MODERN EXPERIMENTAL PSYCHOLOGY—ITS METHODS AND APPARATUS.

Modern psychology is no longer based on the vague, indefinite conclusions reached by purely philosophic thoughts, but it now bears the hall mark of a science that rings true—a science which though at present not as accurate as those of an older growth that owe their standing to experimental physics, is nevertheless destined to rank with them in good time.

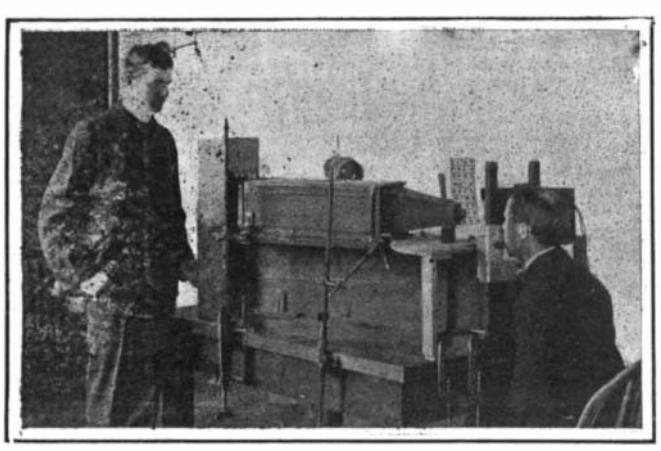
In the development of the new psychology the results achieved are very largely due to the introduction of instruments of precision, which eliminate the errors of unaided observation that were characteristic of the old school, and reduce to a minimum the prejudices of the observer. As Prof. Scripture says, improvement in the method of observation may be made by the use of statistics, experiments, or measurements, or a combination of the three. That is, by taking *statistics* on *numbers* of persons, we might determine if all persons had a green-blue after-image for a red color; by taking statistics on the same person for different times of the day, for different conditions of health, etc., we could settle the question of permanency of the relation of the after-image to the original color; and finally by combining different tints and shades of red, orange, etc., it is possible to gain *experimentally* a basis for the statement that all the colors can be arranged in a closed curve in such a manner that the color of the after-image shall be found at the opposite end of the diameter drawn from the original color. By combining *statistics* with *experiment*, we may prove that the form of this curve is not the same for all persons; if now we introduce measurements with the color wheel or the spectro-photometer, we can determine the exact form of this curve and its relation to all the possible colors. By *statistical measurement* we can gather precise information concerning the mental status of mankind down to the minutest detail that our apparatus and opportunities will permit us to grasp.

It cannot be denied that in many and important portions of mental science the improved methods cannot be adequately applied, and that we must still rely on what has been aptly termed "descriptive psychology"; yet in the past few years advances have been made whereby the application of experimental methods to such apparently inaccessible problems as hallucinations, emotions, the thoughts of the insane, etc., is possible.

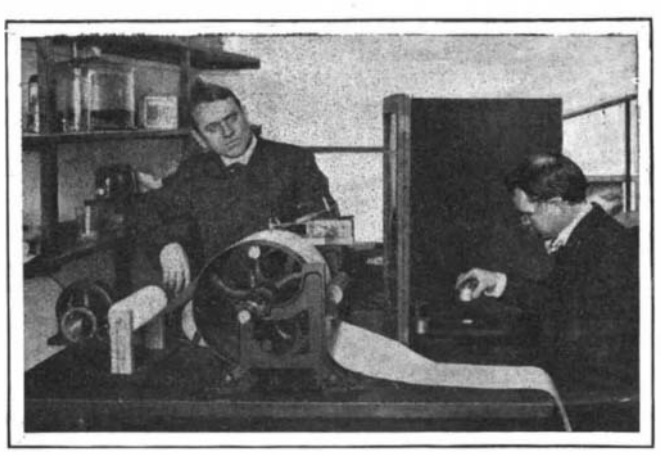
These then, namely, statistics, measurements, and experiments, are the means employed by which the ignorance that characterized the observational metaphysics of old have been thrust aside and superseded by scientific facts, which in turn have elevated experimental psychology to its present high standard.

The apparatus and instruments devised and utilized by psychologists for estimating and measuring the functions of the mind that take place in time and space and in the past and present, as well as those for determining the amount of energy expended in performing the various actions in these elements, are numerous, and some of them, as the following descriptions indicate, are exceedingly ingenious. In experimental psychology one of the most useful pieces of apparatus is the chronoscope, a clock-like arrangement. In measuring reactions requiring some degree of voluntary effort, that is, various activities commonly called voluntary acts or volitions, it is necessary that readings of as small a fraction of time as the 1-1,000 part of a second should be made, and this can be accomplished by the chronoscope. A reflex action takes place in a very much smaller period of time than the voluntary movement. Exner has made some interesting experiments in this direction. He has found, for example, that it takes three times as long to close the eye in response to a signal as it does to close it in response to reflex action when the eye is threatened.

The Cattell Color Wheel for Exhibiting a Color or a Series of Colors.



Instrument for Determining the Movements of the Eye and Its Fixed Points.



Apparatus for Studying the Factors That Enter Into the Perception of Weights.

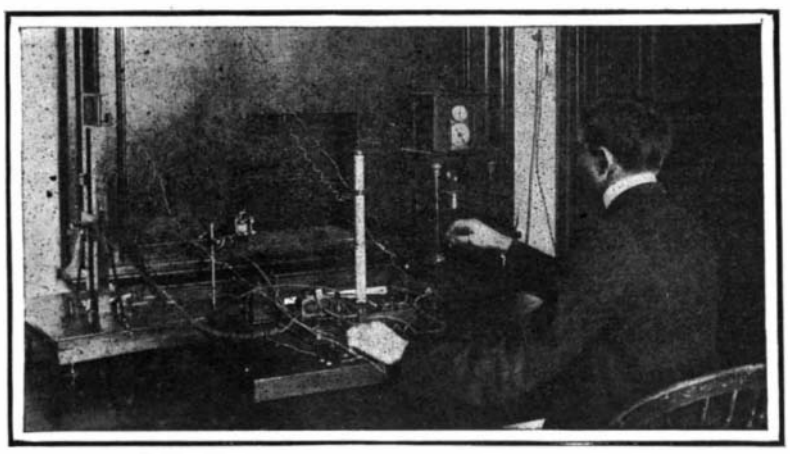
In the usual psychological chronoscope a fine clockwork is set in motion by releasing a spring, the mechanism running for about half a minute. There are two dials, the hand of one indicating tenths and the other thousandths of a second, but these do not move until a controlling lever draws them away from a train of gear wheels, by the opening or closing of an electric circuit. In this arrangement, whereby the production of the stimulus sets the hands into motion and the reaction movement brings them to a standstill, the interval of reaction time can be read off directly. The chronoscope shown on this page is an improvement over the preceding forms, in that two sets of dials are employed, one having black and the other red figures. The black corresponds with those of an ordinary clock, while the hands of the red dial are operated like those of a stop watch.

The chronoscope is useful in combination with other instruments in a large number of experiments, and among the latter may be mentioned measuring the instant the stimulus appears for sound, the noise of the key by which the current is closed being usually sufficient; for sight, when the impression to which a reaction is to be recorded is concealed behind a screen, and the removal of this screen at make and break of the electric current.

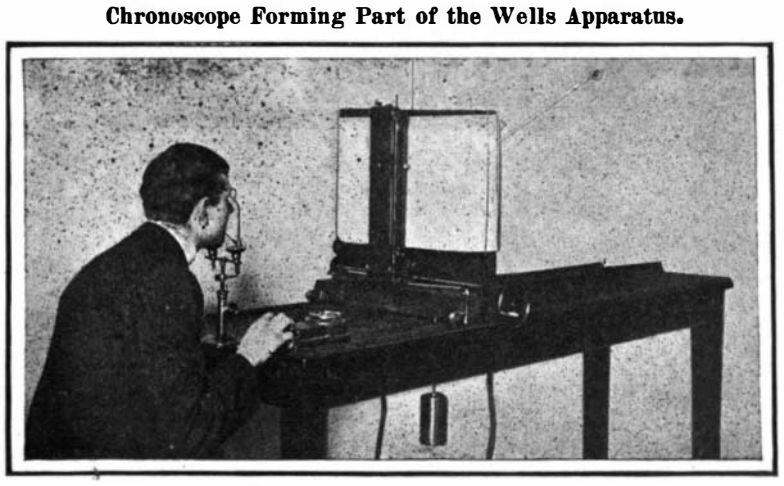
Frequently the subject sits in the dark, and the impression becomes visible only when an electric spark appears or the spark itself becomes the stimulus. For touch, temperature, and taste, a device is used in which the end of a rod touches the sensitive surface, and the pressure so exerted makes a contact with a delicate metallic blade. For smell the movement by which the odor is set free may be similarly utilized. The reacting movement is usually that of pressing an ordinary telegraphic key.

The precision conical pendulum chronoscope shown on page 165 is the invention of the late Ernest Kempton Adams. The purpose of the present apparatus besides its employment as a timekeeper, is for electrically measuring any interval of time in thousandths of a second, the indicator being instantaneously shown upon a dial. The isochronal element of the chronoscope is a large conical pendulum, which is accelerated above its knife-edge suspension by an automatically-wound train, the driving force being obtained from a weight.

The motion of the conical pendulum is confined in true circles by a magnetic controller, thereby eliminating the earth's rotational effect, which is the principal disturbing force that causes conical pendulums in general to travel in ellipses. The driving train is provided with four black-enameled



Chronoscope Forming Part of the Wells Apparatus.



Apparatus for Mapping the Blind Spots of the Eye.

A Sonometer to Detect the Least Perceptible Difference in the Intensity of Sound.

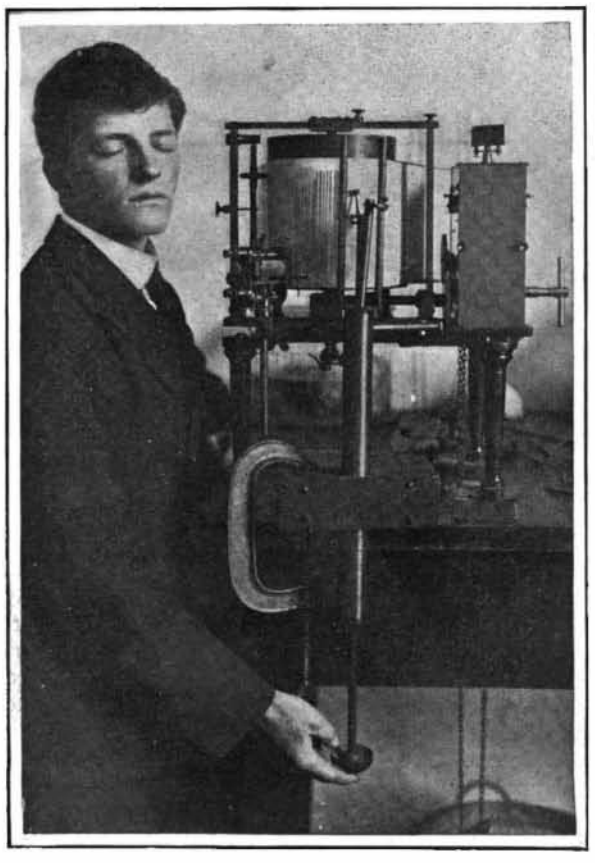
MODERN EXPERIMENTAL PSYCHOLOGY—ITS METHODS AND APPARATUS.

indices, the first turning once per second, the second making one revolution per minute, the third revolving once per hour, and the fourth completing one rotation each mean solar or sidereal day as desired. The first and largest index travels over the periphery of the dial, which is graduated into one thousand parts, each corresponding to one-thousandth of a second. Through the medium of electro-magnetic combinations, a recording train, precisely similar to the driving one, except that the indices are enameled red, may be coupled in with the aforesaid driving train for as long a period as the measuring current lasts. The duration of the current is then registered by the recording indices upon the dial. Synchronizers and magnetic devices are provided for by setting the different indices in accordance with the methods of operation hereafter described.

The functions of the chronoscope are controlled from a small switch table, which may be located in any desired position. If necessary, the machine may be mounted in a small clock room, which would prevent the influence of air currents, dust, and in a measure, temperature variations. In this case the controlling switchboard may be located outside of the clock room, the dial of the chronoscope being observable through a glass partition.

Notwithstanding the scales say that a pound of lead and a pound of feathers are equal in weight, Scripture says that a pound of lead *is* heavier than a pound of feathers as long as you look at it. However this may be, we shall let our readers determine for themselves, and confine our remarks to the experiment of judging weights and the apparatus for recording the extent and rate of movement illustrated on page 164.

The fact that the new psychology was founded very largely on Weber's and Fechner's researches in lifting weights, attaches to this class of investigation more than ordinary interest. Weber



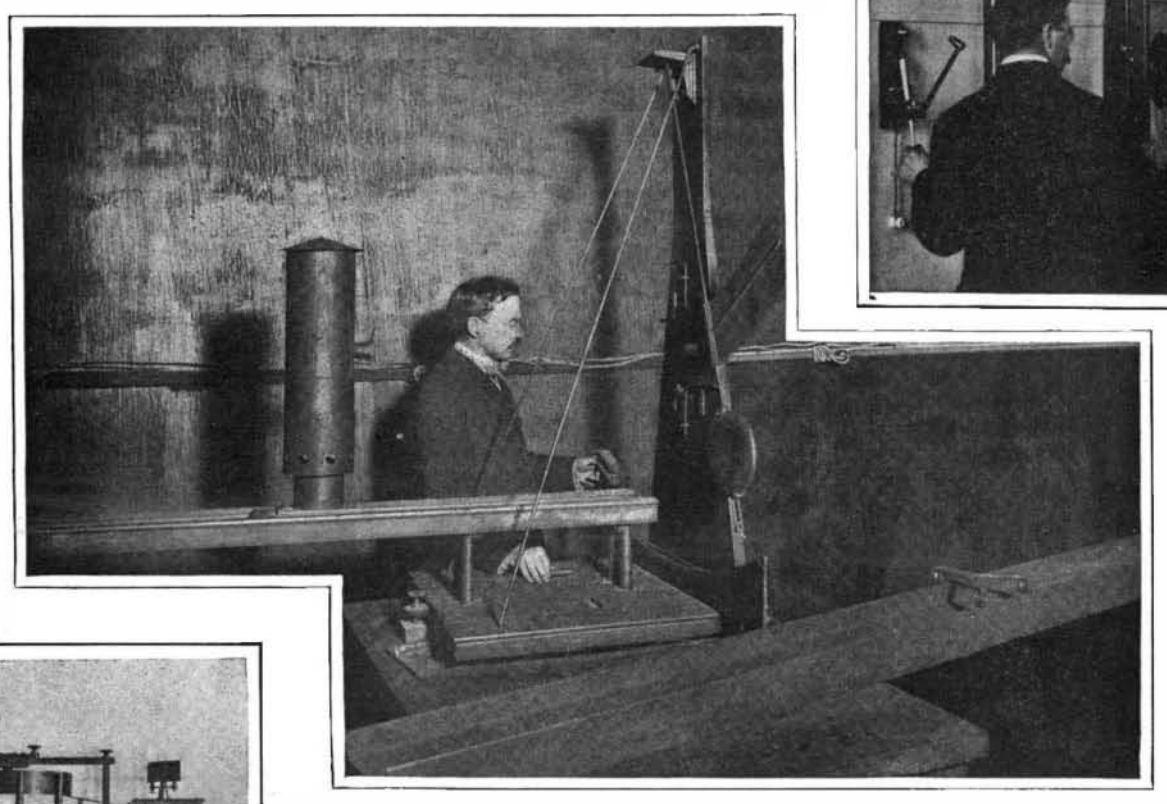
Apparatns for Measnring Preponderance of Weights.

sought to ascertain how much a weight must be decreased before a difference is noticed. He found that for a weight of 32 drachms the average difference for four persons was 3 drachms, and for a weight of 32 ounces it was 3 ounces. Thus it is obvious that the least perceptible difference for a lifted weight was not a constant fraction, but a proportional one. In testing the accuracy of this law, Fechner developed a method for measuring judgments of character, on a method of right and wrong cases as it is called, and which is really the basis of modern psychological work.

The apparatus shown for studying the factors that enter into the perception of lifted weights consists of a drum rotated by an electric motor; the drum carries a wide sheet of paper over its upper surface, while a pen, connected with a plate on which the subject places the weight, records on the moving band of paper the differences noted.

An apparatus for measuring the preponderance of weights is photographically reproduced below. In its essentials it consists of a drum carrying a sheet of paper on its periphery, and revolved by a spring motor; the latter is controlled by an electric current operating through a magnet and a make and break key. A novel form of dynamometer, comprising an upright tube, a rod sliding through it and lifting a weight to which a recording pencil is attached, is clamped to the table.

In making an experiment with this apparatus, the subject raises the weight three times, in each case with his eyes open. A stop limits the movements of the rod and weight, so that each individual movement is exactly the same in extent. Then the subject is requested to repeat the operation, this time with his eyes closed. The stop is removed in this series of trials, and it is the subject's duty to try to force the rod up to exactly the same height as that attained with the eyes open. Curiously enough, as a general rule there is a strong tendency to make larger excursions with the eyes closed than when they are open,



Apparatns of the Pendulum Type for Determining the After-Image Effect.

MODERN EXPERIMENTAL PSYCHOLOGY—ITS METHODS AND APPARATUS.

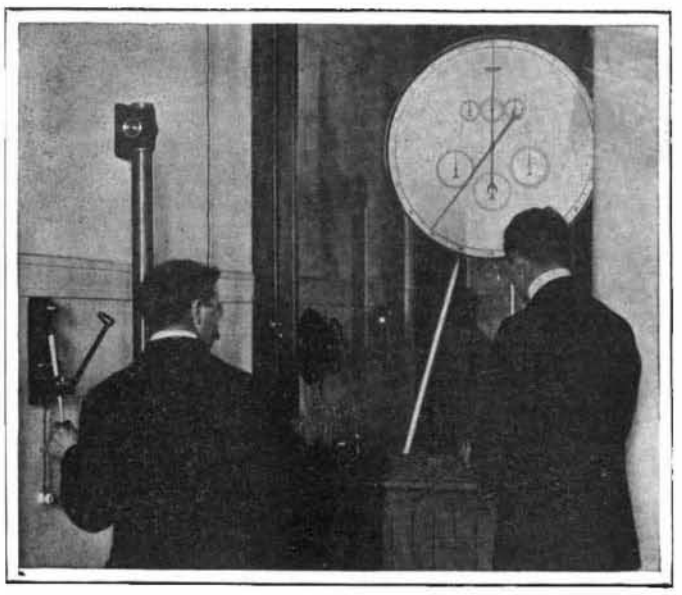
and consequently showing an under-estimation of the perception of weight under such conditions.

A very interesting as well as important branch of psychological investigation deals with the sense of sight and its relation to space. In order to record the movements of the eye, and to determine its fixed points, many arrangements have been devised and used, but the apparatus shown on page 164 is the most recent and best adapted for the purpose. In some of the earlier experiments a sensitive photographic film was made to move evenly in a vertical plane and immediately behind a narrow horizontal slit in the plate holder of a camera. The subject's eye was then brought into such a position before the lens of the camera that a horizontal plane bisected the eye through the middle of the pupil, and thence passed through the horizontal slit.

If the eye was held immovable while the sensitive film was being exposed behind the slit, the negative then presented a series of parallel lines corresponding in cross section at every point to the light and dark parts of an imaginary line drawn horizontally across the eye and bisecting the pupil. A horizontal movement of the eye while the sensitive film was moving behind the slit would be marked in the negative by oblique lines. These oblique lines were the records of the eye movements, and their time values were read off from a time record marked on a sensitive film during its progress. Owing to the untoward features of this method, satisfactory results were not obtained until the eccentric surface of the cornea was utilized as a reflector. Instead of photographing the eye directly, the movement of a bright vertical line as it was reflected from the cornea was photographed instead. Such lines give clean-cut records, which permit them to be magnified considerably, while the amount of light needed is comparatively small.

By referring to the figure, it will be seen that the subject to be tested holds his head perfectly rigid by holding between his teeth a projecting piece of hard rubber. Supported by an adjustable stand, there is an objective lens with an electric light back of it; and either between the light and the lens or in front of the lens, a blue color screen is placed. This part of the apparatus is arranged so that it will project a beam of blue light into the eye while the subject is reading letters or words on a card; the light is then reflected back to the photographic plate.

Another experiment, in which the sense of sight plays an important part in revealing the functions of the mind, is mapping the blind spot of the eye. There is one portion of the field of vision to which the eye is blind. There are many appliances for the determination of the blind spot, but the apparatus pictured in Fig. 5 is one of the most accurate yet devised. The blind spot does not usually take on a black appearance, but rather that of a misty veil, so that if a black letter is printed on a white sheet of paper, where it comes within the radius of the blind spot the eye will be unable to see the letter, and that portion will remain apparently white.



The Adams Chronoscope.

The apparatus referred to consists of a rigid table, on which is mounted at the end where the observer sits an adjustable standard carrying two chin rests for securing rigidity of the head, and therefore the eyes; two rests are provided, so that the blind spot of either eye may be ascertained. On a track there is a slide rest comprising a rigid paper holder and a vertically-moving band having a white spot on it; the upright supporting the band is arranged to travel horizontally over the fixed paper surface; a movable arm having a white disk attached to its free end completes the apparatus.

The term "after-image" is used to denote the direct after-effect of the stimulation of a sense organ. While after-sensations occur in almost all the senses, those of vision are stronger and more permanent, and have consequently been given more attention by psychologists. It has been found by experiment that after the retina of the eye has been stimulated by light for one second or less, the primary image disappears quickly, but at an interval of less than two seconds it is followed by a positive after-image, that is, an after-image of the same quality as the primary image; with some observers a brief stimulus is immediately followed by a negative after-image, that is, an image which differs very greatly in brightness, and is often of a different color from the primary image. One of our illustrations shows an apparatus of the pendulum type for the determination of the after-image effect.

An apparatus illustrated on page 164 is called a sonometer, and is employed to detect the least perceptible difference in the intensity of sound. It is also the invention of the late Ernest K. Adams and is a much more accurate device for ascertaining the discriminating powers of the auditory nerves than the apparatus originally used by Stern in his preliminary observations on the subject. It consists of a heavy pair of steel rods on which reservoirs containing steel balls are carried. These reservoirs may be raised or lowered as desired. Levers permit the balls to be dropped upon a base where they are deflected into a tray.

The operation consists in the experimenter first filling the reservoirs with the steel balls and in seating the subject near the instrument with his back toward it as shown in the illustration. The operator then

raises the two reservoirs to the same or different heights and clamps them upon the rods. He next throws against releasing pins when the balls will drop into the tube projecting below the reservoir. One of the arms is then moved back against the pin, thus carrying the ball around to the opening, where it will start to roll out.

As soon as the first ball has struck the base the second one in the reservoir is allowed to drop. The subject may now discriminate between the two sounds which of course will vary if the balls are dropped from different heights. The upright rods are graduated to enable the operator to vary the heights of the reservoirs by only slight differences, so as to detect the smallest degree of the auditive discriminative powers of the subject. To vary the experiment, the subject may be directed to close first one ear and then the other in order to test the nerves in each ear.

In 1795 the celebrated royal astronomer Maskelyne discharged his assistant because the latter recorded the transit of a star across the wire of the telescope half a second later than himself. Some twenty-five years later Bessel, another astronomer, had his attention called to the act, and upon investigation established the fact that no two observers recorded such transits at precisely the same time. The difference in time between any two observers was usually expressed as an *equation*, and hence the term *personal equation*, which though strictly applicable only to the differences so found, has assumed a much wider meaning.

The individual differences become greater as the process to be performed increases in complexity, and this explains in part why the personal equations as determined by the complicated eye and ear method were so large; with the simpler method of electrical record, these differences are much reduced. The object of the Wells apparatus shown on this page is to determine the differences of sensation measured by the time of the preponderance of those differences in the utterance of sounds. The apparatus is divided and placed in two rooms, so that all possibility of error is excluded. The interval of speaking a particular vowel and that of raising the hand from a Morse key are measured, the chronoscope indicating differences as small as 1-1000 part of a second.

A color wheel for studying the perception of moving objects is shown on page 164. It is so arranged that the rate of motions, size of field, etc., can be accurately adjusted. It consists of a wheel 1 meter in diameter with a rim 9 centimeters wide. Cards and colors placed on the outside of the rim pass the slit, where they are seen by the observer.

It is thus possible to exhibit a color or a series of colors for an interval dependent on which the wheel moves and the size of the colored surfaces. The intensity of the light and the size of the field can also be varied, thus permitting experiments on the relations of time, area, intensity, and color in vision. Originally this wheel was used for experiments on moving objects and commingling colors, and these led to the results on perception with the moving eye, on the relations of time and space in vision, the fusion of moving objects, and the perception of moving objects.

The apparatus shown in the illustrations form part of the equipment of the Department of Philosophy and Psychology of Columbia University, New York city. The author desires to acknowledge his obligations to R. S. Woodward, at Columbia, Professor of Psychology, for much of the data in this article.

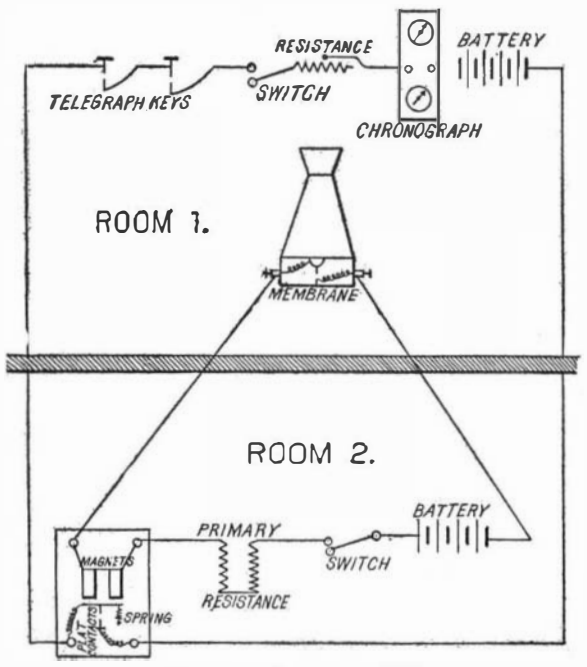
Accidental Inventions.

Gawalowski, in the Allgemeine Ingenieur Zeitung, has an interesting article on accidental inventions, in which he mentions first that the phonograph is due to an accident; Edison having related that one day when he sang in the mouthpiece of a telephone, the vibration caused the fine metal point of the diaphragm to stick in his finger, which led him to produce the talking machine. This story is probably not at all new to American readers, but perhaps the history of some other inventions, which took their rise in Europe, may be.

Natural indigo, which is among the dearest dyestuffs known, and has been used since the twelfth century, at least, has been replaced very largely by the artificial product, which is due to accident. Sapper is said to have discovered it; but Gawalowski states that the invention has been falsely ascribed to Adolf von Baeyer (not to be confounded with Alex. Bayer) and Hermann, although Von Baeyer is always considered as having been the father of this most important discovery. Eosin also owes its existence to A. von Baeyer, who was working at the time in the technical high school in München, and discovered it by accident; in this matter Caro having been of assistance. The Lauth violet and methylene blue were also products of accident; the first being produced by Lauth, and the second by Caro, mentioned above; further, benzopurpurin is due to a laboratory assistant of Duisburg. Antipyrin and saccharin are also the children of accidental discovery; while in medicinal chemistry fluorescin and acetanilid (anti-febrin) were discovered by accident by one of the employees in the Höchst works.

The Imaginative Temper in Science.

Mr. Rider Haggard, speaking at a recent distribution of prizes to the students of the Medical Schools of St. Thomas's Hospital, London, exhorted his hearers to fit themselves for their profession by cultivating, among other things, their imagination. Speaking of this, the Lancet (London) says: "We consider that Mr. Haggard was giving a remarkably good piece of advice, provided always that those who follow it allow their pursuit of science to be not dominated by imagination, but tempered with it. The importance of this faculty in relation to science may not be clear to all. Some certainly will tell us that imagination is for the poet, but they confuse imagination with fancy. Imagination has more affinity to science, to true constructive science, which transcends the bare collection of facts. Indeed, it may almost be said of the great masters of science who revolutionized their own domains that they were endowed with an imaginative grasp of their subject that gave them a well-nigh prophetic insight to its deepest mysteries; and this insight has served them for an ever-strengthening faith that the minute researches to which they have devoted their lives would one day result in the introduction to the world of thought of a grand and glowing truth the faint image of which had been revealed to them, though darkly, in the glass of their imagination many years before. But herein they showed themselves to



The Wells Apparatus.

be men of science and not dreamers, that before they presented their great gifts to the world they had searchingly and patiently applied to them the touchstone of experiment and ofttimes modified them again and again from their original crude forms; in a word, their imagination was their servant and not their master. For illustration, many great names occur. Even though the story of Newton's apple be apocryphal, yet it serves to remind us that he was endowed with an imagination which could conceive of a law of cosmic unity of stupendous import and which had power to urge him to direct the light of his vast intellect upon its elucidation. Will any deny imagination to the scientific faith that in later years confidently announced the existence of an unknown planet with an importunity that met with a triumphant justification? Or if we turn to the sphere of biology, the temper of imagination enters so prominently into the life work of Darwin and Pasteur that we are almost tempted to believe that it was this one faculty which lifted them so high above the many great investigators of their century. In the case of the father of bacteriology, the insight which led him on from the study of the crystallography of tartaric acid to that of fermentation in plants and thence to the bacterial conception of disease is a pure example of what we mean by the imaginative temper in science."

Many other illustrations might be cited, showing the value of imaginative science. Unfortunately, there is another side to the question. Much harm has been done by people who do not control their imaginations by the one safe method of laborious and impartial experiment. It is too easy to enunciate a general principle from some particular example; and this has often been done with most unfortunate results.

It is stated that the tunnel through the main range of the Tauern Mountains, in the Tyrol, begun six years ago, was pierced on July 21. The tunnel is 5½ miles long. It is situated a few miles south of Gastein, and its opening is at Wallnitz, where it passes under the Villach range.

The Spontaneous Production of Bromine from Radium Bromide.

On opening a glass tube containing a milligramme of radium bromide which had been hermetically sealed for almost exactly twelve months, there was a very strong smell of bromine. Now, according to the calculations of Rutherford, the amount of the bromide decomposed in this period would be about 5.4×10^{-7} grammes; the amount of bromine corresponding to this would be about 2×10^{-7} grammes. It might be thought that this exceedingly minute quantity would have been beyond detection by its odor. From some measurements made by Mr. A. C. G. Egerton, it appears that the minimum quantity so detectable is between 10^{-8} and 10^{-10} grammes per cubic centimeter. Experiments are in progress with the object of determining this limit more definitely; but in the meanwhile, the evidence is quite in accordance with the assumption that the bromine detected was produced directly by the spontaneous decomposition of the bromide, and was not the result of secondary actions. As far as we know this is the first application of the olfactory sense to the detection of radioactive changes. It should be observed that the ability to apply it here arose from the cumulative character of the chemical change produced. Of course, from the ebonite cells in which radium is usually stored, the bromine can escape easily enough to prevent its being detected.—Knowledge and Scientific News.

Radium Emanation and Its Products.—According to a letter in Nature, another important discovery has been made in connection with radio-active products. Sir William Ramsay and Mr. F. Soddy showed in 1903 that helium is formed as the result of the spontaneous change of radium emanation. Sir William now finds that if the emanation is in contact with and dissolved in water, neon is produced instead of helium. But, further, if a saturated solution of copper sulphate is substituted for water, argon is produced, with only a trace of neon. The importance of this discovery consists in that this is the first successful attempt to change in some way the products of disintegration. Hitherto, the mode of transformation has appeared to be an inexorable one, yielding in no way to efforts made with the hope of modifying it. How far the above modifications are attended by others has not yet been ascertained. It is possible that the emanation breaks up successively into radium A B C D E, as in the genealogical table of Rutherford. Indeed, it is probable that this is the case, for the helium or other non-valent gas is probably formed out of the Alpha particles shot off in the successive stages of decay. Besides the above direct actions, important secondary actions occur in the surrounding medium. The copper (in the copper sulphate) seems to be partly transformed into lithium, for the red lithium line was observed after treatment, though it was very faint.

The Railroad Commission of Indiana has issued the following circular to railroads: "The general assembly has provided (chapter 205, Acts 1907, page 353) that your railroad, where its gross annual income from operation is $7,500 or more per mile, shall be equipped with an approved block system by the 1st day of July, 1909. This act resulted from an investigation made by the railroad commission, by direction of the assembly, of railroad accidents which had taken place, and of present conditions of railway service and operation in the State. Its purpose was to remedy existing conditions and dangers, and not to postpone the institution of the block system to the time limit made in the statute. You are advised and directed to commence as early as possible to comply with this act of the assembly in its spirit and purpose. Our chief inspector will confer with you at any time at your request as to the kind of system best adapted to your line, having regard first to safety and then to the amount of business and your ability to put in this system. Your attention to this circular will be evidenced by prompt response from your general officers to the commission showing what you have done, and intend to do, to carry out the will of the general assembly, so expressed in this act."

The start of the Wellman airship "America" for the pole has been delayed by adverse winds. The start was set for August 20, but at the time a fresh breeze was blowing from the northeast, and the balloon, ready inflated, was kept in her shed. Later reports show that the wind has continued unfavorable, but the balloon is kept inflated, awaiting a favorable moment. Mr. Wellman has stated that unless he can leave by September 6, the start must be postponed until next year. If the start is made, the steamer "Express" will wait ten days to see if the balloon returns, while the steamer "Frithjof" will cruise off the coast for a month. If the pole is successfully reached and crossed, Mr. Wellman may be heard from in eight or nine days from the start.

Do We Eat Too Much?

BY JOHN B. HUBER, A.M., M.D.

The traveler who visits us is amazed at the variety and plenitude of our fare; our dinner tables groan quite as they did in the good old Elizabethan days. The Englishman especially comes to us from his inn at home, where at breakfast the traditional mutton chop, eggs, marmalade, and one or two other eatables (no more than half a dozen and all excellently prepared) are offered for his choice. In most of our hotels, whether urban or rural, his bewildered eyes will see a hundred things upon the breakfast card, many of them very badly cooked indeed. And he will find the contrast at lunch and dinner even greater. The sturdy steerage immigrant has at home subsisted very well indeed upon his plain bread, his cup of wine, his fresh vegetables, and his stews—a diet into which meats enter at most but several times a week. Here he finds his fellow-laborers indulging generously in meats daily, and often more than once a day.

The dietetic vice of a century ago—the time of the three-bottle men—was alcoholic; now, we Americans at least, eat too much, especially too much meat. It is the concomitant of our prosperity. And to this effect Prof. Chittenden submits a most valuable and scientific work (the second upon the subject) in which are detailed exhaustive experiments done through six years by him and his colleagues at Yale.* This book is well worthy the layman's perusal. In terms easily comprehended, one finds here much light thrown upon the many perplexing problems of nutrition; and much besides that is very interesting and instructive upon the larger subject of physiology.

Human food is composed mainly of organic living tissue, both vegetable and animal; and it has an admixture of inorganic mineral salts which help to make up bone, to enrich the blood, and otherwise to keep the body in good order. For scientific purposes Chittenden, as do all physiologists, divides our foodstuffs into proteids, carbohydrates, and fats. All things which we eat, of whatever nature or origin, are made up simply of representatives of these three classes. Some foods contain all three, others but one or two.

The proteids (or the albuminoids) are the most important. In addition to carbon, hydrogen, and oxygen, they contain also nitrogen, sulphur, and phosphorus. We sometimes call them the nitrogenous foodstuffs; for they contain the nitrogen which is absolutely essential to build our cells, tissues, and organs, and to repair the constant waste which is attendant upon the vital processes. We cannot maintain life without the proteids; besides, if heat and energy are lacking from other sources, they can supply them, temporarily at least. They enter variously into the composition of all foods. They are most in cheese and then in diminishing order in pulses (peas and beans), nuts, meat, eggs, and grain. There is a fair amount in bread and other grain products, and very little in fruit and many of the vegetables. The carbohydrates and the fats are made up of carbon, hydrogen, and oxygen; they contain no nitrogen. The carbohydrates comprise the sugars and the starches, and they yield energy for heat and work; as do also the fats. These two elements ordinarily furnish the fuel which is consumed in the body. They may replace each other; but they cannot be substituted for the proteids.

There has of recent years been much experimental work upon nutrition; and among the standards which have found pretty general acceptance are those of Voit and Atwater. Voit found that a dietary providing 118 grammes of proteid and 3.055 calories are required daily by the average man weighing 70 kilogrammes, if he is to do moderate work. Atwater's standard calls for 125 grammes of proteid and 4.150 calories. Chittenden submits the following as a specimen dietary for one day: Breakfast, one shredded wheat biscuit, one teacup of cream, one German water roll, two one-inch cubes of butter, three-fourths cup of coffee with the remainder cream, and one lump of sugar; lunch, one teacup home-made chicken soup, one Parker House roll, two one-inch cubes of butter, one slice lean bacon, one small baked potato, one rice croquette, two ounces maple syrup, one cup of tea with a slice of lemon and one lump of sugar; dinner, one teacup cream of corn soup, one Parker House roll, one-inch cube of butter, one small lamb chop broiled, one teacup of mashed potato, apple-celery-lettuce salad with mayonnaise dressing, one Boston cracker, split, one half-inch cube American cheese, one-half teacup of bread pudding, one demi-tasse coffee, one lump of sugar.

Such a dietary as this would furnish 60 grammes of proteid and 2.800 calories, which Chittenden holds is ample to maintain the body in health and strength, both mental and physical; and this with the least expenditure of time, attention, and energy. He counsels us to cut down especially the proteids in our food; and it is the meats which should be reduced, since they are our chief nitrogenous foodstuff. He concludes that the dietary standards which now obtain are much too high; and that better health, increased efficiency, and greater chances of longevity would certainly follow upon our reducing our proteids at least fifty per cent. In his opinion we consume altogether too much above what the body needs for its building up and to keep it in repair. Physiologists declare that proteids are the one substance in food which the body cannot burn up thoroughly when they are eaten in excessive quantities. Thus such organs as the liver, the stomach, and the kidneys become overtaxed in the undue efforts they have to make to dispose of them; and when this overtaxing becomes long continued, these organs are bound to develop chronic diseases, and too often to break down quite disastrously. Chittenden indeed found his interest in the subject upon which he was working to increase enormously when he found that at the end of a short period after he had himself begun to go without breakfast and otherwise to cut down his own food consumption, his general health had decidedly improved; he had rid himself of a rheumatism which had before been quite rebellious to treatment, and he also was free from bilious attacks and sick headaches.

Prof. Curtis has well likened the body to a furnace. The combustion of proteid within it yields a solid ash which must be raked down by the liver and thrown out by the kidneys. "Now, when this task gets to be over-laborious, the laborers are likely to go on strike. The grate, then, is not properly raked; clinkers form, and slowly the smothered fire grows dull and dies."

Chittenden's work is all the more valuable by reason that he is no faddist. The mixed diet is the normal for human beings. He would not have us vegetarians, though many people would do very well indeed upon an exclusive vegetable dietary. "Complete vegetarianism is entirely successful in many cases, and disastrous in others." In the latter an occasional use of meat is needed "for some reason not perfectly clear," probably because meat is "peptogenic," in that it stimulates the secretion of the gastric juice, which is essential to digestion. Many among those who abstain from meat during a number of months find a meat hunger asserting itself for a few days only, after which a long period elapses before another such craving occurs. Some who abstain from meat for years find themselves declining in health, which, however, becomes immediately restored by again including meat in the dietary. It seems that many popular vegetarian food preparations imitate very strikingly the meat flavors, thus satisfying an instinctive and quite normal craving.

Nor would he have us altogether Fletcherites, although that wise man has advised much which is salutary. Fletcher when nearly fifty years of age was literally obese, he suffered from several diseases, he was rejected by all life-insurance companies; yet he regained complete health and vigor to the degree "that he could tire out young athletes at their own work and carry a severe mental labor at the same time." This result he obtained through complete mastication of all food, both solid and liquid, and yet at the same time eating far less than the ordinary sedentary person. He declared: "If you eat only when you have an earned appetite, masticate your food thoroughly, and take great care to eat only what appetite approves, the rest will take care of itself."

Yet a faithful adherence to Fletcherism in all cases would not be healthful. For instance, Dr. F. G. Shattuck, of Boston, has observed that Fletcher's son-in-law, Dr. Van Someren, who used to be a rather stout and good-natured gentleman, has become cadaveric, although he is quite satisfied that his father-in-law's system is enabling him to maintain his metabolic equilibrium. While in Cairo Dr. Shattuck met Dr. Sansmith, who practises in that region; and the latter told him that he not infrequently had the opportunity of seeing patients who had been under the Fletcher system; and the main thing he had to do with them was to encourage them to eat more, and so build them up to their normal condition of health. Besides, as I intimated in a paper contributed to these columns on June 8, it is not well for the body to take in only enough food for its maintenance. We must ingest a little more, in order to provide and support our "factors of safety." We would hold a railway company criminal which would provide, for the passage of its trains, bridges of just sufficient strength to bear them and no more; such bridges should be and generally are made capable of enduring several times the strain ordinarily put upon them.

*The Nutrition of Man. Russell H. Chittenden. F. A. Stokes Company, New York.

The new German military dirigible balloon and the Parseval airship have just made successful test trips in Berlin. The Parseval airship's test included a journey of over two hours against a strong head wind. The motor worked splendidly, and the ship made good progress, answering her helm with the greatest facility. The military balloon made a number of short voyages, and executed a series of complicated maneuvers. After being in the air for some hours, the two balloons landed at the same moment on the exact spot whence they had ascended. They sailed side by side in the air for a short distance before alighting.

Analysis of Hens' Eggs.

M. Barbieri, of Paris, recently carefully analyzed the yolks of hens' eggs, and separated a certain number of compounds. The first body is the oil of the yolk, and when this is purified by animal charcoal it is found to be quite free from nitrogen, phosphorus, sulphur, or ash. Analysis of the oil shows it to be made up of carbon 76.5, hydrogen 11.7, oxygen 11.8 parts. Its composition is therefore very near that of trioleine. The second compound is a solid substance which is soluble in hot alcohol, but upon cooling it is separated in the form of a jelly-like mass. After purifying, it yields a white crystalline body which melts at about 140 deg. F. Its composition is carbon 76.2, hydrogen 12.2, oxygen 11.6. This body is identified with tri-stearine, and the latter has the same melting point From the two bodies can be separated stearic acid, oleine, and stearine. Another body found in minute quantity is a white crystalline substance. It is soluble in an excess of alcohol and the solution is neutral. It melts at 356 deg. F., having the composition: carbon 64.8, hydrogen 11.3, nitrogen 3.66, phosphorus 1.35, sulphur 0.40, oxygen 18.49, ash 0. This body, mixed with tri-stearine, was observed by other experimenters, and known as cerebrine. By its composition it seems to be related to the cerebric acid of Fremy. M. Barbieri proposes to call it *ovine*. He also obtains a white mass from the yolk which divides into two layers, a lower oily portion and an upper layer. Treating the latter he finds a substance which swells up when placed in wood-spirit, but did not continue to observe it at present. From the yolk he then separated a body known as *ovo-cholesterine*. When purified, it appears as a crystalline compound, and has the composition: carbon 83.44, hydrogen 11.84, oxygen 4.72. Another body is an oil which has an intense yellow color, known as *chromatine*. When treated by ether or chloroform it yields small octahedral crystals whose melting point is found to be 239 deg. F. What is remarkable is that these crystals are nearly pure sulphur.

Sulphur exists in various forms, which may be classified into amorphous and crystalline, the former being insoluble, and the latter soluble in carbon bisulphide. Of the crystalline modifications, the most stable is that in the form of minute rhombic octahedra, and the small prismatic crystals which form when melted sulphur solidifies gradually change into octahedra, heat being evolved in the process. Amorphous sulphur also undergoes a gradual change into the rhombic crystalline condition, but, as Mr. Rankin has recently shown, the converse change of the crystalline into the amorphous form can be brought about by the agency of light. Thus, if a solution of rhombic sulphur in a suitable solvent be exposed to daylight, a precipitate of amorphous sulphur is produced. The intensity of illumination needed to effect the change decreases with the increase in the concentration of the solution, but more light is required when the solution is heated. Only the violet and ultra-violet rays of light are concerned in the precipitation, and the nature of the solvent does not have any influence. The precipitation is prevented by adding ammonia or sulphureted hydrogen to the solution, and strong sunlight has then no effect. In Mr. Rankin's opinion, there is a state of equilibrium between the two forms of sulphur, one being more stable in the light and the other in the dark.—Knowledge and Scientific News.

The Current Supplement.

The SCIENTIFIC AMERICAN SUPPLEMENT, No. 1653, contains an unusual number of varied and interesting articles. Of zoological value are an article on the Okapi and a paper by Prof. Alexander Agassiz on the "Progress of Zoology." Dr. Allerton S. Cushman's brilliant investigation of the corrosion of iron, which resulted in his discovery that electrolytical action is the real cause of iron rust, is concluded. J. H. Morrison's excellent treatise on the development of the armored war vessel is continued. "The Rise of Man" is the title of an interesting book review which gives not a little information on the descent of man. I. M. Angell writes on some curious hybrid tomatoes that imitate fruits. Henry Clay Weeks reviews mosquito extermination work in Massachusetts. To the roll of long and important tunnels the Karawanken was added last year. Although its construction was based upon what is known as the English system of tunnel building, yet it presents many features of novelty and interest, especially with regard to rapidity of execution. Paul T. Warner writes on the modern locomotive and discusses the various types at present in use.

The railroad ticket tax imposed a year ago by the German Empire was estimated to produce about 24,000,000 marks the first year. The Secretary of the Treasury recently announced that the prospect is that only about 12,000,000 marks will be realized by it. The diversion of travel from the higher to the lower classes has been greater than was estimated.