlehem, Pa., Plant's electric furnace melting department, producing fine alloy and tool steels.

WALT BANTZ, E.E., SCRANTON '63— Engineer at our research laboratories in Bethlehem, Pa., Walt is shown evaluating performance of ultrasonic equipment for detection of flaws in steel plates.

DAVE SPARKS, MIN.E., OHIO STATE '60— Dave is Assistant to the Superintendent of one of our modern mines. His previous assignments covered virtually all aspects of our coal mining operations.

ROLAND MOORE, C.E., MICHIGAN '59— Rollie is our Sales Representative in Des Moines, Iowa. His technical training has been a valuable asset in selling steel products.

ROGER BOLLMAN, M.E., RENSSELAER '60— Roger is a production engineer in the Sparrows Point plate mills. He has been working on the development of rolling procedures for alloy steel plates.

JIM LESKO, CH.E., PENN STATE '60— As Turn Foreman in the coke works at our Johnstown, Pa., Plant, Jim applies both his undergraduate engineering background and his natural leadership abilities.

These alert young men are a few of the many recent graduates who joined the Bethlehem Loop Course, one of industry's best-known management development programs. Want more information? We suggest you read our booklet, "Careers with Bethlehem Steel and the Loop Course." Pick up a copy at your Placement Office, or write to our Manager of Personnel, Bethlehem, Pa.

An equal opportunity employer

PERIODIC TABLE

(*Continued from Page* 25)

However, these mistakes had to be righted before a true periodic classification could result. Mendeleeff realized this and left spaces in his table of 1872 for yet undiscovered elements or rearranging known elements in different places.

Despite these problems, the bulk of the development of the periodic table took place in a comparatively short time of seventy years, from Dalton's atomic theory of 1802 to Mendeleeff's table of 1872. It is very common today to hear people talk of the rapid development of scientific thought and technique during the last thirty to forty years. But one can see that this same type of rapid development took place in the classification of the elements and, considering the techniques and equipment that were available in the 1800's, it is a matter for no small wonder that these men were able to accomplish what they did.

Originally, the periodic classification of the elements served three purposes: (1) it was useful in the verification of atomic weights; (2) it served as a guide in the prediction of undiscovered elements; and (3) it was a systematic correlation of chemical and physical properties of groups of elements, which permitted the student to study these groups rather than individual elements. However, only the third purpose is useful today. This usefulness was quite apparent to me when I took freshman Chem. at Rose. Much of our course was based on the concept of being able to recognize certain physical and chemical properties that certain elements would exhibit from their position in the periodic table. From the efforts of Dalton, Prout, Berzelius, Dobereiner, Pettenkofer, Dumas, Gladstone, Cooke, Stas, de Chancourtois, Newlands, Meyer and Mendeleeff, my courses at Rose concerned with chemistry have been greatly simplified, and for this I am certainly very thankful to this handful of men.

DUALISTIC THEORY

(*Continued from Page* 29)

but does not exist in the same sense as a railroad track guiding a train along its path. Thus the wave function is not a physical entity, but is nothing more than a smeared-out trajectory.

De Broglie himself writes:

> "In the Theory of Matter, in fact, this introduction of waves side by side with corpuscles has proved quite successful, since among other things it has supplied us with an explanation of the quantized character of corpuscular motion on the atomic scale."

In addition the wave theory has shown us that in order to make stable motion of a corpuscle of atomic size possible it must be associated with a stationary wave. This condition is satisfied by quanta considerations. We found that de Broglie's fundamental equation of wave mechanics, which gives wavelength in terms of mass and velocity of the corpuscle, involves Planck's constant. Planck's constant seems to be the connecting link between the ideas of waves and corpuscles. Because this important constant appears in both systems, the systems are mutually restrictive and necessary. De Broglie writes that it is necessary to accept the dualism of corpuscular-wave theories of light and matter in order to describe their properties. He explains himself in the following way. We can no longer imagine an electron as being just a minute corpuscle of electricity. It is now necessary to associate a wave with it. This wave is not a mere figment of man's imagination; for its length and interferences can be predicted and measured. A whole group of phenomena may be predicted before being observed. On these grounds de Broglie champions the dual nature of light and sound.

The Two Camps

Max Born in 1953 indicated that physicists are divided into two camps, the particle chasers and the wave defenders. We are apparently only slightly closer to finding one general theory of matter than we were twenty years ago. Both camps have strengthened their theories and appear to have made them water tight. Schrodinger has believed that all of physics is wave theory and there are no particles, stationary states, instantaneous quantum jumps or transitions, only waves. His cleansing campaign centered on an adequate substitute in wave mechanics for the instantaneous quantum jumps to which he was so opposed. But the majority of physicists continue to use the particle image to speak of atoms, nuclei, electrons, etc.

The dual nature of the corpuscular-wave theory of light and matter seems to lack the symmetry that man feels a theory of natural phenomena should have. At this time we are bound to the dualistic theory of matter by experimental evidence. So far as we can presently see we will remain bound to a dualistic concept of light and matter until a higher level general theory is developed.

library notes

by harry gilbert, librarian

The colleges, whilst they provide us with libraries, furnish no professor of books; and I think no chair is so much needed.

Emerson, Society and Solitude:
Books.

With new emphasis on the Humanities and Social Sciences on the Rose campus has come a corresponding build-up of the library holdings in these areas. Many new titles in the fields of religion, philosophy, and literature have been received in the library in the past few months. A representative list of some of these new books will follow at the end of this article.

This being an election year, a political novel is certainly apropos here. But, going on the assumption that American political buffs have properly had their fill of the homegrown variety by now, a novel centered elsewhere might be a refreshing change-of-pace.

CORRIDORS OF POWER, by C. P. Snow, does for the British what Allen Drury's ADVISE AND CONSENT did for the Americans by way of arousing interest in the off-stage workings of politics. The maneuvers and strategies in each country are obviously dissimilar, as different as Lyndon Johnson and Harold Macmillan. But Sir Charles Snow gives his readers a virtual anatomy of the British Government on the highest levels of influence. And in this context the two systems are all too similar.

This is the story of the rise to power of a young, ambitious man, Roger Quaife, and of those so placed in government or society that they help or threaten his success at every turn. The setting is the very near past, England of 1955-58, but the real personages of those years are deliberately drawn so as to bear no resemblance to Eden or Macmillan. The debate over England's role in the nuclear age, which provides its plot and pivotal crisis, did not come openly into politics until after the period covered by the novel.

The fact that the story is fiction does not prevent it from creating a persuasive sense of truth. The England of the great aristocratic families, the Cabinet members who fake history with their decisions, the old Ministers clinging desperately to power, the young Members in their race for power appear on every page. The charming hostesses who manipulate their guests, the old warriors of WW I and WW II who think in terms of the campaigns of a vanished day, the illicit loves of people, all these and more are in CORRIDORS OF POWER.

This is a novel which takes time in the reading. Behind its seeming trivia great issues are at stake. The theme is society in the nuclear age. But its ultimate plea is that England admit to herself that she is no longer a major power and by withdrawing from the missile race, accept her new lot and set the world a sensible and much needed example.

PHILOSOPHY

The Great Philosophers, by R. A. Tsanoff. Harper, 1964.

Nicomachean-ethics, Aristotle. Translated by Martin Ostwald. Bobbs-Merrill, 1962.

Indian Philosophy, by Chandradhar Sharma. Barnes and Noble, 1962.

Plato's Theory of Knowledge, by Norman Gulley. Barnes and Noble, 1962.

The Individual and the Cosmos in Renaissance Philosophy, by Ernst Cassirer. Harper and Row, 1964.

Magic: Its History and Practical Rites, by Maurice Bouisson. Dutton, 1961.

Humanism: The Greek Ideal and Its Survival, by Moses Haddas. Harper, 1959.

RELIGION

The Dead Sea Scrolls, by R. K. Harrison. Harper, 1961.

Israel and the Ancient World, by Henry Daniel-Rops. Image Books, 1964.

Osiris; the Egyptian Religion of Resurrection, by E. A. T. W. Budge. University Books, 1961.

Buddhist Texts through the Ages, by Edward Conze. Harper, 1964.

Cretan Cults and Festivals, by R. F. Willetts. Barnes and Noble, 1962.

The Psalms for the Common Reader, by Mary E. Chase. Norton, 1962.

Christian Beginnings, by M. S. Enslin. Harper, 1956.

The Mediaeval Mystics of England, by Eric Colledge. Scribner, 1961.

The Influence of Greek Ideas on Christianity, by Edwin Hatch. Harper, 1957.

The Ancient Gods; the History and Diffusion of Religion in the Ancient Near East and the Eastern Mediterranean, by E. O. James, Putnam, 1960.

Adonis, Attis, Osiris; Studies in the History of Oriental Religion, by J. G. Frazer. University Books, 1962.

Greek Folk Religion, by M. P. Nilsson. Harper, 1961.

LITERATURE

Greek Rhetoric and Literary Criticism, by W. R. Roberts. Cooper Squarr, 1963.

Praisers of Folly: Erasmus, Rabelais, Shakespeare, by W. J. Kaiser. Harvard University Press, 1963.

Drama and Commitment; Politics in the American Theatre of the Thirties, by Gerald Rabkin. Indiana University Press, 1964.

A Moveable Feast, by Ernest Hemingway. Scribner, 1964.

On the Eve of the Reformation; Letters of Obscure Men, attributed to Ulrich von Hutten and others. Harper and Row, 1964.

The Masks of Tragedy; Essays on Six Greek Dramas, by T. G. Rosenmeyer. University of Texas Press, 1963.

Discussions of Poetry: Rhythm and Sound, by George Hemphill. Heath, 1961.

Discussions of the Short Story, by H. S. Summers. Heath, 1963.

The Holy Grail; the Galahad Quest in the Arthurian Literature, by A. E. Waite. University Books, 1961.

Discussions of the Canterbury Tales, by C. A. Owen. Heath, 1961.

Studies in English Renaissance Literature, by W. F. McNeir. Louisiana State University Press, 1962.

LeMorte D'Arthur; The Book of King Arthur and His Knights of the Round Table, by Thomas Malory. University Books, 1962.

Charles Lamb: The Evolution of Elia, by G. L. Barnett. Indiana Univ. Press, 1964.

Albert Camus and the Literature of Revolt, by John Cruickshank. Oxford University Press, 1960.

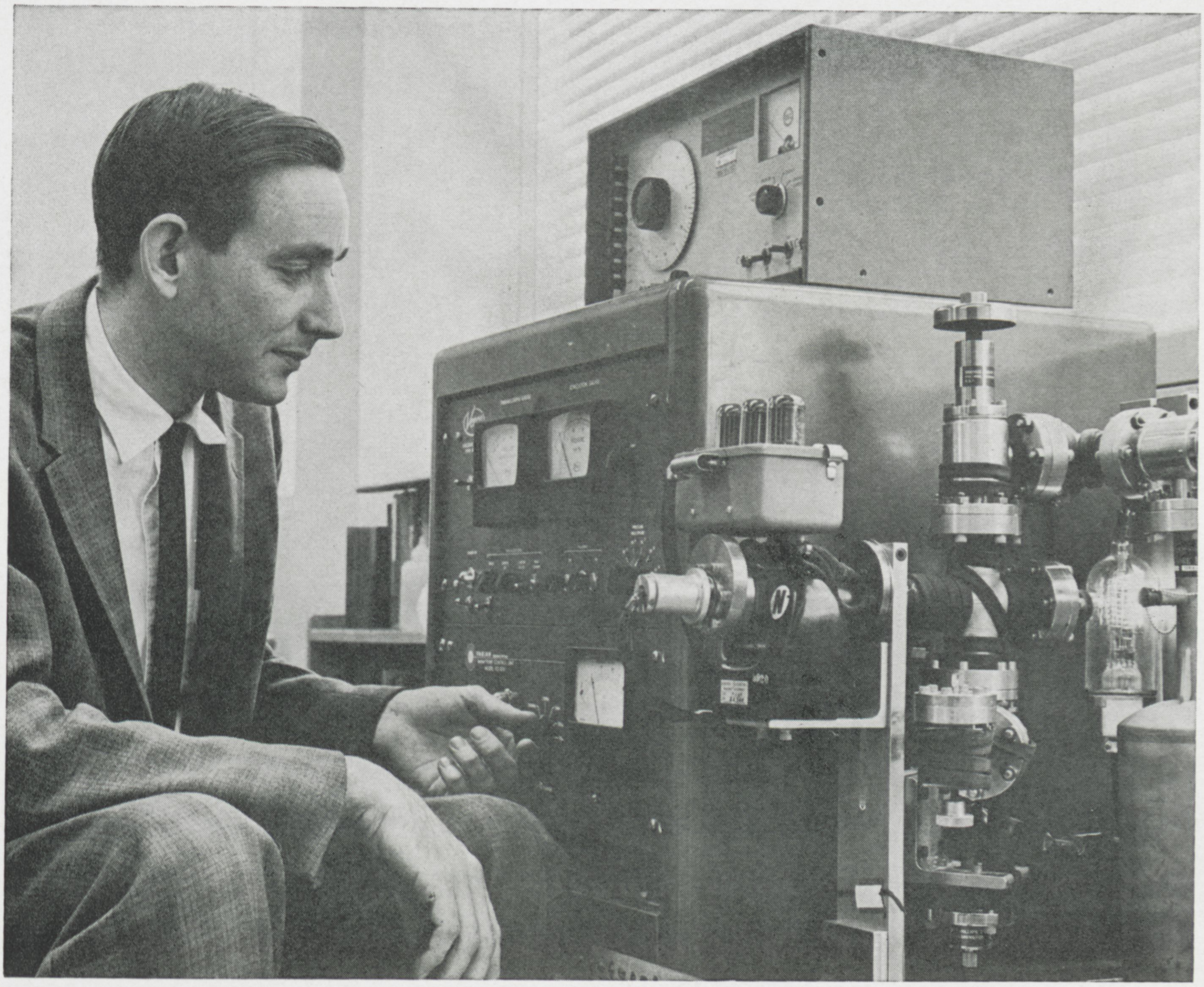
DUST PARTICLES

(*Continued from Page* 32)

satellites. If this planet is the earth, there must be a concentration of dust particles near the earth. Mariner II has shown that there are 10,000 times more dust particles per unit volume in the immediate vicinity of the earth than in the interplanetary space.

In summary, the direct measurements obtained with microphone and photomultiplier systems from more than two dozen rockets, satellites, and space probes of the United States and the Soviet Union have provided a basis for analyzing all the available direct measurements of interplanetary dust particles. Two important conclusions can be reached on the basis of these analyses: (a) the accretion of particulate matter by the earth is dominated by dust particles of a few mircons and the total accretion rate amounts to 15,000 tons per day on the earth, and (b) there are 10,000 times more dust particles in the vicinity of the earth than in interplanetary space.

#2 OF A SERIES



FROM CAMPUS TO CAREER WITH DELCO RADIO

Just 10 years ago, Max Stanton received his BA in Physics from Indiana University.

Today, Max is a senior project engineer at Delco Radio Division of General Motors Corporation in Kokomo, Indiana.

Max is shown above analyzing gas ambients found in sealed transistor enclosures. The system—a residual gas analyzer—is pumped down to a low vacuum with an absorption tank and vacion pump. Then a transistor is punctured and the gas introduced into the analyzer. Using mass spectrographic techniques, an analysis of the constituents through mass number 80 can be made. Such analyses are helpful in the study of surface effects in solid state devices.

Max Stanton has established a challenging and satisfying career with Delco—the electronics division of General Motors. As a young graduate engineer, you, too, could soon be on your way to a long-time, rewarding career at Delco.

Opportunities exist now in silicon and germanium device development, ferrites, solid state diffusion, creative packaging of semiconductor products, development of laboratory equipment, reliability techniques, and applications and manufacturing engineering.

Our brochure detailing the opportunities to share in forging the future of electronics with this outstanding Delco-GM team is yours for the asking. Watch for Delco Radio interview dates on your campus, or write to Mr. C. D. Longshore, Dept. CR, Delco Radio Division, General Motors Corporation, Kokomo, Indiana.

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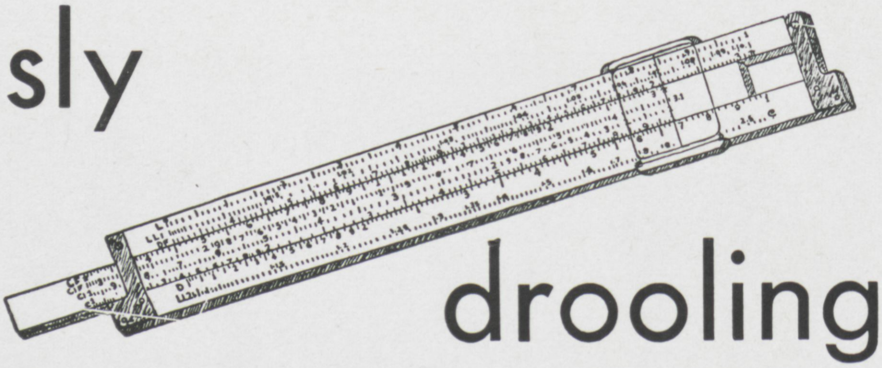

Stolen by
Larry MacDonald
Sr. M.E.

Pat was sent by his employer to take charge of an Italian funeral, since the dead man had been a member of the employer's construction gang. After observing the ceremony, Pat came back to make his report.

"Faith, boss, an' 'tis a curious custom them Italians have a puttin' a twenty-dollar gold piece in the hand of the corpse before burying him."

"That's an old superstition, Pat. It's to pay the man's way across the River Jordan."

"Well," said Pat slowly, "I hope that Wop can swim. I got the twenty in me pocket."

* * *

Patient (recovering from operation)—"Why are all the blinds drawn, doctor?"

Doctor: "Well, there's a fire across the street, and I didn't want you to wake up and think the operation was a failure."

* * *

"Mommy, why it is that Daddy doesn't have much hair?"

"Because he thinks a great deal, dear."

"But Mommy, why is it that you have so much hair?"

"Finish your breakfast, dear."

The Southern father was introducing his family of boys to a visiting governor.

"Seventeen boys," exclaimed the father, "and all Democrats—except John, the little rascal. He got to readin'."

* * *

A lonely chick taking a look around the electric incubator of unhatched eggs—"Well, it looks as if I'll be an only child. Mother's blown a fuse."

* * *

ME Prof.: "If you were at the top of a tall building, how could you measure the height, using a barometer?"

Student: "I would tie a rope on the barometer, lower it to the ground, and then measure the rope."

* * *

"What is the heaviest penalty for bigamy?" a young man asked a judge.

"Two Mother-in-laws," he replied.

* * *

"I'll see you," said our hero as he laid down a royal flush in a game of strip poker.

Is it possible that a builder of space simulation equipment has a hand in Becky Hull's ballet lesson?

You'd expect that the leading maker of arc carbons that produce the brilliant light for projecting motion pictures would be called upon to duplicate the sun's rays in space simulation chambers. These chambers are used to test space devices, such as the communications satellites and space vehicles... and even the astronauts themselves.

And it probably wouldn't surprise you to learn that a company that produces half a dozen different types of plastics would also create an anti-static agent as part of the vinyl plastic it developed for phonograph records. This keeps dust from sticking to record surfaces. The sound is improved. The record lasts longer. And Becky Hull's ballet lessons are performed to music that's more faithfully reproduced.

But would space simulation equipment and better materials for phonograph records come from one company? Indeed they would, in the unusual case of the company known as Union Carbide.

All kinds of seemingly unlikely side-by-side activities turn up at Union Carbide every day. As a leader in metals and alloys, it developed a new, stronger stainless steel, and among the results are better subway cars for New York City. In cryogenics, it manufactures the equipment for a technique in brain surgery based on the use of supercold liquid nitrogen. Its consumer products include "Eveready" brand batteries and "Prestone" brand anti-freeze. And it is one of the world's most diversified private enterprises in the field of atomic energy.

In fact, few other corporations are so deeply involved in so many different skills and activities that will affect the technical and production capabilities of our next century.

And we have a feeling that Becky Hull's future is just as bright as ours.

UNION CARBIDE

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Divisions: Carbon Products, Chemicals, Consumer Products, Food Products, International, Linde, Metals, Nuclear, Olefins, Ore, Plastics, Silicones and Stellite.

Advancement in a Big Company: How it Works

An Interview with General Electric's C. K. Rieger, Vice President and Group Executive, Electric Utility Group

C. K. Rieger

■ Charles K. Rieger joined General Electric's Technical Marketing Program after earning a BSEE at the University of Missouri in 1936. Following sales engineering assignments in motor, defense and home laundry operations, he became manager of the Heating Device and Fan Division in 1947. Other Consumer-industry management positions followed. In 1953 he was elected a vice president, one of the youngest men ever named a Company officer. Mr. Rieger became Vice President, Marketing Services in 1959 and was appointed to his present position in 1961. He is responsible for all the operations of some six divisions composed of 23 product operations oriented primarily toward the Electric Utility market.

Q. **How can I be sure of getting the recognition I feel I'm capable of earning in a big company like G.E.?**

A. We learned long ago we couldn't afford to let capable people get lost. That was one of the reasons why G.E. was decentralized into more than a hundred autonomous operating departments. These operations develop, engineer, manufacture and market products much as if they were independent companies. Since each department is responsible for its own success, each man's share of authority and responsibility is pinpointed. Believe me, outstanding performance is recognized, and rewarded.

Q. **Can you tell me what the "promotional ladder" is at General Electric?**

A. We regard each man individually. Whether you join us on a training program or are placed in a specific position opening, you'll first have to prove your ability to handle a job. Once you've done that, you'll be given more responsibility, more difficult projects—work that's important to the success of your organization and your personal development. Your ability will create a "promotional ladder" of your own.

Q. **Will my development be confined to whatever department I start in?**

A. Not at all! Here's where "big company" scope works to broaden your career outlook. Industry, and General Electric particularly, is constantly changing — adapting to market the fruits of research, reorganizing to maintain proper alignment with our customers, creating new operations to handle large projects. All this represents opportunity beyond the limits of any single department.

Q. **Yes, but just how often do these opportunities arise?**

A. To give you some idea, 25 percent of G-E's gross sales last year came from products that were unknown only five or ten years ago. These new products range from electric tooth brushes and silicone rubber compounds to atomic reactors and interplanetary space probes. This changing Company needs men with ambition and energy and talent who aren't afraid of a big job—who welcome the challenge of helping to start new businesses like these. Demonstrate your ability—whether to handle complex technical problems or to manage people, and you won't have long to wait for opportunities to fit your needs.

Q. **How does General Electric help me prepare myself for advancement opportunity?**

A. Programs in Engineering, Manufacturing or Technical Marketing give you valuable on-the-job training. We have Company-conducted courses to improve your professional ability no matter where you begin. Under Tuition Refund or Advanced Degree Programs you can continue your formal education. Throughout your career with General Electric you'll receive frequent appraisals to help your self-development. Your advancement will be largely up to you.

FOR MORE INFORMATION on careers for engineers and scientists at General Electric, write Personalized Career Planning, General Electric, Section 699-11, Schenectady, N. Y. 12305

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