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SOME SIMPLE ILLUSTRATIONS OF THE PHOTOELECTRIC EFFECT.

The commercial success attained in the transmission of photographs by wire and radio naturally led to the hope that the transmission of moving pictures by the same media would also become a reality in the near future. This latter problem, obviously a much more difficult one, has indeed been solved quite recently though perhaps not quite as satisfactorily as one could wish. Mr. C. Francis Jenkins of Washington has been one of the pioneers working along these lines. Under the direction of Dr. Herbert Ives the Bell Telephone Laboratories have developed a rather elaborate system of television which had several public demonstrations and Dr. Alexanderson of the General Electric Company has been working upon a simpler system which has already been tried out in private homes in connection with radio sets. A brief description of the fundamental principles of the Bell system is given in the following article. As is well known the photoelectric cell forms an essential part of the present systems of transmitting either photographs or moving pictures. For this reason and also an account of its inherent remarkable properties, this cell can hardly be ignored in our college courses in physics. Indeed, the photoelectric effect, apart from any of its practical applications, is of special interest at present on account of its bearing on current theories of radiation. As the ordinary texts say but little about it, it may be worth while to point out some simple experiments illustrating the effect itself and its applications in the cell to which it has given its name.

A number of electro-optical effects are known in physics. Two of the most important are the change in the electrical resistance of selenium upon exposure, and the emission of electrons from certain substances when light of a definite falls upon them The latter phenomenon is the true photoelectric effect. Its discovery goes back some forty years, when Hertz found that an electric spark starts more readily between the balls of a discharger when they are illuminated by light rich in violet and ultra-violet. Further experiment showed that the action of the light consists in the ejection of electrons from the surface of the substance. A number of substances show the effect the electron emission always starting at a definite wave length. The wave length is greater according as the element is more electropositive. Thus the alkali metals such as potassium, sodium, caesium which are the most active have this maximum wave length in the visible spectrum and hence respond to ordinary light. The photoelectric effect has been studied in great detail by Millikan and has been frequently described by him. The laws governing it are: 1) the number of electrons emitted per second is proportional to the intensity of the incident light; 2) the energy of any one electron leaving the metal is independent of the energy of the incident light. This second law is quite remarkable as it does not fit in with the inverse square law. It was tested by Millikan for several different metals and found to follow the Einstein equation within the limits of experimental error. This equation is based upon the quantum theory and has the form $E = \frac{1}{2}mv^2 = hv - w$. m is the mass of the electron, v its velocity, h = Planck's constant and v is the frequency and w is the energy required to extract it from the metal. Millikan's apparatus and methods are described in detail in his book on "The Electron".

Experiment 1: THE EMISSION OF ELECTRONS FROM A ZINC PLATE BY ULTRA-VIOLET LIGHT.

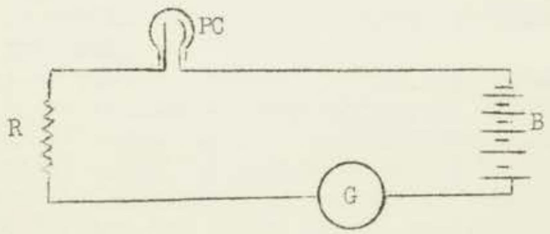
This experiment is mentioned in various books. It is simple and effective and easily understood and well worth showing to a class. For this reason it is described here in some detail. A small wire loop is soldered to a rectangular zinc plate which is then polished with fine sand paper and suspended perpendicularly on an insulating stand. The upper edge of the zinc may be bent over and the sheet hung from a glass rod held in an ordinary laboratory support or it may be suspended from the rod by wire loops. An open arc lamp, preferably of the 90 type, is placed in front of the sheet. An ordinary electroscope is set up between the objective and condenser of a lantern and the image of the leaves focussed upon a screen. The knob or plate of the instrument is connected by a wire with the loop on the sheet.

The plate is first charged negatively. The leaves will diverge. The arc is then started and the light allowed to shine upon the plate. The leaves will gradually come together. If the experiment is repeated first charging the plate positively, the leaves will remain unchanged showing that the light has no effect upon a positive charge. In the first case there is an excess of electrons upon the plate and these are extracted by the light causing the charge to disappear. In the second case there is already a deficit and the light produces little or no effect. To show that it is the ultra-violet rather than the ordinary light from the arc which produces the effect, a glass plate may be interposed between the arc and the plate when the latter is charged negatively. Little or no effect is produced. As soon as the glass is removed the leaves collapse. This shielding effect of glass illustrates incidentally the fact that ordinary glass is almost opaque to the ultra-violet. If a quartz plate or lens is available it may be used showing its transparency to ultra-violet. The experiment works best if the plate is freshly polished. In the Vorlesungstechnik of Volume I of Geiger und Scheel's new Handbuch der Physik the authors, Mecke and Lambertz, recommend amalgamating the zinc with mercury. They place a grounded wire screen between the plate and the arc. They also suggest using an arc with iron instead of carbon rods. This is very rich in ultra-violet light. For this reason it is not wise to look at it directly.

Experiment II: TO DEMONSTRATE THE PHOTOELECTRIC CURRENT PRODUCED BY A PHOTOELECTRIC CELL.

It may be pointed out in connection with the preceding experiment, that if the plate is connected to the negative terminal and a wire in front of it to the positive terminal of a battery, then under proper conditions there will be a steady flow of electrons from the plate to the wire causing a photoelectric current. This leads directly to the photoelectric cell of which there are several types now on the market. The prices are rather high. One of the simplest is that made by the G M Scientific Instrument of Urbana, Illinois and sold by the Gaertner Scientific Corporation of Chicago. It is the G.M. Photoelectric Cell No. 1005 whose price is $18.00 It works well and may be used for several interesting experiments. It consists of a small bulb resembling an incandescent lamp. The interior is lined with the sensitive material a portion being left clear to serve as a window. Very pure potassium is used which is afterward converted into potassium hydride by a special process. The positive terminal or anode is a loop of wire. The glass bulb is mounted like an ordinary radio vacuum tube and can be set up in any standard tube socket. The positive terminal corresponds to the grid binding post of the socket while the sensitive surface terminal corresponds to the opposite filament binding post. In any cell the current increases with the applied voltage. Beyond a certain critical voltage, however, the increase in current in most cells is very rapid and is likely to rise to a point which may cause injury to the sensitive surface. The applied voltage should always be kept below this critical value.

A circuit is made up according to Fig. I



PC is the cell. G is a galvanometer. Any instrument sufficiently sensitive may be used. The ordinary Type P Leeds and Northrup galvanometer works very well. Its deflections may be shown to a class in the ordinary way by reflecting a beam of light from its mirror to a screen. R is a high resistance. We have used a cartridge type resistance of 50,000 ohms in a clip socket such as can be purchased in any radio store. B is a battery of about 120 volts. About one hundredvolts may be used in the beginning.

If this does not give a sufficiently large deflection it can be increased. The sensitive surface is connected to the negative terminal. When the cell is dark there is no current and hence no displacement of the light spot. A deflection takes place as soon as a flash light is pointed at the window. It will be noted that the response of the cell is very prompt. As a matter of fact it is almost instantaneous though, on account of the inertia of the moving coil of the galvanometer, this can be illustrated only within a limited degree.

Experiment III: TO SHOW THE EFFECT OF VARYING THE INTENSITY OF THE INCIDENT LIGHT.

To show this it is only necessary to vary the distance of the flashlight from the cell. A lamp socket may also be set up at a fixed distance and lamps of different wattage successively inserted. The magnitude of the deflection is noted in each case. This relationship between current strength and the intensity of illumination is very important as most of the applications of the cell depend upon it. It can be tested in the laboratory with greater accuracy if a photometer is available. The illumination in foot candles and the corresponding current for different light intensities are measured and the results plotted. The current is computed from the galvanometer constant. Practically a straight line is obtained showing that the photoelectric current is proportional to the intensity of the incident light. Curves may be plotted for different voltages. The importance of this property of the cell in photometry and in the transmission of pictures is obvious.

Experiment IV: TO SHOW THE EFFECT OF VARYING THE VOLTAGE APPLIED TO THE CELL.

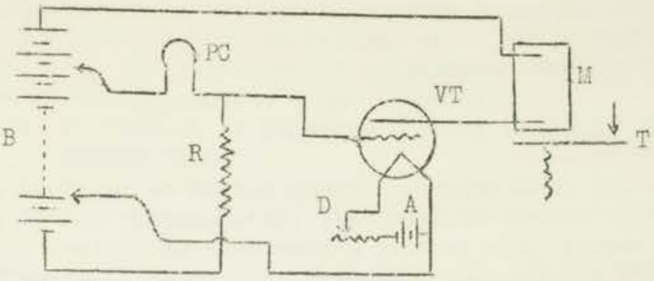
A lamp is set up at a convenient distance from the cell and the applied voltage varied by shifting the battery terminals or the battery may be connected in series with a high resistance sliding contact rheostat and different voltages tapped off. The distance of the lamp should be such that with about 120 volts the deflection will not be much over 200 millimeters. Starting with about 10 volts the voltage is increased by intervals of about 10 volts its value being measured each time. A double throw switch is convenient for connecting up the voltmeter. The corresponding deflection is noted and the current computed. The results are then plotted. For moderate voltage changes the relationship is fairly closely a linear one.

Experiment V: TO SHOW THE EFFECT OF VARIOUS ABSORBING MEDIA BETWEEN THE LIGHT SOURCE AND THE CELL.

The same circuit is used as in Fig. I. The lamp is placed in a fixed position at such a distance that the galvanometer gives a fairly large deflection. A glass plate is then interposed between the lamp and the cell. Some of the light is reflected from the surface of the glass nearer the lamp amd a small amount is absorbed by the glass itself. This is shown by the fact that the deflection is slightly diminished. Colored glasses may also be used provided they are not too dark. Another way which appeals more to a class is to blow tobacco smoke in the path of the beam. The change in the deflection will depend upon the density of the smoke. The light spot returns its original position as the latter is dissipated.

Experiment VI: TO CONTROL AN EXTERNAL CIRCUIT BY MEANS OF LIGHT FALLING UPON THE CELL.

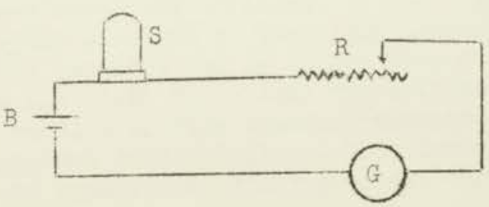
The generation of an electric current in the cell by means of light suggests the possibility of using it to produce various mechanical and electrical effects with the aid of an electro-magnetic relay. In this way artificial illumination can be controlled, fire alarms operated, materials sorted according to color etc. One difficulty in the way is the fact that the photoelectric current is usually very small, in fact too small for most relays. However the effect may be increased by any desired amount by means of a vacuum tube amplifier which is then connected with the relay. A simple circuit suggested by the makers of the cell is given in Fig.



PC is the photoelectric cell. VT is a radio tube. A UX 201 A Tube works well. B is a B battery of about 130 volts. R is a 10 megohm resistance such as is used in resistance coupled radio amplifiers. A is the filament battery and D its rheostat. M is a sensitive relay. A satisfactory type is one suggested by Fr. Phillips for another purpose. It is the G - II Standard Telephone Relay made by the Western Electric Co. and, sold by the Graybar Electric Company in Boston and doubtless elsewhere. It has a resistance of about 1550 ohms and the operating current is 0.0015 amperes. The price is $3.50. This relay is placed in the plate circuit of the tube. T is the moving contact of the relay M which with proper battery strength controls the outside circuit The contacts of T are small so it may be necessary to interpose another relay. This depends on the magnitude of the current to be controlled. The filament current and the voltage applied to the cell are adjusted until the light action actuates the relay. A striking experiment is to show how a 150 watt lamp may be lighted by means of a match. It is well to connect M with a telegraph relay and a dry cell. The moving contact of the second relay is connected in series with the lamp and the lighting circuit. If the filament current and the cell voltage are properly adjusted the lamp will flash out when a match is struck close to the cell. Of course the lamp will go out as soon as the match unless by some means its circuit is kept closed. Other devices may be operated in the same way. The only precaution to be taken is to avoid excessive sparking at the relay terminals.

Experiment VII: TO SHOW THE CHANGE IN THE ELECTRICAL RESISTANCE OF SELENIUM UNDER THE INFLUENCE OF LIGHT.

This is another kind of photoelectric effect which has various applications in the so-called selenium cell. Such a cell is necessary for the experiment. One we have used here is the No. 6A McWilliams Photoelectric Cell made by the Electric Bean Grader Products Company of Ithaca, Michigan. It costs ten or twelve dollars. Its resistance in the dark is about 50,000 ohms and about 2,000 ohms in the light. The glass bulb which is evacuated is cylindrical in form about 9 cms long and $1\frac{1}{2}$ cms wide. The selenium is in the form of a rectangular plate being spread upon fine gold wire. It is quite translucent which is an advantage. It has an Edison type of base being screwed into a small socket. The makers claim that the cell does not have the lag characteristic of selenium and that it can be used in a strong light. It should not be used with more than three volts and a resistance should be inserted in the circuit. A circuit is arranged as in Fig.



S is the cell, R a variable resistance, B a dry cell and G a galvanometer. The cell is covered and the resistance is varied until the galvanometer gives only a small deflection. If the galvanometer is very sensitive B may be connected with a sliding contact tubular rheostat of high resistance and a small voltage tapped off. When light falls upon the cell the galvanometer deflection immediately increases. The increase varies with the variations in the light intensity.

Experiment VIII: TO CONTROL AN EXTERNAL CIRCUIT BY LIGHT FALLING UPON A SELENIUM CELL.

The circuit is arranged as in the preceding experiment but a sensitive relay is substituted in place of the galvanometer. The relay is connected with the external circuit with a battery in series. We have used a Weston relay connected in series with an electric bell and a couple of dry cells. With the cell covered the current through the cell is adjusted until it is not quite able to operate the relay. The bell rings as soon as a light is flashed on the cell. The McWilliams Cell mentioned in these experiments is used in machines which sort beans according to color. This operation used to be performed by hand. In the machine light is reflected from the bean on to the cell. Its intensity will vary according to the color of the bean. The current controlled by the cell operates a magnetic finger which removes the bean from a travelling belt.

TELEVISION

Some inventions are simple in themselves and momentous in their consequences; others of slight economic importance, are most marvelous in themselves. In the first category may be placed Watt's improvement of the steam engine, which lead almost directly to the Industrial Revolution of the Nineteenth century. In the second, is television. We are not startled at its possible consequences, we are startled at its very possibility. Its mastery over space and time seems uncanny. Yet television, with all its initial mystery, is now an actual reality; and a description of it should be both opportune and interesting.

How is it possible to gaze upon a scene that is being enacted hundreds of miles away? The fact is,we do not observe the distant scene, but an instantaneous reproduction of it, made by the receiving apparatus. What spans the distance is not light but electrical energy derived by proper terminal equipment from the original object and reconstructed at the receiving end into a moving picture for the observer.

The first step, the transformation of light variations into electrical variations, is easily understood if one is familiar with the use of the photoelectric cell. The cell consists of a glass bulb coated on the inside with a photo-electrically sensitive surface - some alkali metal or its hydride. The light reaches this sensitive surface through a small portion of the glass which is left uncoated. This is the window of the cell. In the position of the filament of an ordinary lamp is a wire loop, which forms the positive terminal or anode. The photoelectric cell does not supply a current of itself. The sensitive metal merely expels electrons under the influence of light. But by connecting the sensitive surface to the negative terminal of a high-voltage battery, and the anode to the positive terminal, these electrons emitted from the sensitive metal are attracted to the anode, thus completing an electrical circuit, and causing a current to flow. The electrons lost by the metal are replaced by others from the battery and the flow of current can continue. The cell can be called a photoelectric switch, which is closed under the influence of the light. But it is more than a switch, for it varies the current strength as the light intensity varies; responding to the variations with extreme rapidity and in direct proportion to the intensity of the light

We have seen how light variations can initiate electrical variations by means of the photoelectric cell; a problem somewhat analogous to the conversion of sound into electricity in the original Bell telephone. This latter, however is comparatively easy because it involves the conversion of air pressure varying withtime to an electrical current varying with time.

The visible object however, is not a temporal succession of anything but a special arrangement reflecting different light intensities. If we illuminate an object and allow the reflected light to strike a photoelectric cell, a current of electricity proportional to the strength of the light will be sent along the wire, and can be again transformed into light corresponding to that which affected the photo-cell. But a beam of light does not make a picture. How then are we to transmit this special arrangement of light and shade?

A theoretically possible system of television could be made by copying the eye. In the eye an image is formed upon the retina, a sensitive screen consisting of a multitude of individual light sensitive elements. Each of these elements is the termination of a nerve fibre which goes directly to the brain, the entire group of many millions of fibres constituting the optic nerve. Thus in copying the eye, a number of photo-sensitive elements would be connected, each with an individual transmission channel and signals could be sent simultaneously from each of the sensitive elements. For instance the sensitive cells that receive a small amount of light reflected from the black hair would send less current than the cells receiving the light reflected from the white forehead, These separate currents could be transmitted over the wires and each converted int the proper amount of light simultaneously, thus giving a picture of varying light and shade. Practically however such a system impossible, and since we cannot send the whole image simultaneously, then we must send it part by part. The visible object with its special arrangement must somehow be converted into a temporal succession and then reconverted at the receiver into a picture with the proper special parts.

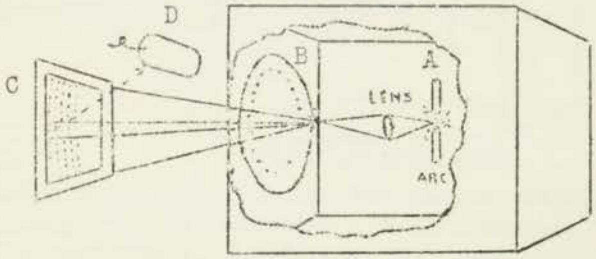


DIAGRAM OF TRANSMITTING APPARATUS
Light from the arc passesthrough openings in the revolving disk. The reflection of the light on the frame is received by the photoelevtric cell.

The first diagram shows how this is done in the transmission apparatus of the Bell system. At the first public demonstration of this system, April 7, 1927, Herbert Hoover, at Washington, spoke to and was seen by, friends in New York. Light from the arc (A) passes through the openings in the revolving disk (B) one at a time. The person whose picture is to be transmitted, is bounded by the frame (C). A beam of light striking the object is reflected diffusely, some reaching the photoelectric cell (D) and a current proportional to this light is transmitted from the cell, to the distant receiving apparatus.

The perforations in the disk are arranged in a spiral and light passes through them one at a time. The light through the first or outermost perforation illuminates about a quarter inch square of the upper left hand corner of the object. This portion reflects a greater or smaller amount of light depending on whether it is white or black. The reflected light strikes the photoelectric cell and a proportional current is sent to the receiving apparatus. Now as the disk revolves the beam sweeps down, illuminating successively each small portion of the left hand side of the object, and varying currents proportional to the light and shade of each particular part are sent successively to the distant station.

The visible object however, is not a haphazard succession of anything but a [illegible] arrangement reflecting different light intensities. If we illuminate an object and allow the reflected light to strike a photoelectric cell, a current of [illegible] proportional to the strength of the light will be [illegible] [illegible]

A [illegible] [illegible]

Diagram of the mechanical [illegible]

Light from the arc passes through openings in the revolving disk. The reflections of the light of the [illegible] are received by the photoelectric cell.

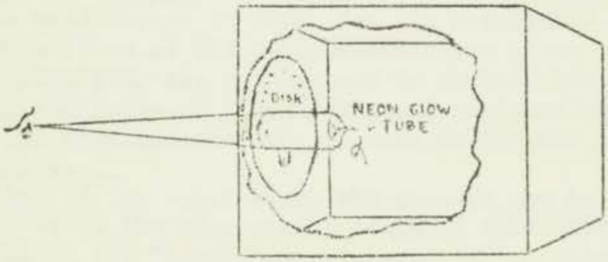
The first [illegible] which has been [illegible] in the television [illegible] of the Bell System at the first public demonstration of this system, April 7, 1927, [illegible] [illegible] Light from the arc (A) passes through the openings in the revolving disk (B) [illegible]

The perforations in the disk are arranged in a spiral and light passes through [illegible]

As the beam reaches the bottom it is cut off by the guiding frame placed immediately before the disk, as indicated by the dotted lines. But now the second perforation is in position; a narrow beam of light escapes through this, sweeping a downward path a little to the right of the first path and is followed successively by the beams of the inner perforations. The first, second and third dotted lines on the frame show the paths that are illuminated by the beams of light escaping from the first, second and third perforations respectively. As the innermost hole of the spiral completes its line along the inner edge, the first hole is ready to start a new cycle at the outer edge.

It must be remembered, however, that at one particular instant only one small portion of the object, about a quarter of an inch square, is illuminated; and sends a definite amount of light to the cell, which in turn transmits a corresponding current. The entire field then, is divided into 2500 small areas, but the disk revolves so rapidly that the entire scene is scanned in one eighteenth of a second.

We have seen now, how the object is divided into parts and how the reflected light fron each small portion acts on the photoelectric cell initiating a corresponding current. This current is amplified and sent by wire or radio to the receiving station. But after having divided the object into 2500 parts haw can we put it together again?



RECEIVING APPARATUS

The Neon glow tube has the unique quality of changing its intensity almost instantly to correspond with different impressed terminal voltages.

The second diagram shows how the temporal succession of electricity is changed into a special arrangement of light and shade. It is the receiving apparatus of the Bell system; similiar to the transmitter but of converse function. In place of the arc light there is a special lamp which lights up immediately with a brilliancy proportional to the instantaneous current that is received from the transmitting station. For a long time no such light was known, until D. McFarlan Moore perfected the Neon Tube. These bulbs containing the rare and inert Neon Gas, are now called "Oramatrons" or "sight tubes". When a current is sent through the tube, the gas gives a characteristic pink glow, familiar in the electric-light advertisements of the night. Its value to television lies in its ability to respond instantaneously and proportionately to the fluctuating charge fed into the tube.

In the receiving apparatus there is a revolving disk similar to the disk of the transmitter, with spiral perforations similarly placed there is a stationary guiding plate in front of the disk, with a rectangular opening as shown by the dotted lines. Which permits the light to be seen through only one hole at a time.

The current that was sent from the transmitting apparatus (at the first instant) causes the gas to glow with a brightness corresponding to that of the detail of the scene which the photo-cell was observing at that moment. This light escaping through the first opening produces a bright dot at the upper left hand corner of the guiding frame. Next a dot of light appears just below this, the first corresponding to the brightness of the second quarter inch square that was observed by the photo-cell; and so on for the other twenty five hundred dots that are flashed before us every eighteenth of a second.

[illegible]

[illegible]

[illegible]

In reality what is presented to the observer is a series of dots of varying brightness, one dot following the other (in quick succession) but in such quick succession, some forty five thousand a second, that due to the persistence of vision, the eye observes not a succession of bright dots but the whole rectangular field lighted at the same time with different intensities at different points. That is, there appears to the observer a special arrangement of light and shade. This conversion of successive dots into the appearance of a real image can be understood by a comparison with Moving Pictures where a similar physiological phenomenon takes place.

If the receiving disk revolves with exactly the same speed as the sending disk, then each portion of the distant scene will be observed in its proper place; but if the disks are not revolving synchronously, we will not have a picture but a jumble of light and shade. For years experimenters in the field of television have struggled with this problem of synchronization. Various synchronous links have indeed been used, and the Bell Company has developed an elaborate system - so elaborate, it seems, as to be commercially impractical. Just recently, however, Dr. Alexanderson of the G.E. Laboratories has solved the problem, and very paradoxically he uses no synchronization link. And yet how simply, he merely made arrangements for the person at the receiving set to vary the speed of his disk-driving motor until the picture is clear.

Such a receiving apparatus as has been described, produces a rectangular image two by two and one half inches in size. Yet the details of such a small picture are remarkable. Research workers at the Bell Laboratories claim that a distant person can be seen and easily recognized, his motions can be plainly followed as he talks into a transmitter, turns the pages of a magazine, and performs other similar actions. Large size pictures in the magazine can even be seen as the subject turns the pages and looks at them himself.

Yet because of its small size, the picture can be viewed only by a limited number of persons. It is the "Ear-phone" stage of television. What we want now is something analogous to the "Loud-Speaker", some device which will enable a large group to view the picture. An apparent solution at once presents itself. Cannot the image be projected on a large screen similar to the "Silver Screen" of the movies? Such a projection would be inefficient and would demand the electrical control of an impractical amount of light. For since the light passes through only one perforation of the disk at a time, the effect is the same as if the whole screen were illuminated by the light escaping through one pin-hole. And that tiny beam of light, when distributed by the scanning operations over the whole screen, will reduce the brightness of the picture in the ratio of the relative areas of this elementary spot and the whole screen. The amount of this reduction will be a factor of several thousand, and at present, there is no light source known so intense that it can be spread over a large area and give an average brightness which would be at all adequate. So the projection method must be abandoned and a more direct method of obtaining a large picture sought.

The Bell Laboratories have developed such a system. The transmission apparatus is of course, the same, but at the receiving end, instead of a relatively small Neon Glow tube successive portions of which are viewed at successive intervals, a special Grid type of receiver is used. This is a lamp which consists of a single long neon filled tube bent back and forth to give a series of fifty parallel sections of tubing. There is one interior electrode and 2500 exterior electrodes, the latter consisting of metal foil cemented to the glass. A fluctuating voltage applied between the interior electrode and one of the exterior electrodes will cause the tube to glow in front of that particular electrode. The varying voltage is applied to the exterior electrodes in succession from 2500 bars on a distributor by a brush rotating synchronously with the disk at the transmitting station.

As the current corresponding to each portion of the object reaches the receiving apparatus, it is distributed to the proper electrode and causes a flash of light corresponding in location and intensity to that portion of the distant object which is "scanned" at the instant. Eighteen times a second each of the 2500 areas of the grid tube shines forth with a brilliancy proportionl to that of each portion of the distant scene.

But due to the persistence of vision the observer apprehends not a series of discrete light flashes but a continuous and moving picture.

This method of presenting television to a large group is both efficient in it operation and satisfactory in its results, efficient because the glow discharge is viewed directly, thus there is no loss of energy after the picture current has been converted into light. Moreover each illuminated area of the screen responds to the picture current in the proper proportion, both because the exterior electrodes are exactly alike and because the use of a single large tube insures uniformity in the pressure and purity of the gas. Thus the areas of light and shade are all properly co-related, and a clear continuour picture is produced, of a size (2 by $2\frac{1}{2}$ feet) sufficiently large to be viewed by many.

Of course we have seen only the essentials of television. The practical difficulties are great and multiple. The sending of the current involves serious problems in both radio and wire transmission. The Neon Grid tube with its 2500 electrodes requires a maze of wires and electrical connections. But the problems major and minor have been or are being solved and it would seem as though the day were not far distant when television will be as common as radio.

It is indeed true that the rapid progress made during the past year in over-coming the mechanical and electrical difficulties is a firm foundation for optimism; but if that optimism is over-fanciful, it will be shaken by two practical facts. In the first place it must be kept in mind that television is a more expensive proposition than telephony because it requires many times the transmission capacity required for voice transmission. And secondly, although with the present apparatus a distant person can be seen as well as heard even by a large group, yet the transmission of events such as athletic contests does not seem probable even in the distant future, is at least by present methods. The fundamental reason is that the apparatus now quite perfected is not designed for such broadcasting. We have seen that the whole process begins with a tiny beam of light which is reflected from the object to the photo-cell. But if the scene is already flooded with daylight, this tiny beam would be entirely lost amid the excessive and uncontrolable illumination. It would be a literal example of holding a candle to the sun. Television with all its initial mystery is now indeed a reality. But not the reality which a Jules Vernes, disregarding all practical difficulties, might picture for us.

Note: For further details the reader is referred to the Bell Laboratory Journal October 1927. The diagrams used in the paper, first appeared in the Tech Engineering News.

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ORGANIC SYNTHESIS FOR SECOND SEMESTER LABORATORY.

Canisius College for the past five years has used organic synthesis in the second semester laboratory as a substitute for the ordinary cook-book chemistry. Its teaching value and technique are readily recognized since such steps as nitration, diazotization, reduction and sulphonation are grasped by the students as reactions of general application rather than as separate reactions having no direct nearing or possible connection with each other. It has the further advantage of rousing student interest to the plane of competition. The synthesis done was that of the dye and indicator methyl orange drom benzene in four successive steps. This synthesis is the foundation of the second semester laboratory and the rest of the work is built around it.

Norris's manual was used. Before starting the synthesis each student submits a written report on which he is quizzed, which report treats in broad outlines the chief points of the synthesis, explains the preparation of benzene from coal-tar and points out the successive steps by which the benzene is to be converted into nitro-

benzene, nitrobenzene into aniline, aniline into sulphanilic acid and thins into methy. orange. The Chemical reactions for each step are given. Before starting each step in the synthesis a preliminary written report is required. This report discusses the chie reaction in the experiment about to be performed, calculates the theoretical yield of the product that should be obtained, discusses any side reactions that may take place or any other condition that influence the actual yield. The method for calculating the percentage is indicated and the reason assigned for calculating from the substance use as a basis in the calculation. A discussion of the general principles involved in the preparation follows, e.g. in preparing aniline from nitrobenzene the question of reduction in general and of a reducing agent is treated.

On the completion of each step in the synthesis the actual yield must be submitted to be checked by the instructor for purity and amount and reserved for the next step. Should the amount prepared be in excess of the amount required for the next step the excess is handed into the office; should it be less than the amount required the instructor furnishes the required material and the student notes the amount furnished and allows for it in his calculations of his percentage yield. The methyl orange prepared in the final step is turned into the office in sample bottles present in the locker equipment. On the completion of the synthesis a report on the whole synthesis is submitted. This covers chiefly the theoretical and percentage yields of methyl orang from benzene and discusses reasons why the particular experimenters did or did not obtain satisfactory yields. The student work in pairs thrucut the synthesis and competition between laboratory sections is keen because the laboratory section having the best average percentage yield is allowed to omit answering any one question from the final examination in organic chemistry. Interest is further stimulated by posting average sectional percentage yields for each step in the synthesis.

This method of laboratory has been very encouraging. While the experiments, with the exception of the preparation of sulphanilic acid were performed in the laboratory before the synthesis was incorporated into the course still the increase in student interest in organic chemical synthesis as well as the slight knowledge of organic chemical literature required have demonstrated the superior value of synthesis over the isolated preparations.

Another synthesis run on the same basis is that of aspirin from benzene thru nitrobenzene, aniline, phenol and salticylic acid. This is of especial interest to premedic students.

Harry L. Fisher in his laboratory manual has the synthesis of camphor from pinene.

H. C. MacLeod, S.J.
Weston College.

NEW PUBLICATIONS.

H Ion. LaMotte Chemical Products Company, McCormack Building, Baltimore Maryland has just published the fourth edition of their "A B C of Hydrogen Ion Control" This brochure of one hundred and twenty eight pages, - free, contains a very clear exposition of the meaning of pH.

H. C. M., S.J.

THE "BEST METHOD" OF TEACHING FRESHMAN - CHEMISTRY.

In the January-February number of this Bulletin the author of the contribution TEACHING FREASHMAN CHEMISTRY, raised the question - "Given any class in Freashman-Chemistry, what is the best method of teaching that class?" - and he desires an answer.

It seems to the present writer that one very good way of answering this diffi cult question would be to adopt the same plan as that initiated by the author in putt the question, namely, to let each Freshman-professor explain his own "best Method" as experienced in his own particular college and then to leave it to each interested observer to garner from here and there that which may appear sound to him and perhaps applicable to his own needs.

In accordance with these sentiments and following the same general division which was used in the article cited above, a brief account will now be attempted of the plan that has given the most satisfaction at the Ateneo de Manila, where we are trying to follow the same system of studies as in vogue in all our other American Jesuit Colleges.

I. "LECTURES".

THEIR GENERAL NATURE: Strictly speaking we should not call them lectures. Any lectures as such are few and far between and are given only where the textbook does not treat of an important topic or else on that point is either confusing or inadequate. Otherwise the practice here is to stick to the assigned author as much as possible.

THE QUIZ SYSTEM: This system has been chosen instead of the lecture system so-called. At the beginning of the class the textbook is opened to the advanced lesson brief remarks are made as found necessary for showing connections, emphasizing important sections, giving the method of study etc. and then all books are laid aside. The order from then on is a cross-examination for the individual, oral generally, but also when occasion requires, written on paper or on the blackboard, on the matter assigned at last class. The individual is called upon at random.

SOME ADVANTAGES: We merely indicate a few. Others will doubtless suggest themselves:

I. This quiz system was suggested by the students themselves so it cannot be considered too much of a grind.

2. The quiz is long enough to enable making the wording of the questions careful and hence careful answers may be exacted.

3. It banishes the biggest temptation of the lecture system as we have here experienced it, namely, the passive attitude.

4. It avoids confusion that is likely to result from minor differences in method between author and professor.

5. It promotes perfect control by the professor of the important things to be emphasized for study and an intelligent method of so doing in the student.

II. LABORATORY.

BRIEF OUTLINE: A printed list of the experiments to be performed with the number, title, object and any necessary N.B.'s, is placed in the hands of the students at an early date to be followed for the year, semester, week or other period so long as it is definite enough. No one is admitted to the laboratory without this list or without the manual and textbook for reference. For actual work the large class is divided up into sections and one section assigned to each assistant professor. At some convenient time the sections may be shifted so as to give each professor a new one. The idea of being around is not to do everything for the student, but to let him develop his own initiative within reasonable bounds. Quizzing at convenient points of the individual experiment helps both student and professor.

SOME GUIDING PRINCIPLES: As the enumeration of a few of these will cut out a whole lot of many more details of the particular methods used in the laboratory we shall give them for convenience,

I. Much exercise in laboratory practice, even if extra hours have to be allowed.

2. Coordination of class matter and experiment, keeping them as much abreast as possible.

3. Personal attention to individuals rather than mass instruction, or, "letting them go".

ADVANTAGES: Only a few will be emphasized:

I. The handing out a definite list of experiments beforehand, even if we should change them a bit later on, makes the student responsible for a previous acquaintance with the experiment and stimulates preparation for the quizes on that experiment.

2. Where there is much practice there is more chance for impressing more forcibly the memory with facts previously known only from print or theory; so too when we coordinate theory and practice and keep the experiments up to the class matter.

3. The dividing into sections gives much opportunity for intimate acquaintance with the experiment and personal good, attention being proportional to the students strength or weaknesses, to encouraging or restraining, speeding up or slowing down, as the case may be, etc. etc..

III. TESTS AND EXAMINATIONS.

THE FIRST PROBLEM: When we first tried out the lecture system and ever afterwards our great difficulty was how to keep a check on it, that is, how could we make sure "it was taking", or, that the students were alive to its demands.

THE SECOND PROBLEM: The mere idea of tests and examinations as a solution to the first difficulty introduced a second one, namely, where would we get the time for them? If we took the time from the lectures then we couldn't manage to cover much ground - not of course merely to cover ground, but there is always more than we can cover in the time allowed even when it is a question of only essentials. Long examinations would therefore be out of the question for us. And to hold short tests before or after lecture seemed too inadequate.

THE SOLUTION: As results were not satisfactory because frequent tests and examinations were omitted we were obliged for other reasons also to choose the Quiz system to take care of everything including the lectures as well as the ordinary recitations. This system with its advantages has already been described under "Lectures", so we need only indicate here how inclusive and comprehensive the scheme is. And with such a scheme we think the greatest asset is its economy of time without sacrificing anything that is vital.

The only other examinations given here are the midyear and final and about these we can report nothing new.

Mr. F. D. Doino, S.J.
Ateneo de Manila.

EDUCATIONAL MOTION PICTURES AGAIN.

In a recent issue of this Bulletin attention was called to the experiments carried on under the auspices of the Eastman Kodak Company in the use of motion pictures for teaching. While the complete report of the results of these trials is not yet issued, enough is known to warrant the statement that classes which had been taught subjects in which motion pictures were used showed uniformly greater progress

learning than classes of the same grade taught without assistance from the motion picture. Accordingly Mr. Eastman has donated a million dollars to a company formed for the purpose of producing films to illustrate all subjects in the primary and grammar school curriculum.

Some graduates of Harvard University have incorporated a company to produce educational films. While the company has no organic connections with the University, the films will be edited largely by the University professors.

VALUABLE GOVERNMENT BULLETIN.

A recent bulletin of the U.S.Geological Survey which will be of great value to teachers of trigonometry and surveying and to instructors in geology is "Topographic Instructions of the United States Geological Survey, Bulletin 788-E: Topographic Mapping". The Bulletin has just been published by the Survey and may be had for the asking.

UNCERTAINTIES IN GEOLOGICAL "ANTIQUITIES".

Only two things can be affirmed with certainty regarding geological time, viz. that it was enormously long and that it cannot be expressed accurately in years but only by the relation of one period to another. Estimates by geologists of the entire length of geological time vary from one hundred and fifty million years to nearly two billion years or more. Obviously when there is such a difference of opinion nothing is "known" with any degree of certainty. But we can confidently say that the Paleozoic lasted at least three times as long as the Mesozoic, which was itself twice as long as the Cenozoic, the relative thickness of the sediments of these three eras being as 3 is to 2 is to 1. The uncertainty of the estimation in years is recognised by geologists generally. Thus Chamberlain and Salisbury say of the estimates of the length of the sub-divisions of the glacial period in North America. "Little value is to be placed on estimates of this kind, except as a means for developing a conception of the order of magnitude of the time involved". And similar expressions are to be found in most geological texts.

An interesting example of the uncertainty of these year - estimates is found in the recent discovery of a fossil camel skull in Utah. At first it was thought to be the skull of a living camel species, perhaps the skull of one of the dromedaries which had been imported and released in the southwest United States some where in the seventies of the last century. But detailed comparison with the skulls of modern dromedaries showed that the Utah specimen was not identical with them, but was unmistakably a Pleistocene Camelops, which had been assumed to have been extinct for roughly half a million years. Now the Utah skull was perfectly fresh in appearance, with no replacement of the bone material by mineral material, and there was a bit of dried muscle still adhering to a portion of the skull. The specimen was found under three or four feet of fine dry eolian deposit in a cave formed in old lava beds, which are admittedly very late Pleistocene in age. Its position in these beds, together with its fresh bony appearance, would seem to place it conclusively at a very recent date, say not more than three or four thousand years ago at the very earliest. Concerning the bearing of this conclusion on the antiquity of man in North America, Professor Romer of the University of Chicago has this very reasonable comment to make:

This point has a bearing on another question -- the antiquity of man on this continent. Whenever human artifacts are found with the remains of extinct animals the anthropologist springs to arms to repudiate the association. This point of view is not unreasonable in view of the usual implication that this connotes a considerable antiquity. As an illustration, the apparently certain association of stone implements and a fossil fauna in the Frederick (Okla.) gravel pit is attacked by Dr. Spear in a recent number of this journal since the fauna (containing the "camel," etc.) is assigned by Dr. Hay to the first interglacial, while the artifacts are of a type which,

even in Europe, are only present during or after the last glaciation. But may it not be true here (and presumably in other similar cases) that the true situation is not that man reaches to a remote antiquity in this continent, but that the camel and perhaps other Pleistocene forms have survived until a much later date than has been believed previously"?

M. J. Ahern, S.J.
Weston College.

SERIES VII. OF THE ATLAS STELLARUM VARIABILIUM.

In the June-July, 1927, number of Popular Astronomy, there was an article by Father J. G. Hagen of the Vatican Observatory on the coming publication of the latest addition to the Atlas Stellarum Variabilium, namely Series VII. In that article he gave a list of fifty-five stars to be included in the series, and observations sufficient to prove that the variables were really identified.

A prospectus of the work has recently been received at the Georgetown College Observatory. The Seventh Series is published by Herder & Co., Freiburg, Germany. It is the combined work of Father Esch of Valkenburg and of Father Hagen. According to the notice in Popular Astronomy, the steps were estimated by Father Hagen and the rest of the work done by Father Esch.

The new series consists of forty-one charts, each covering one square degree. The manner of making the charts differs from that of the preceding series. The former charts were plotted from the positions of the stars as observed at Georgetown. This series however was made from photographs taken at Rome after the completion of the work on the Astrographic Charts. This of course increases the accuracy of the maps. The price of Series VII. and accompanying catalog is $15.00.

It might be interesting in this connection to recall that the so-called Series XII. of the A.S.V., consisting of a number of additional comparison stars for the charts of the first six series of the atlas and published at Rome in 1922 under the title "Aggiunte alle Carte dell' Atlas Stellarum Variabilium", was dedicated to the International Astronomical Union, and that the Union in its meeting at Rome in that year passed a resolution thanking Father Hagen for the honor paid to the International Astronomical Union in that dedication.

Thomas D. Barry, S.J.
Georgetown University.

SOME NOTES OF INTEREST.

In Vol. 232, No. 17 of the Astronomische Nachrichten there appears an extended biographical notice of Father Julius Fenyi, S.J. who died on December 21, 1927.

Father Fenyi was born on January 8, 1845 in Sopron (Oedenburg), Hungary. He entered the Noviatiate in 1864. He made his theological studies at Innsbruck during the years 1874-1878. In 1880 he was appointed as Assistant to Father Braun, S.J., Director of the Haynald Observatory in Kalocsa, Hungary, and it was here that he remained until the end of his life, except for the years 1882-1885 during which he taught Mathematics in the Scholasticate at Pozsony (Pressburg). In 1885 he was appointed Director of the Haynald Observatory and held this position till 1913. The instrumental equipment of the Observatory induced him to take up the visual observation of the solar Prominences and to this untiring labors the scientific world owes an uninterrupted series of these observations extended over a period of 32 years, namely from the time he was made Director in 1885 until four years after the termination of his directorship in 1913. The results of this valuable series of solar observations are contained in Volumes IV, VI, VIII, X, XI, XII, XIII, XIV, XV of the Publications of the Observatory.

His labors were highly valued and he was honored by many Scientific Societies both in his own country and in foreign lands.

When the funds of the Observatory were exhausted and the hardships consequent upon the World War made it impossible for him to publish his results he appealed to friends in America and in his old age was rejoiced to be able through their contributions to publish the last twenty-five years records. The author of this note, Father Th. Angehrn, S.J., thus sums up Father Fenyi's traits: "Aa a Religious he was at all times a model. The Society of Jesus, and in particular the Hungarian Province, has lost in him one of its ornaments, and Hungarian astronomy its universally Patriarch."

The Radio Service Bulletin for April 30, 1928, gives on page 13, the number and class of radio stations of the world for each year from 1913 to 1927. The numbers for the first and last of these years are here given to show the growth and present status of radio transmission stations.

American Stations in	1913	in 1927	
Merchant ships	483	2092	
Commercial transoceanic	1	26	
Commercial ship to shore	44	69	general public service
Commercial point to point and ship to shore	30	245	private service
Experimental	11	185	
Technical and training school	7	41	
Special amateur	4	--	discontinued combined with general and restricted amateur
General and restricted amateur	1224	15926	
Government land stations	77	333	
Government ship stations	229	1203	
Broadcasting	---	694	N.B. None prior to 1921 when there were 382 licensed.

Foreign Stations

Commercial and Government (land)	347	1373
Government ship stations	1237	2172
Commercial ship stations	1390	10276

"WORTH ITS WEIGHT IN GOLD.

Gold is still a precious metal, and I suppose that many of us in our childhood days thought it was the most precious material in the world. But there are quite a number of things more precious than gold; diamonds, for examples, and pearls and many other gems. Radium of course is more precious than any of these; what its market price is, if it can be said to have market price, I do not know but I doubt if it is the most costly commodity for sale. Recently Adam Hilger, Ltd., the well known London dealers in scientific instruments and supplies, sent out a circular advertising that they are prepared to supply from stock pure Kryton and Xenon and almost pure Neon: these as far as I know are the most costly supplies regularly kept in stock by any dealer. The price of Xenon is L14 net per tube containing 5 cubic centimeters; at the normal rate of exchange this means that Xenon will cost the chemist $78,070 per ounce Troy. As one ounce of Gold is worth $16.00 it follows that Xenon is worth 4,879 times its weight in Gold; in other words, to buy one ounce of Xenon we would have to give in exchange for it 407 pounds of "the precious metal". Kyrton is a little cheaper, being worth $61,274 per ounce, or 3,830 times its weight in Gold. Neon, however, is comparatively worthless being offered at the insignificant price of $498 an ounce.

I wonder whether the dealers were trying to be a little bit facetious when they added in italics, "Postage Extra"; it would surely seriously cut into their profits if they had to pay the two or three pennies exacted by the Post Office.

We often hear the practical value of lightning rods called into doubt. The following quotation in The Journal of the Franklin Institute for August, 1927, from U.S.Department of Agriculture Clip Sheet, No. 472, July 17, 1927; shows that these doubts, at least so far as they concern farm property, is unfounded.

"Available statistics indicate that lighting rods, both good and defective, as hitherto found on farm buildings have reduced lightning losses by about 85 per cent of the loss incurred from lightning on corresponding exposures of unrodded buildings, and that properly installed and well-maintained rods have shown an efficiency in the prevention of lightning damage of well nigh 100 per cent".

The estimated annual property loss on farms in the United States caused by lightning is at least $20,000,000. The loss of life is between 400 and 500 persons per year. The number of persons injured by lightning is over twice the number of those killed by lightning.

The February, 1928, number of the Monthly Notices of the Royal Astronomical Society, of London, (Vol. LXXXVIII, No. 4, page 257) contains an extended biographical notice of the late Rev. William F. Rigge, S.J. who had been a Fellow of the Society since 1909.

The results of extensive calculations on the orbits of 50 asteroids are communicated from the ZO-Se Observatory of the Jesuits in China; these results indicate the perturbations which these planets will be subject to throughout the years 1935 to 1940. They are given in the Astronomische Nachrichten, Vol. 232, No. 8. The author is Father de la Villemarque, S.J.

At the Seventh International Conference on Weights and Measures, it was announced as the result of work done at U.S.Bureau of Standards that the international unit of length, the meter, is equal to 1,553,164.13 times the wave length of red light from cadmium vapor under standard conditions.

EXTRACT FROM - THE SEATTLE DAILY TIMES

(EDITORIAL)

"THAT UNIVERSITY SEISMOGRAPH.

Upon several occasion The Times has called attention to the fact that inspection of the seismograph at the University of Washington appeared to be nobody's business. Seldom, if ever, is the instrument examined until after reports have been received from various parts of the world. Outside reports of seismic disturbances sometimes have been confirmed, but it is not recalled that the University has ever reported an independent or first reading.

It cannot be doubted that the appearance of alertness would be of advantage to the University. It would show, for one thing that attention was paid to scientific matters and that this school was as much interested in disseminating information as any institution of higher learning in the country. Instead of lagging behind until other seismographic stations have reported, the University of Washington should occasionally be first in the news dispatches.

It is a matter of general comment that the Georgetown University at Washington, D.C., is always among the first to report.

It sent out the news Friday of that great seismic disturbance somewhere on the other side of the world. Several hours later, when the record of the local instrument was read on request, the Georgetown report was fully confirmed.

The Times had hoped that the new administration at the University might see that this routine duty was looked after with greater regularity, but the results thus far have not been encouraging. If no dean or professor wishes to assume the responsibility of scanning the seismograph record regularly perhaps some student would be pleased and proud to take it over. At least the novice would report when an upheaval had taken place, after which an expert could try his hand at interpreting the lines".

Fr. E. Phillips, S.J.
Georgetown University.

PUBLICATIONS.

The Philippine Weather Bureau has recently published a report by the Director Fr. M. Selga on "Astronomical and Meteorological Conditions of the Eclipse of the sun May 9th, 1929, in the Philippines" This coming eclipse will be remarkable for the long period of totality the maximum being 5 minutes 7.2 seconds. Under favorable conditions it will afford an unusual length of time for observation, As much will depend upon the weather Fr. Selga has made an elaborate study of the meteorological conditions which are likely to prevail in the path of totality in the Philippines. He submitted a report to the third Pan-Pacific Congress at Tokio in October 1926 which was afterwards published in Popular Astronomy for April 1927. Further requests were after received in anticipation of which all observations of the past which might be of assistance to eclipse observers were summarized and the Weather Bureau observers of the totality zone were instructed to make extra observations for cloudiness during the first fifteen days of may in 1926 and 1927. In addition Fr. Selga went over all the towns between Iloilo in the Province of the same name and San Jose de Buenavista in the Province of Antique inspecting places and looking for advantageous sites. Detail accounts of living conditions, lodgings, means of communications, lighting facilities, labor etc. are given. Several maps prepared by Fr. Deppermann are also given.

The Astronomical Journal for June 2nd, 1928 has an article giving observations of the occultations of seventeen stars made at the Georgetown Observatory by Fr. Phillips and Mr. Barry. It is stated that Fr. P. McNally who had recently joined the observatory staff had assisted in the computations.

Popular Astronomy for June-July has an article with chart of the occultation of Sigma Sagittarii on July 2nd. 1928 by Mr. W.C.Doyle of the Creighton Observatory. It also has a brief review of Fr. Puig's book on the Observatorio del Ebro which was mentioned in our last number. It states that the work contains numerous diagrams and photographs of the instruments and buildings which add much to the interest and understanding of the reader. Work is carried on at the observatory in seismology and meteorology as well as in solar physics. From the description given in the volume one is led to ascribe to this observatory a very attractive setting and a large amount of important and valuable work. The first article in this number describes the new observatory at Columbia University, New York. It is of interest on account of the fact that the instruments, including a 12 and 3/8 inch equatorial and a 4 inch combined zenith telescope and transit instrument, are mounted on the roof of a thirteen story building. The elevation gives a good view of the sky and eliminates much of the stray light of the city. The possibility of vibration and of the swaying of the building naturally gave the greatest concern. The author states that except in very high winds one notices scarcely any unsteadiness either with the equatorial or with the transit instrument. Yet the instruments are not mounted, as is usually the case, on piers reaching to the ground but are supported by heavy steel girders embedded in concrete and extending from one side of the building to the other.

"It therefore seems that when the building sways in the wind it moves in such a manner that the top bottom and sides always form a parallelogram. Thus any motion of the telescope owing to the swaying of the building will be a motion of pure translation without rotation; and since the celestial objects are at an infinite distance compared to the small possible displacements of the top of the building, the image cannot shift in the focal plane". Some trouble is experienced in the use of artifical horizons for sextant work. This has been avoided by substituting glycerine for mercury as it is more viscous. A black glass mirror with levelling screws has also been used.

We have recently received the 2me Fascicule of Tome I of the Annales de L'Observatoire de Ksara. It was sent to us by the present director Fr. Combier. We shall refer to it again in a later issue.

Fr. Dopp the editor of "La Revue des Questions Scientifiques" has also kindly sent us a copy of his article on "Le Sentiment Religieux et La Science" Part I. which appeared in the May number.

Mr. T. Barry also calls attention to the following:

In Columbia for May there is an article by Thomas Moore of Woodstock entitled "A Question for a Question" The article deals with the reasons for making retreats. Popular Mechanics for June carries an undersigned article under the title "On the Trail of the Quake". Among the pictures illustrating the article are one of Fr. Tondorf and his Galitzin vertical photographic instrument and one of Fr. J.M.Jung, S.J. and his Seismograph at Gonzaga University Spokane. There is another of Fr. Tondorf studying a gram.

Mr. J. Tynan of Fordham the director of the University Seismic Station has an article in "Instruments" for May 1928 describing the new station site and its equipment

NOTES.

Fr. M. Ahern of Weston College was elected, vice-president of the Boston Geological Society on May 10th, 1928. Congratulations. In addition to his work at Weston, Fr. Ahern has also lectured on Astronomy and Geology at Holy Cross College during the past year and he has also lectured before various organizations on a number of occasions.

Our president Fr. Phillips of the Georgetown Observatory attended the June meeting of the American Association of Variable Star Observers at Poughkeepsie and sailed for Europe the latter part of June. He is to attend the meeting of the International Astronomical Union at Leyden Holland during July. Mr. Barry writes that Fr. R. Schmitt has been appointed by Reverend Father Provincial to take charge of the coming meeting at Woodstock. This seems to indicate that Fr. Phillips may not be back in time to preside. Mr. Barry will be in charge of the observatory in the absence of the director. Mr. Doyle of Creighton University joined the staff for the summer.

Fr. P. McNally left the Georgetown Observatory on June 18th. going to California to take a research fellowship at the Lick Observatory. We wish him every success in his work.

Fr. Jos. J. Sullivan of the New England Province received the degree of Ph.D. from Johns Hopkins University, Baltimore on June 12th. 1928. The subject of his dissertation was "Catalytic Studies on Acetoacetic Ester". It will be published in the Journal of the American Chemical Society probably in the November number. The Bulletin congratulates Father Sullivan most heartily on the completion of his post-graduate studies and wishes him equal success in his future teaching career, a work which he will doubtless soon resume again. We quote some notes of interest from a recent letter of Fr. Deppermann of the Manila Observatory. He has been working on a Navy Static Reducer. With this he hopes to cut down the excessive static of the Tropics and be able to record time signals from Nauen and Bordeaux in peace. The new shutters of the dome of the equatorial have finally been completed.

Now one person can easily open the shutters in two or three minutes whereas formerly it took two huskies twenty minutes. He plans to test the objective of the equatoral by the Hartmann test.

The Zi-Ka-Wei Observatory thinks highly of his recent redetermination of the Longitude of Manila and has sent copies of the report to France to be presented with their own work. They think it will doubtless replace the U.S.Coast and Geodetic Surve value at Manila. "I am getting some interesting results from from my atmospheric electricity measures. Our curve is very peculiar and I think I can trace the trouble to the influence of two winds, NE bringing clouds from the mountains driven by the monsoon winds and especially the SW wind from the Bay". My sky polarization measures have shown that the sky polarization is quite regular.

Mr. J. Priestner of the Ateneo de Manila writes from the Villa at Baguio: "Everybody knows our place here as the Observatory". Hundreds of visitors come up every day, - autos upon autos filled Most come for the view of the valleys between us and the China Sea and the China Sea itself. The "Observatory" consists of two rooms on the lower floor of the house, and, of course, some instruments outside. There are two seismographs one local, invented by Vicentine an Italian having four pins, - three for the directions of the disturbance and one for the time. The other is for distant quakes invented by Omori a Japanese and has three pins, two for direction and the third for time. There have been three slight tremors since we were at Mirador and two while we were at camp. They were just about strong enough to wake the lighter sleepers of the community. Many didn't feel them at all.

Besides the usual barometers and thermometers there is a single instrument which records electrically wind direction and velocity, rainfall and hours of sunshine It is made by Julien Friez of Baltimore. Mirador has an altitude of 1512.5 meters. It is the place for seeing clouds, sunsets and lightning. Many afternoons good sunshiny weather turns into nothing but heavy white clouds all around us, - and that in about a half an hour. Frequently one cannot see the bottom of our hill because of clouds and it is interesting to watch the clouds come up the valley and settle about us.

The sunsets here even surpass the famous ones of Manila Bay we think, and many visitors come up at evening just to see them. But the lightnings - we could watch them for hours. We get mostly sheet lightning and during it one scarcely hears a rumble of thunder. What makes the lightnings beautiful is their reflection among the cloud formations . The flashes seem to last a long time and some nights the reflections from the white clouds are so bright that one's eyes tire very quickly when watching".

The following extract from "The Seattle Daily Times" was sent to us by Mr. T. Barry. We print it as it shows the educational value of a college or university seismograph and how it is regarded by those interested in the institution and also the reputation enjoyed by the Georgetown Station even in the far west.

According to press reports Father Gianfranceschi the rector of the Gregorian University and for a number of years also professor of Physics there accompanied General Nobile's ill fated expedition to the far north. He remained however at Kings Bay during the air ship Italia's flight to the pole.

WOODSTOCK MEETING. The summer meeting of the Association as was announced in the last number of the Bulletin will take place at Woodstock. The date is August 25-27. It is hoped that there will be a large attendance of the science and mathematics teachers of the Maryland-New York and New England Provinces. All are urged to be present and to prepare a paper. The title of the latter should be sent to Mr. T.D.Barry the Secretary at Georgetown and also to the Vice-president of the section. The secretary should be informed in good season by those going to Woodstock that preparations may be made by local superiors.