The Notre Dame Scholastic

·DISCE·QUASI·SEMPER·VICTURUS· ·VIVE·QUASI·CRAS·MORITURUS·

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Tears.

SOME memory, some joy of long ago
  Grown sweet in dreaming, mellowed with the years,
Steals on me in the long day's after-glow
  And fills my void, unseeing eyes with tears.

Dreams all so sweet, so tender and so deep,
  That lisping, faltering words could never tell
Their soothing sadness,—dreams that ever keep
  Within myself, and there forever dwell.

Vain idle dreams and idle tears, in thee
  The world finds solace, and in thee all woe
Doth vanish in the misty summer sea
  Of memories of long ago.

L. P. D.

Galvanometer Scales.

RALPH L. PALMER.

IN the reading of galvanometer deflections considerable method is required in order that correct results may be attained in making measurements. In some galvanometers, such as the ordinary tangent, sine and Nobili's astatic, the deflections are read directly from the position of a pointer of glass, aluminum, or other non-magnetic substance placed so as to swing freely over a scale in the case of the single needle type, or from one of the needles in the case of the astatic form.

When great delicacy and sensitiveness are necessary, the galvanometer magnet is made extremely short and light. In order to observe the movements of the magnet a very small and light mirror is attached to it, by means of which a ray of light may be reflected to a graduated scale. In this way the slightest change in the position of the needle can be noticed.

There are several forms of reflecting galvanometers. The mirror galvanometer of Sir William Thomson affords a good example of this type. The needle, which is extremely short, is firmly attached by a silk fibre to a small concave mirror and hung in the centre of an upright coil with a small radius. The mirror is of silvered glass and, together with the small magnet which is generally a piece of magnetized watch spring, weighs only a little more than a grain.

As mentioned above, the mirror, or reflecting type of galvanometer, requires for the reading of the deflections a graduated scale. There are several methods of reading the deflections; the English and French plans, reading by means of a telescope, and another method of which I shall speak further on.

In the English method the scale—which is generally made of well-varnished paper—is graduated into millimeters and halves, or inches and parts, and is glued to a strip of wood. To the upper edge of this strip is hinged a wooden top which may be raised or lowered by an adjustment; the object of the hinged top being to shade the scale. The strip and top are fixed to a shelf which is held to a wooden base by means of a clamp-screw. In the base is cut a vertical slot which permits of adjustment for height by means of the above-mentioned clamp-screw. On the shelf is placed an ordinary paraffin lamp furnished with a copper chimney, a plane glass window in front and a concave mirror behind. In the shelf just below the scale and before the lamp is an opening through which passes a hollow cylinder. Into this latter another cylinder fits closely having a convex lens in one end and at the opposite end of the first tube a small wire is stretched across the opening. The object of the last arrangement is to focus the wire in the middle of the spot of light, the latter being reflected to the scale from the mirror. The scale is placed in a horizontal position a short distance before the galvanometer, and the image of the fine wire, which is reflected from the mirror upon the scale, serves as an index. The deflections are then read from the scale, the observer standing in front of the instrument.

There are several objections to this method. In the first place the position of the observer is necessarily at some distance from the scale, and hence the deflections are not easily read. In the second place, besides the difficulty of adjusting the scale for height, the scale and attachments being cumbersome, the lamp is a disagreeable characteristic, since there is a great deal of trouble in trimming the wick, regulating the exact placing of the lamp that a good image of the wire may be obtained.

The French plan is a far better one in many respects. The scale in this case is made of a strip of celluloid graduated into millimeters. In order to insure firmness the lower edge of the celluloid is clamped between two brass strips. These strips are attached below to a disk to which is fixed a hollow cylinder. At the end of the cylinder, facing the galvanometer, is a rectangular opening across which is stretched a fine wire.

On the back of the scale, directly behind the opening in the disk, is placed a rectangular mirror which may be moved in all directions. The object of this is to adjust the reflection of the light through the opening to the galvanometer mirror. The disk and scale are fixed rigidly to a brass post which slides in a hollow cylinder, the bottom of the cylinder having a heavy base to prevent unsteadiness.

To use this scale the galvanometer is placed a few feet in front of it. The light for the reflection must be furnished by a lamp or gas jet placed to one side of the scale. The light is reflected by means of the mirror on the scale through the opening in the disk to the mirror, then back to the scale. The deflections are read directly from the scale, the observer standing close behind it and just in front of the galvanometer. The celluloid being translucent the readings are easily and accurately made. This is a very good method; the only difficulties arise in the proper placing of the light for good reflection, and the correct adjustment of the scale mirror, and also the prevention of the direct rays from the light too strongly illuminating the scale.

The telescope method is not so desirable as the other three since it requires much more patience and time in setting up the apparatus.

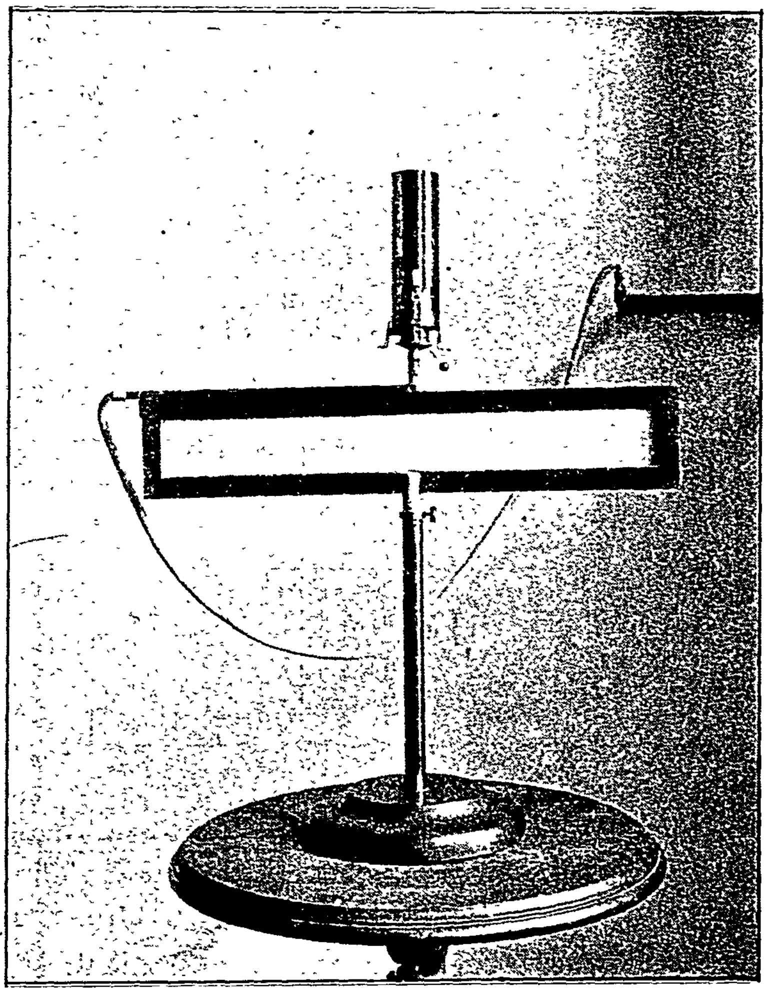
The instrument used in this method for noting the deflections is a small ordinary telescope mounted on a base of the tripod pattern. The post to which the telescope is attached carries a graduated scale, the zero of the scale being in the centre. The numbers are upside down and backwards; those to the right are colored red, those to the left black.

The scale, which can be lowered or raised, is held in place by means of a set screw. The tripod legs are each provided with a screw enabling one to level the instrument. The telescope, besides having adjustments for focusing, has also a number of screws attached by which it may be raised and lowered, or turned to the right or left.

In using this method, the telescope is placed before the galvanometer at a short distance; if placed too far, the deflection being large may pass off the scale. The scale is raised or lowered and the telescope adjusted so that the scale is reflected from the galvanometer mirror to the eye-piece. When the galvanometer needle is at rest the zero of the scale should be covered by the vertical cross-hair of the telescope. The deflections to right or left are read directly through the telescope, the scale appearing to move instead of the mirror. The great objection to this method is the fact that the telescope requires much adjustment, levelling, focusing, adjusting for height and getting a good reflection of the scale to the eye. There is also the objection that a galvanometer with a plane mirror must be used.

The fourth method involves the use of a scale and appurtenances designed and built by myself under the direction of the head of the Department of Electrical Engineering here at the University. The scale itself is made on thin ground glass ruled accurately in millimeters with the dividing engine. The scale is framed in well-seasoned black walnut, and the frame is made thick in order to prevent the light of the lamp from falling on the scale. To the centre of the frame bearing the scale is attached a maple post, this post sliding in a hollow brass cylinder on the top of which is placed a set-screw. The adjustment for height is made by sliding the post up or down in the cylinder, the set-screw holding the post firmly. The cylinder fits into a large somewhat heavy base of black walnut. To the top of the frame is firmly fastened a piece of brass tubing, one end of which projects over the end of the frame to permit of connection to a gas pipe with rubber tubing, the other end is at the centre of the frame where it is connected to an Argand gas-burner. Over the jet is placed a glass chimney and holder. The chimney is heavily coated with black asphaltum varnish, except on the side facing the galvanometer where a small rectangular aperture is left. The light passes through this space to the mirror and is then reflected below to the scale. To make the reading more accurate a fine wire is placed in the centre of the clear space on the chimney, perpendicular to the frame, so that when the spot of light is focused upon the scale the reflection of the wire permits the reading to be made most accurately.

This scale is easily adjusted, almost all light, except that needed for the reflection, can be shut off, the adjustment for height is simple,



GALVANOMETER SCALE.

as the post can be pushed up or down in the cylinder and held in place by the set-screw. The large base holds the scale firmly, and, as far as reading is concerned, which, by the way, is of most importance, the reflection of the fine wire enables one to obtain remarkably close results. The scale being so light, the focusing is easily done by moving the instrument backwards or forwards. The method is most simple, the scale very easily adjusted, there being only one adjustment and that for height.

Dividing Engine.

EUGENE A. DELANEY.—JULIUS A. ARCE.

AMONG the various machines and instruments which constitute the cabinet of a physical laboratory, the dividing engine is the simplest in principle, and most easily admits of accurate manipulation. The apparatus consists essentially of a sliding table or platform upon which is placed the object to be measured or divided. This table slides on an iron frame. As in most instruments designed for the measurement of short distances, the micrometer screw is used to propel the platform. Above the screw, and attached side by side to the frame on which the carriage moves, are a microscope and a marking point. These contrivances, modified and perfected, make up the elaborate and formidable looking machine which has proved indispensable in physical measurements.

The propelling screw is of a very regular pitch, one of its revolutions moving the table one millimeter. A circle whose circumference is divided into two hundred parts is attached to its end and provided with a vernier. On this vernier five divisions correspond to four divisions on the circle. By this attachment, the table may be propelled the almost unappreciable distance of 0.001 of a millimeter, or 0.00004 of an inch. Moreover, this wheel, which is four inches in diameter and three-fourths of an inch in thickness, is grooved on its periphery and provided with automatic stops, and any fractional parts or whole numbers of revolutions are governed by the setting of these stops, which are regulated by the grooves of the wheel.

In addition to this minute subdivision of the screw's revolution, there is the filar micrometer attachment. This attachment is used for the accurate measurement of such distances as can not be readily obtained by the use of a vernier. The micrometer is combined with a microscope whose magnifying power is from thirty to fifty diameters. Two movable measuring wires, usually of fine spider's web, are set parallel to each other in a frame which moves by means of a screw with a very fine thread. This screw is graduated into fifty divisions on the circumference.

The whole revolutions are noted by observing how many teeth of a comb-scale are passed over by the moving wires. This scale is nearly in the plane of the wires and has one tooth for each complete revolution of the screw. Fractional parts of a revolution are read on the graduated head, one of whose divisions corresponds to the 0.0008 of a millimeter, or 0.000032 of an inch.

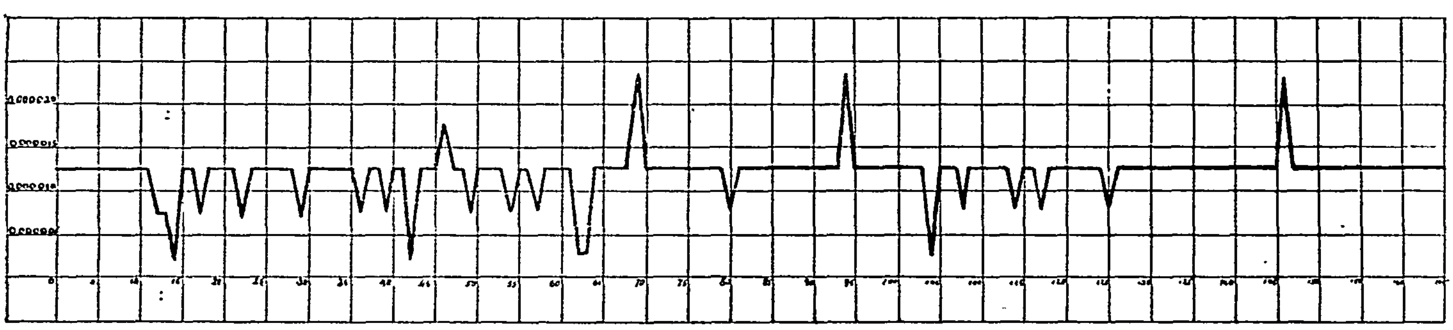
As the image, which lies in the same plane with the movable measuring threads, is always larger than the object, a given movement of the thread corresponds to a much shorter distance on the object. The relation should be such that twenty-five revolutions of the screw carry the wire over one millimeter on the image. If this condition does not exist the value of each revolution must be found by running the wires in both directions and taking the mean, called "the run of the screw." Any inequality in the pitch of the screw would also necessitate this correction.

One of the essential parts of the instrument is its tracing point or marker. This is suspended above the sliding platform from a smaller framework which is fixed to the frame on which the platform slides. It has two simultaneous motions, up and down and forward and backward. The extent of its motion—the length of the line which it may mark—is governed by a ratchet-wheel. This wheel may itself be so adjusted as to give such motion to the marker that its sharp point will trace lines of different length and mark them at desired intervals. When these attachments are set to give the required movements, the operation of the apparatus consists merely in turning the screw and moving the marker; this operation can be repeated to any desired extent. The dividing engine is used principally to mark division lines in metal rules, glass rods, etc. It is also employed to calibrate and find the error of divisions already made.

The marking of division lines in a metal bar and in a glass rod,—a thermometer stem, for instance,—is similar, the only difference being that the metal bar after it has the division lines marked in its paraffin cover is immersed in an acid, usually nitric, while the glass rod is subjected to the fumes of hydrofluoric acid which is easily obtained by treating fluor-spar with sulphuric acid.

If a steel rod is to be ruled it is first carefully covered with paraffin, and then firmly clamped to the sliding platform parallel to the motion and under the marking point. All adjustments having been made, the marker is now brought to bear on the steel; and when pressed forward, its sharp point takes away not only a thread-like curl of the wax, but also a delicate filament of the metal beneath it, leaving a naked line on the steel. This operation is repeated until a desired length of scale is marked. The steel with its newly-marked lines is now immersed in dilute nitric acid, which attacks the unprotected division lines, and in fifteen minutes they are permanently etched. The paraffin protects the main body of the scale against the acid. If both sides of the steel are to be divided, a new coating must replace the old before the marking is repeated.

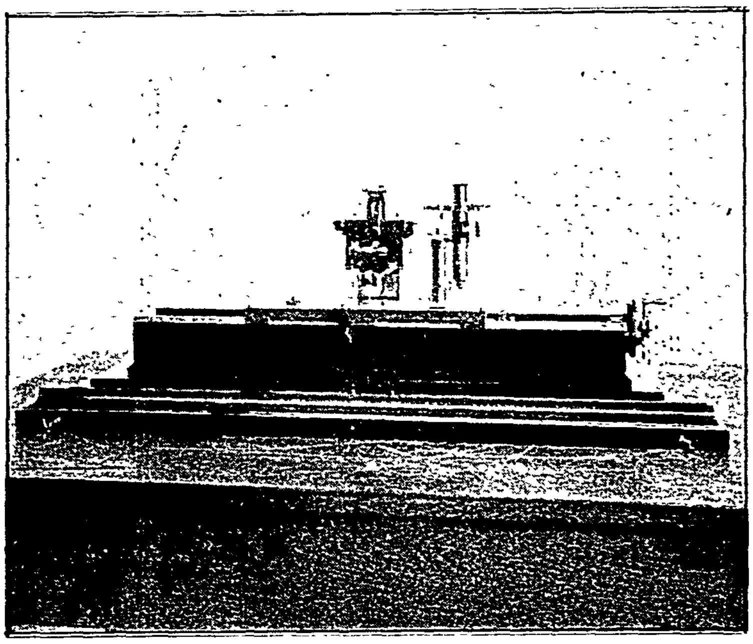
The most difficult phase of the whole operation is the covering of the prepared steel with its armament of wax. If the paraffin be melted over a hot flame and then quickly applied with a rag, the coating will be continuous and regular; heating the steel and then applying the wax leaves the edges unprotected. The scale having been prepared, it may be placed on the platform and its divisions examined. In this operation the filar micrometer is used in conjunction with the micrometer screw.



Curve showing the error of the pitch of the micrometer screw.

To calibrate the pitch of the micrometer screw a standard meter-rod is firmly clamped to the sliding table. Then one of the wires of the microscope is made to coincide with one of the divisions of the meter, and the head of the micrometer screw is turned once around. One whole revolution should bring the wire to coincide with the next millimeter division of the rod; the screw being constructed to advance the table one millimeter at each revolution.

If the hair does not quite coincide with the division of the meter rod it shows that the distance that the screw has carried the table is not a millimeter. To measure this difference or error two methods can be employed. One is by moving the wire of the microscope until it coincides with the division of the meter, and then reading in the graduated head of the microscope screw the distance through which the wire has been moved. The other method is by turning the micrometer screw until the division of the meter and the wire coincide and reading in the graduated head of the screw the distance that the table has advanced.



DIVIDING ENGINE.

In the accompanying diagram the abscissas are the divisions of the standard meter-rod; the ordinates are the error of the pitch of the screw. The scale of the abscissas is 1mm.= 1mm. In the ordinates 5mm. = 0.00001 mm. The curve thus found shows more inequalities of the pitch in the first part of the micrometer screw due to its being used most often. The 113 threads following No. 147 gave no error, and therefore is not shown in the diagram. This curve also shows that the error is generally minus: that is, one revolution of the screw is not quite one millimeter. This error varies from 0.00005 mm. (0.000002 of an inch) to 0.0001 mm. (0.000004). The error was plus in three threads only, the excess being from 0.000055 mm. (0.0000022 of an inch) to 0.0001 mm. (0.000004 of an inch.)

The Equipment of the Department of Physics.

NOTRE DAME has a collection of physical apparatus which is equal to any in this country. The pieces used to illustrate the principles of sound and music are especially numerous and of very fine workmanship. Several excellent spectroscopes, sets of prisms and lenses accurately mounted, Fresnel's mirrors and other fine pieces furnish means to do very interesting and accurate work in light. In electricity there is a valuable historical collection, beginning with the reciprocating motor, and ending with the latest form of the X ray apparatus. The following is a partial list of the more important pieces of apparatus:

In Machanics, etc:—

- Large physical balance
- Standard kilogram
- Standard meter
- Geneva cathetometer
- Dividing engine
- Atwood's machine
- Break circuit chronograph
- Powerful hydraulic press with attachments
- Rotary air pump and receivers

In Acoustics:—

- A mercadier radiophone
- Set of König resonators
- Set of electrically operated tuning forks by König.
- A Scott König phonautograph
- Large double siren
- König's movable tuning forks to draw compound curves on smoked glass
- Three sets of organ pipes.
- Three sets of fine tuning forks
- Edison phonograph
- Apparatus for manometric
- Sets of vibrating rods, tubes and bells

In Light:—

- Complete set of diffraction and interference apparatus by Solcil, Paris
- Sets of polarizing apparatus
- Two heliostats
- Sets of lenses and spherical mirrors
- Two Rowland gratings, 14,000 lines to the inch
- Sets of photographs of solar spectrum by Rowland
- Four spectroscopes
- A polarizing saccharimeter

In Heat:—

- Standard thermometers
- Melloni's apparatus for measuring radiation, absorption and reflection of heat, complete with prepared substances
- Air thermometer
- Steam engine indicator

In Electricity and Magnetism:—

- An absolute electrometer
- Ten galvanometers of various types
- Ammeters and voltmeters
- One 2000lb. electro magnet
- Seven induction coils
- Six bridges of different types
- Set of historical motors
- Standard resistance coils
- Set of storage cells.

Switch Board.

FRANK H. HESSE.

THE change in the Electrical Engineering Course here at the University requiring more extensive laboratory work, also necessitated a change in the equipment of the laboratory. Among the many new additions of this year has been a switch board, designed and built by Mr. Ralph L. Palmer and myself.

As in all other cases of designing, it was necessary to determine the requirements that would be needed in the construction of the board, the number of circuits and where they were to be placed. This being done, a working drawing was made, and the material gathered for construction. Patterns were made for all the castings used in the construction. They were made of well-seasoned wood and then given a coat of shellac to give them a smooth finish and also to keep them from warping. The castings were made of scrap brass, copper and zinc found about the laboratory.

The switch board is situated near the west wall of the dynamo room. The framework consists of two uprights 2″ × 4″ placed out about 18″ from the wall. Two of the ends are fastened to the floor; the other two were nailed to a crosspiece, which was bolted to the ceiling. On these uprights were placed four boards, 5 feet long 6″ wide and $\frac{7}{8}''$ in thickness. All the woodwork consists of well seasoned poplar and is finished on all sides. The first board was placed 3′ from the floor the ends extending out six inches from the uprights. The distance between each of the remaining three boards is 8″. On the back of the first board is placed two wooden blocks 12″ × 4″. On these blocks are fastened brass castings, which contain heavy fuses to protect the dynamos. The castings are in two pieces and form a part of the main dynamo leads. On the second board is fixed two dynamo terminal blocks and terminals for six circuits. The terminals for one circuit are set very near the dynamo terminals, so that they can be connected to the dynamo mains by little plugs which are inserted between the dynamo and the circuit terminals. The circuit terminals on the third board are four in number, and are to be used in case additional circuits are placed on the switch board. On the front of the fourth board are arranged two dynamo terminal blocks and terminals for one circuit. They are placed in the same manner as the four central blocks on board two; but the plugs used in connecting up the circuit are different from those used in the former case. On the back of this board are two blocks similar to those on the lower board. A ground detecter is situated above the top board which consists of a single branch block and part of another. These are fastened to the back of a board; the lamps are put in from the front; connections are made to the mains and a ground wire runs up the centre of the board. The grounds can be taken off by unscrewing a fuse plug which is placed on the back of the branch board.

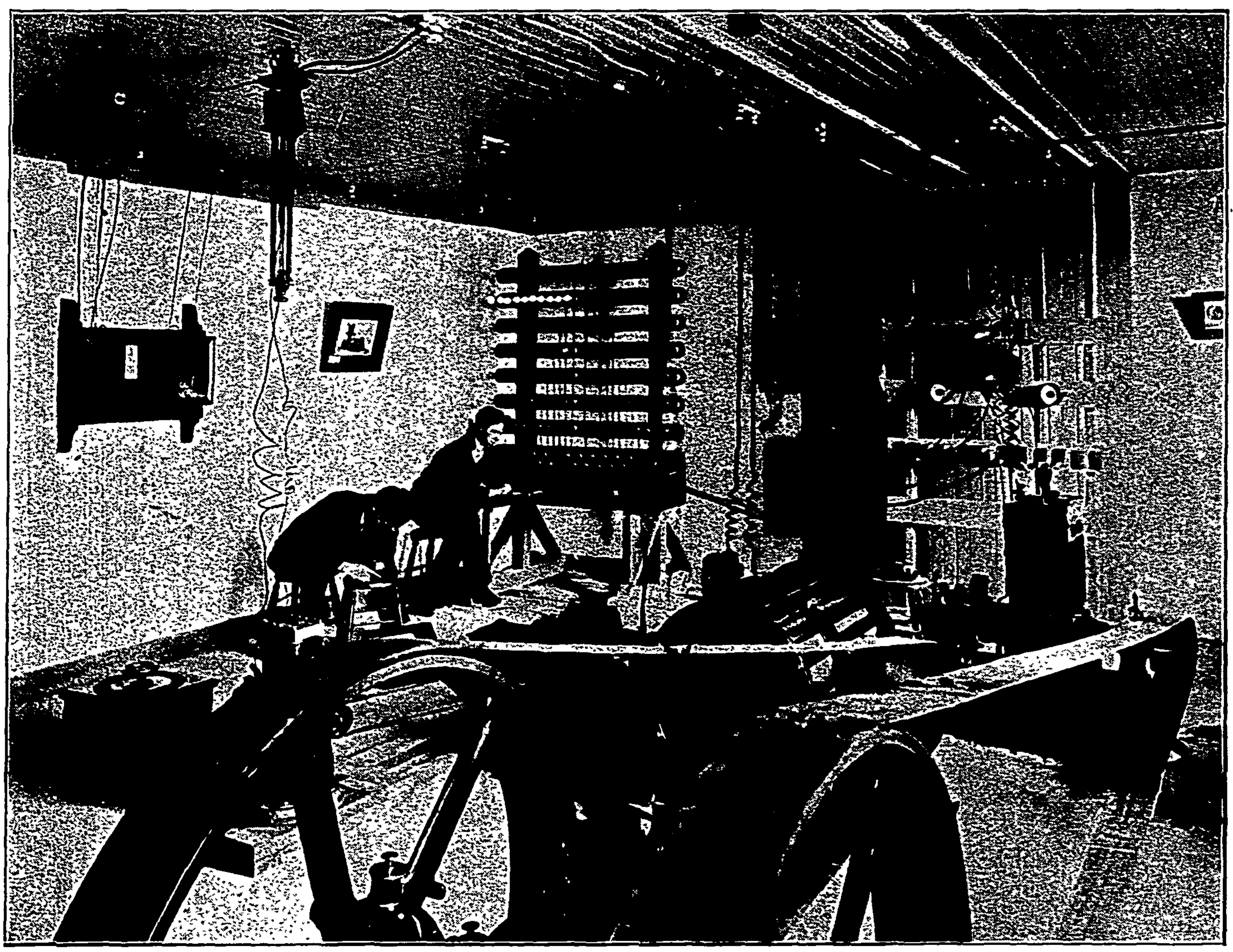
The terminal blocks were made from the castings. Those used for the dynamo terminals are 4″ × 4″ × $\frac{3}{8}''$. Four of these were used. The faces and edges were planed and four holes were bored in each one. The holes were reamed by a $\frac{3}{8}''$ taper reamer. On the back of these blocks in the centre is an extension two inches long, which is threaded at the end. The castings for the circuit terminals are 2″ × 4″ × $\frac{3}{8}''$. These were finished in the same manner as the large ones. Two holes were bored in these, so that connections can be made from one circuit to another. Twenty of these castings were used. These blocks are fastened to the board by a nut which is placed on the extension. A hole was bored where the block was to be placed. The extension fits closely in this. A washer was placed over the extension and against the board. The wire for one side of a circuit was put next to the washer; then a nut was screwed down tightly insuring good connection and making the block fast to the board at the same time. The nuts were made from a hexagonal brass casting.

The wiring is all open work, so that repairs or changes can be made easily. All the wires and castings used were of sufficient cross-section to carry any current up to the capacity of the machines. The position of the wires can be seen from the cut. The mains from the Edison machine run down the upright posts; one on each post passing through the castings on board one; then up to the large terminal blocks on the second board; from these blocks wires run up the centre of the board, terminating in the two large blocks on the back of the fourth board, the wire on the right passing through an ammeter which is set between the two upper boards. The feeders from the main power house of the University come in from the top of the switch board and terminate in the upper portion of the castings on the back of the fourth board. The upper portions of these castings are connected to the terminal blocks on the front of the board.

The first circuit on the left of the second board is connected to the arc-light generator. This can be used for a repair circuit for arc-lamps. A hanger board was placed on the ceiling of the dynamo room, upon which lamps can be hung when in need of repairs. The arc-light can also be sent up to the physical laboratory from this circuit. The other circuits are used in the electrical and physical laboratories. The circuit on the upper board is used as the feeder for Science Hall.

The plugs used in connecting the circuit on board four to the dynamo terminals were shaped like thumb screws. A small washer was placed on the back of the board at the centre of the two blocks, the plug screwed into this making contact with the dynamo and circuit terminals. Two of these plugs were used. On board two the plugs used were turned from brass; they are tapered, and fit in between the dynamo and circuit terminals. The plugs used in connecting up circuits were made as follows: a casting was made of brass; one end being made to taper so as to fit the holes in the circuit blocks. A thread was cut on the other end which screwed in a nut made of brass 1¼" long; to this nut was fastened a cable wire. A wooden handle was turned of maple and bored so that the casting would fit in it; by screwing the casting in the nut the handle was made to fit tightly. On the other end of the cable a similar arrangement was made. Four pairs of these flexible cords with plugs were also made.

The wiring was put up on porcelain insulators. The castings were polished and lacquered and the woodwork painted a light color to correspond with the other fixtures in the room. The terminal blocks are so arranged that a current can be obtained on any of the circuits either from our own laboratory plant or the main plant of the University. The switch board has been used in several experiments and found perfectly satisfactory in every respect. All the designs were submitted to the head of the department for examination and the switch board built under his direction.



DYNAMO LABORATORY.

A Convenient Lamp Rack.

STEWART MCDONALD.

THIS contrivance, designed and constructed in the Electrical Laboratories forms a means of furnishing a variable current within wide limits. It has proved itself, by reason of its extended use and accuracy, to be indispensable to the well-equipped laboratory. It was originally designed to be used as a variable resistance applicable to such work as taking dynamo characteristics and similar curves, where the current starts at zero and increasing by changes of five amperes reaches the capacity of the machine. This rack consists of 140 sixteen candle-power lamps mounted in seven rows on the skeleton frame, thus making 20 lamps to the row. All the lamps of the six upper rows were wired in parallel groups of 10, each group being controlled by a single pole snap-switch. In like manner all but three of the remaining lamps were wired in parallel and in groups of 5, 5, 3, 2 and 1, each controlled by its own switch; these three lamps were put in series and connected to a three point switch. The wiring in all possible cases was kept upon the back of the rack, and was arranged symmetrically with respect to the centre line of the contrivance. The mains, as seen in the cut of the dynamo laboratory, start from the brass plug-blocks on the right end of the switch board. Thus with the aid of a pair of "plugs" connected to flexible conductors, it is possible to operate the lamp rack in any part of the dynamo room, the source of current being either the main switch board or a machine in question.

The cut shows a convenient device used in connecting the ammeter; in its construction the lower main was cut, and two brass blocks, with an eighth of an inch intervening, were connected one to each end of the main; the blocks were cast with projections on the back, so that when they were put upon the front of the board the projections were the means of connecting with the main; binding posts were also put on each block and the adjacent ends drilled and reamed to admit a brass plug; thus it is seen that if the terminals of ammeter are connected to the binding posts, by merely putting in or pulling out the "plug," the ammeter is cut in or out.

The three lamps in series, located on the left of the last row are of great value when the rack is employed for calibrating purposes. As the current given by any ten lamps is not a constant, usually approximating five amperes, some additional current must be used to bring the pointer of the instrument to a definite reading, and thus save a long and tedious calculation to determine the mark upon the instrument in question. As one lamp in series gives 0.5 amperes, 2 lamps 0.25 and 3 lamps 0.1666 amperes, it is evident that by throwing in as near the correct number of lamps as possible and then adding the series lamps, the needle can be brought quite near to a definite standpoint. Suppose a current of 59 amperes is desired: 118 lamps should give this. By throwing on eleven of the ten lamp groups, a 5 and a 2, it should give the required current; but the chances are the amperage would be either high or low. Taking the reading as 58.83 by adding the three lamps in series the current is brought up to 59.

The contrivance as now constructed will, with the addition of a small rheostat, yield absolutely any current between 0 and 70 amperes. If for any occasion a greater range be wished, lower voltage lamps may be substituted and the range increased accordingly. The rack consisting of ten lamp groups is far in advance of the usual larger group method. Its advantages are many and varied. In the case of dynamo curves it is possible to start with infinite resistance, and successively increase the current by changes of about five amperes, there being no going back or starting over after the operation has once commenced, thus giving a true curve.

Hidden Gems in Nature.

MICHAEL M. OSWALD.

THE charms of nature, showy gifts of earth,
Have not for man alone been made. A few,
Enwrapped in rare and beauteous vesture's girth,
Has nature kept away from human view.
Before we rise our labor to renew
The nightingale has sung his sweetest lay;
The ocean counts the precious pearls his due;
The prettiest flower blooms ere dawns the day,
And dazzling gems are deep, embedded in the clay.

Methods of Determining Specific Gravity.

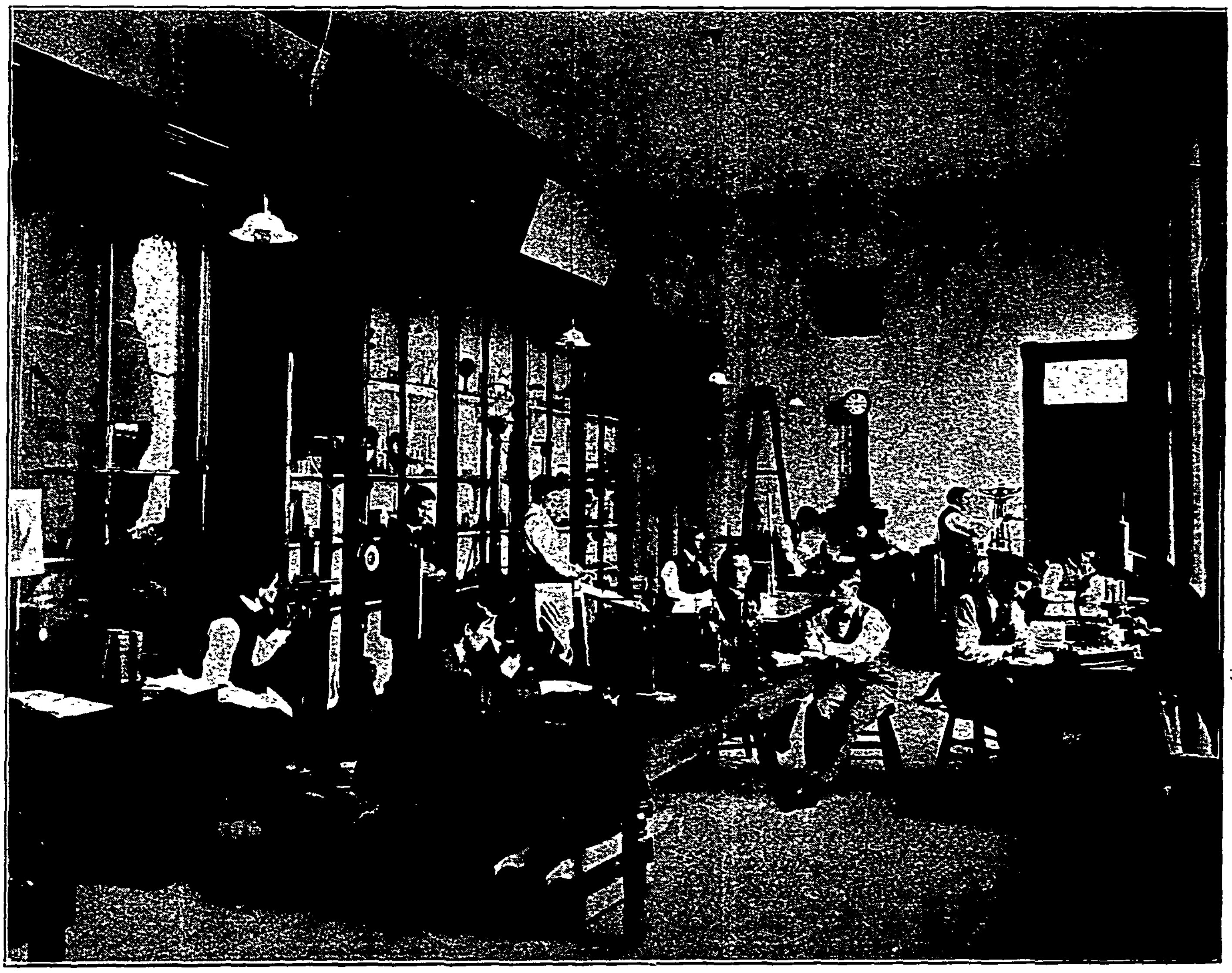
EDWARD H. PULSKAMP.

THE specific gravity of a body is the ratio of the weight of the body in air to the weight of an equal volume of water. There are three general methods of determining the specific gravity of a solid,—by weighing the body in air and then in water; by the use of an hydrometer; by the use of the specific gravity bottle or pycnometer.

By the first method, the body is placed on a physical balance and accurately weighed. Then it is suspended in water from one arm of the balance by means of a fine wire, and the weight again noted. A string could not be used instead of the wire, since on account of capillary attraction it would absorb water and thus change the weight. The difference between the two weighings will be the weight of the water displaced by the body. Hence, by definition, we find the specific gravity by dividing the weight of the body in air by this difference. For accurate work in all the methods, the temperature of the water should be noted, and then the volumes reduced to the condition of standard temperature.

Nicholson's hydrometer is usually employed in the second method. It consists of a hollow brass cylinder, conical at both ends, with a wire longitudinally through the centre. A short distance above the cylinder, a light disk of the same diameter is fastened on the wire perpendicular to it. About midway between this disk and the cylinder, a mark is made on the wire. Below the cylinder, the wire terminates in a hook from which is suspended a piece of brass of the same diameter as the cylinder, flat on the upper surface and conical on the lower. This is the heaviest part of the apparatus and hence serves to keep the axis of the hydrometer in a position perpendicular to the surface of the water.

When the hydrometer is in use, it is placed in water, and the body whose specific gravity is to be found is put on the disk above the cylinder. Then weights are placed on this same disk until the mark on the wire coincides



PHYSICAL LABORATORY.

with the surface of the water. Next the body is placed on the lower piece of brass, and weights are placed on the disk above sufficient to make the mark coincide with the surface of the water again. The difference between the weights used in the two cases will be the weight of the water displaced. To find the weight of the body in air by means of the hydrometer, balance the hydrometer in water and note the weights used. Next place the body on the upper disk and again note the weights required to balance. The difference between the weights used in the two cases will be the weight of the body in air. Hence we can find the specific gravity by dividing the weight of the body in air by the weight of the water displaced. The following results were obtained for a piece of glass:

Weight used to balance glass above water........	.57
Weight used to balance glass below water........	3.824
Weight used to balance hydrometer without glass	9.54
Weight of the water displaced....................	3.254
Weight of the glass in air........................	8.97
Specific gravity of the glass......................	2.75

The specific gravity bottle is a sort of flask with one rather large mouth in which is carefully fitted a thermometer. The solid whose specific gravity is to be found is also inserted through this opening. Another opening through a very fine tube is found on one side of this larger one. The tube has a mark on it, so that when the bottle is used the exact amount of water required can easily be found, since just enough is put in to make it reach this mark. First weigh the solid in air together with the specific gravity bottle filled with water up to the mark. Then put the solid into the bottle and take out water until the level is the same as it was before. The difference between the two weighings will be the weight of the water displaced. Weigh the body in air, and the result divided by the weight of the water it displaces gives the specific gravity. This is also the most convenient method of finding the specific gravity of a solid in a powdered state.

When a solid is lighter than its own volume of water, a sinker is employed. This sinker may be of any material so long as it is insoluble in water and does not absorb it, and is sufficiently heavy to hold the given solid under water. By the first method, the sinker may be suspended in water by means of a fine wire from the arm of the balance on which the solid is placed to be weighed. Before placing the solid on the scale, balance the sinker suspended in water by putting pieces of iron, lead, or anything else on the other arm; then the weight of the sinker need not be determined. Next place the solid on the arm of the balance from which the sinker is suspended and note the weights required to balance. Then attach the solid to the sinker in the water and again note the weights required to balance. The difference between the weights used in the two cases will be the weight of the water displaced by the solid. Then the solid is weighed in air, and the rule for finding the specific gravity is the same as for heavy bodies.

In the second method, no sinker need be employed; but when the solid is placed on the lower part of the hydrometer it must be fastened to it; otherwise the process is the same as though the substance were heavier than water.

When the specific gravity bottle is used for such a substance, a sinker must be employed, and is put into the bottle before the latter is weighed. When the solid is put into the bottle, it is attached to the sinker; otherwise the operations are the same as described before. When the body whose specific gravity is to be found is soluble in water, the same methods are used as for other solids, except that some other liquid of known specific gravity in which the substance is insoluble is used instead of water. The specific gravity is then found by multiplying the specific gravity of the liquid used by the number obtained from the experiment.

Hydrometers are generally employed for liquids. An ordinary hydrometer for liquids consists of a glass tube containing a scale whose zero mark is obtained by immersing the instrument in distilled water at a known temperature. A scratch is then made at the surface of the water. The temperature according to which the scale is made is also marked, so that in experimenting the results can be reduced to any desired temperature. Below this tube is a glass bulb containing mercury which serves to keep the instrument in a vertical position.

For liquids heavier than water, the zero of the scale is at the top, for lighter liquids it is at the bottom. Another point, fifteen, is obtained by immersing the instrument in a solution of eighty-five parts of water and fifteen parts of salt. The distance between these two points is divided into fifteen equal parts, and the graduation may be continued by laying off these small distances on other parts of the tube.

Optical Lever.

STEWART MCDONALD.

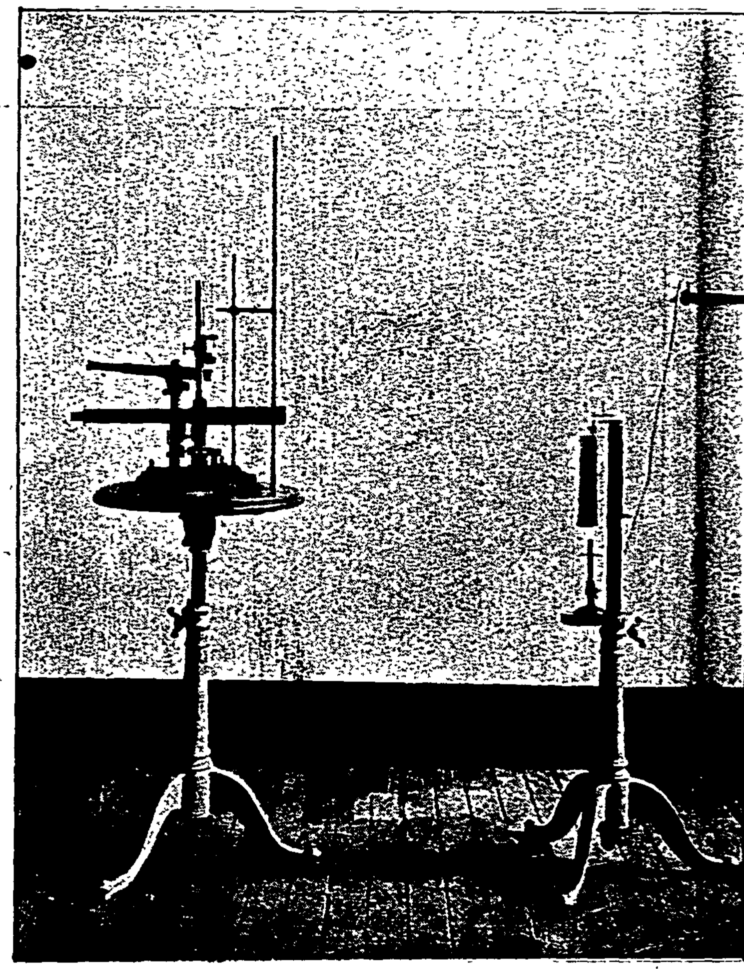
THIS instrument offers a most exact method by which the coefficient of expansion of metal bars can be determined. It was designed and used in the Physical Laboratory of Notre Dame University.

The accompanying photographic cut shows the detailed method of arrangement. As seen in the figure, the apparatus consists of a special calorimeter, with openings in the top to admit the bar to be measured, and a thermometer. In its construction solder was in all possible cases avoided, seamed joints being used instead. Thus a greater range of temperature can be safely used. About an inch from the bottom of this vessel and coincident with its diameter, an iron bar 4″ long and $\frac{7}{16}$″ thick was run through and securely soldered to both sides. At a point directly below the opening for the bar to be experimented upon, a conical depression was made in the iron crosspiece large enough to admit the base of the bar.

The expansion of the bar is made evident by motion in the upward direction only. The protruding piece of this supporting-bar is securely screwed into the wooden upright of the stand, which is constructed of wood because it can not conduct heat, and therefore does not expand under the imposed conditions. In this way a constant foundation is obtained.

Resting partially upon the upright and upon the top of the bar is placed the optical lever, which was made in the workshop of the Department of Electrical Engineering. The base of the instrument is a solid piece of brass five centimeters long, two and one-half centimeters wide and four millimeters thick. At each side near one end is securely fixed a pointed steel pin at right angles to the base; and through the other end, which has the corners cut off, is placed a brass thumb screw, so that the distance of its point from the base can be varied. On the upper side is placed a small plane mirror three centimeters high and as wide as the base, securely fixed by means of its brass frame at right angles to the base. In this mirror the reflection from the scale is read by means of a short focus telescope set up opposite it as shown.

In using the instrument the bar to be measured is placed in the calorimeter, resting upon its support and held in position at the top by a cork. A centigrade thermometer is next run through a cork; and before putting it in place the vessel is filled to within an inch of the top with water (oil if greater range is wished); the thermometer is then adjusted. The optical lever is now set in position, and by means of the set screw is made to reflect any particular number of the scale which is placed at right angles to the plane of the table and so arranged that its reflection in the mirror can be seen



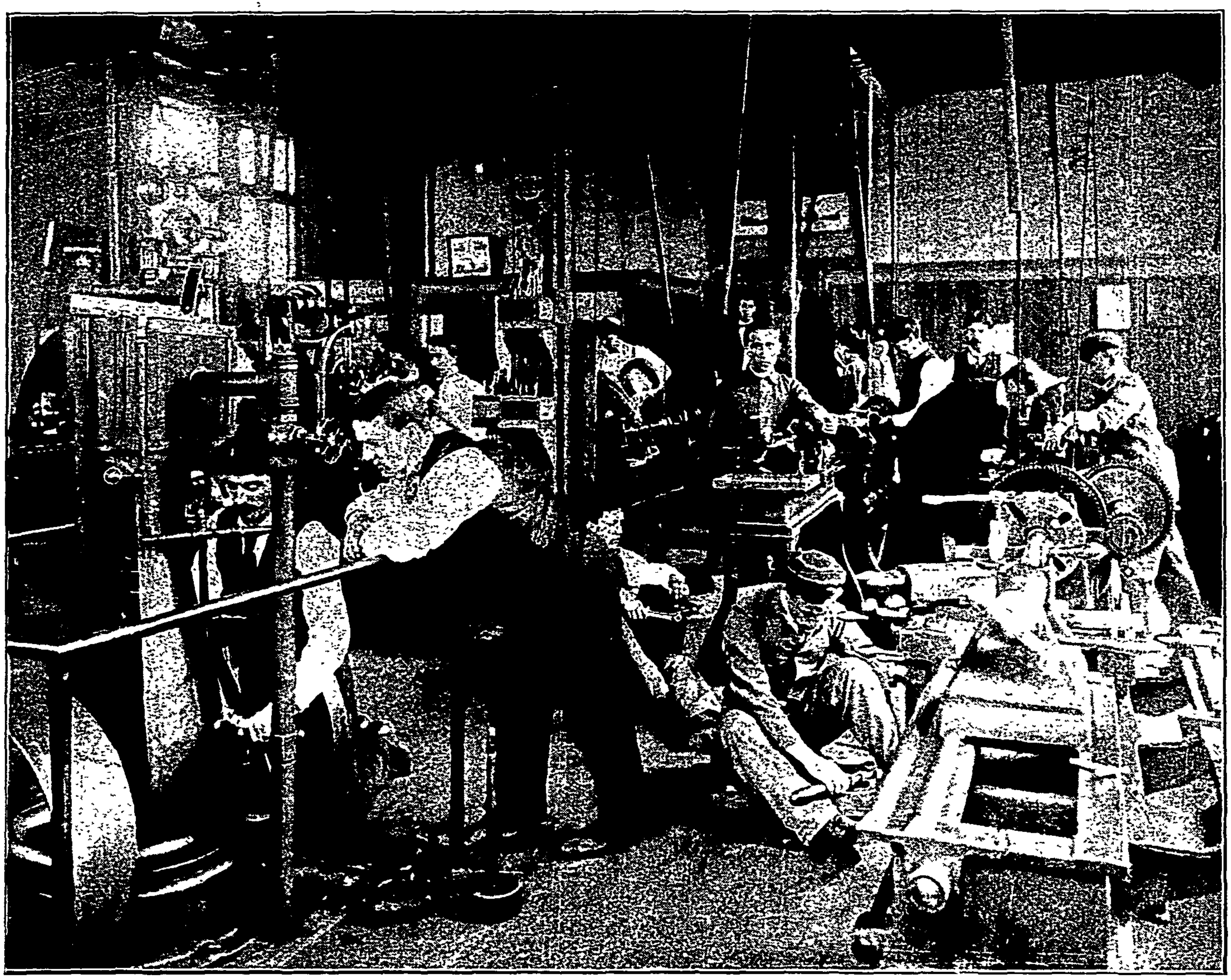
TWO TELESCOPES. OPTICAL LEVER.

through the telescope. For convenience in calculation the scale is usually placed at some even number of centimeters from the back of the mirror. A second telescope is used to read the thermometer; thus inaccuracy due to parallax is avoided.

With everything in readiness the temperature is taken, and with the first reading on the scale as zero, a gentle heat is applied to the bottom of the calorimeter by means of a Bunsen burner. At intervals the time, temperature and scale reading are taken. Often during the heating it is well to take the source of heat away from the vessel and let the bar expand from the effects of the heat in the water. As the bar elongates under the influence of the heat it expands, raising the head pin of the lever. The base turns on a line passing through the points of the two fixed pins as an axis, and moves through an angle α, registered on the scale according to the principles of optics as 2α.

If n is the number of scale divisions between the first and last reading by reflection from the mirror on the lever, and l' the amount the bar expands, R the distance of scale from *back* of mirror, and r the "lever constant," that is the distance on the lever from the point of the head pin to a point half way between the points of the other two pins, then

$$\frac{r}{n} : R :: l' : r$$



MACHINE SHOP.

Thus if the length of the bar at any temperature τ is l, and for any other temperature τ', the length is $l + l' = l''$, then

$$l'' = l \left[1 + \beta \left(\tau' - \tau \right) \right] \text{ or } \beta = \frac{l'' - l}{l \left(\tau' - \tau \right)}$$

where β is the coefficient of linear expansion.

The results derived from this method were very satisfactory. For brass β was found to be .00001976, the published results being .00001906, a difference of only .0000007. For zinc the difference was .00000015 and for steel .00000021.

A Chat with the Mechanical Engineers.

THE COURSE IN GENERAL.

WITH the modern developments and improvements in machinery and its application, the field of engineering has become greatly enlarged. Although our educational institutions are turning out thousands of young engineers annually, the demand for young men who have had the advantages of a theoretical training, far exceeds the supply. Manufacturers and business men realize the advantage to be gained from the employment of college men, knowing well that after the theory has been mastered, the practical part of the work is more quickly and effectually acquired. In the early part of this year the *American Machinist* corresponded with over two hundred of the leading manufacturing firms of this country regarding the apprenticeship of college graduates. The replies show that it is the custom of more than seventy-five per cent. of the firms to receive apprentices, and of these ninety-two per cent. consider the system satisfactory.

It is the purpose of the course in mechanical engineering to prepare young men for assuming the duties of some branch of the profession of engineering. Special attention is paid to the inculcation of the practical principles involved, the course being modelled in the twofold belief that a thorough fundamental training is essential to success in engineering, and that this training is best secured by a study of the practical application of the theoretical principles involved. Students applying for admission to the course should be strong in both pure and applied mathemaics and in physics, in consequence of their direct influence on the course. The courses given which adhere most closely to mechanical engineering are as follows:

(1) THERMODYNAMICS.—This treats of the laws of thermodynamics of gases, saturated vapors and superheated steam, the theory of steam and other heat engines, analysis of indicator cards, and the study of prime movers, governors, injectors and refrigerating machines.

(2) MATERIALS OF CONSTRUCTION.—This is a study of the manufacture, properties and uses of iron, steel and the alloys, and of the strength, ductility and resistance of materials as affected in loading.

(3) STEAM ENGINE DESIGN.—During the first session of the senior year the student is expected to make a study of the forms and sizes of steam engines, and to design the simple, non-condensing type. The second session is occupied in designing a multiple-expansion and condensing engine for marine service.

(4) KINEMATICS.—This is a geometrical study of machinery and includes the theory of cams and gear teeth, the motion of machine parts and the study of kinematic trains.

(5) MACHINE DESIGN.—This course treats of the proper form, strength and size given to parts of machines in designing, and of power transmission by means of belts, toothed wheels and ropes.

(6) VALVE GEARS.—This gives the student a thorough acquaintance with the various makes of valves in the market; the method of designing and adjusting slide valves, Corliss and Green valves, link motions and shifting eccentrics.

(7) MECHANICAL LABORATORY.—During the summer there will be placed in the laboratory a 100,000 pound automatic and autographic, testing machine, which will enable students to become familliar with the properties of materials under actual strain. Further work in the course consists of testing, under various running conditions, steam engines and other motors, including gas and hot-air engines. There are also boiler trials, injector and governor tests with the use of the prony brake and other dynamometers.

(8) SHOP WORK.—The principles of carpentry and the uses of the turning lathe are taught first. Pattern making is then taken up, which involves the application of both carpentry and turning. When sufficient skill has been attained the work of the blacksmith shop is taught. Iron and steel working are followed up in detail until the student is prepared to make the machine tools needed in the shop.

The machine work, which finishes the course, extending over two years, is designed to acquaint thoroughly the student with iron and steel work of any kind. Chipping and draw-filing are first taught, and this is followed by easy exercises on the lathe. More accurate work is then required on the lathe, planer and milling machine until the student finally is required to construct, as a graduating piece, a complete mechanism of approved design.

The equipment is thorough in all respects. The wood shop is supplied with circular and jig saws, planing and mortising machines, a planer and lathes for turning, with a full complement of all the smaller tools necessary. In the iron working shops the latest improved lathes have been provided. Two drill presses, a shaper, a planer and a Brown and Sharpe milling machine with other specially designed machines complete the equipment. During the ensuing year the advanced students will undertake the design and construction, from an original design, of a rotary steam engine. Its efficiency under various running conditions will then be determined by testing in the mechanical laboratory.

The second session of the senior year is largely taken up in the preparation of a graduating thesis. This work embodies the culminating effort of the course and is expected to be replete with originality. Some subject embracing experimental investigation, original research or designing, to be approved by the instructor, is selected, and a complete study of the same is made. Here especially the student is taught to depend as much as possible upon his own resources and abilities in exercising his ingenuity.

W. L. B.

The Course in Shop Work.

AS the object of the course is to give the student a thorough training in the theoretical principles underlying the science of machines and mechanics, and at the same time to enable him to become practically familiar with their numerous applications, advantage is taken of the profusely equipped shops of the University, and a complete course in practical work is taken under competent instructors.

Starting in the wood shop, the beginner is first taught the fundemental principles of carpentry. The more ordinary constructions such as joints, boxes and dove-tailing are particularly dwelt upon. Then he gradually becomes acquainted with the use of the circular and band saws, revolving planers and other machinery adapted to the heavier work in wood.

The lathe is next taken up, and as considerable time is spent upon this a reasonable amount of accuracy is expected. At first the student follows the exercises laid down by the instructor designed to acquaint him with the tools, and works from a drawing or pattern. After these the choice of work is left much to the student himself, thus giving him an opportunity to display his taste or originality.

Passing from the wood shop the foundry is the next subject in question. Its equipment consists of an eighteen inch cupola, with all the necessary sand, ladles, crane and flasks for making castings. The student thoroughly masters the principles of working such a shop, and derives a fair degree of proficiency. Likewise at the forge, which is next taken up, mediocre work only is expected, as it would be impossible in the short time spent to turn out competent smiths. However, sufficient skill, such as will enable the student to shape and temper tools and overcome such obstacles as are ordinarily met with, is in all cases expected.

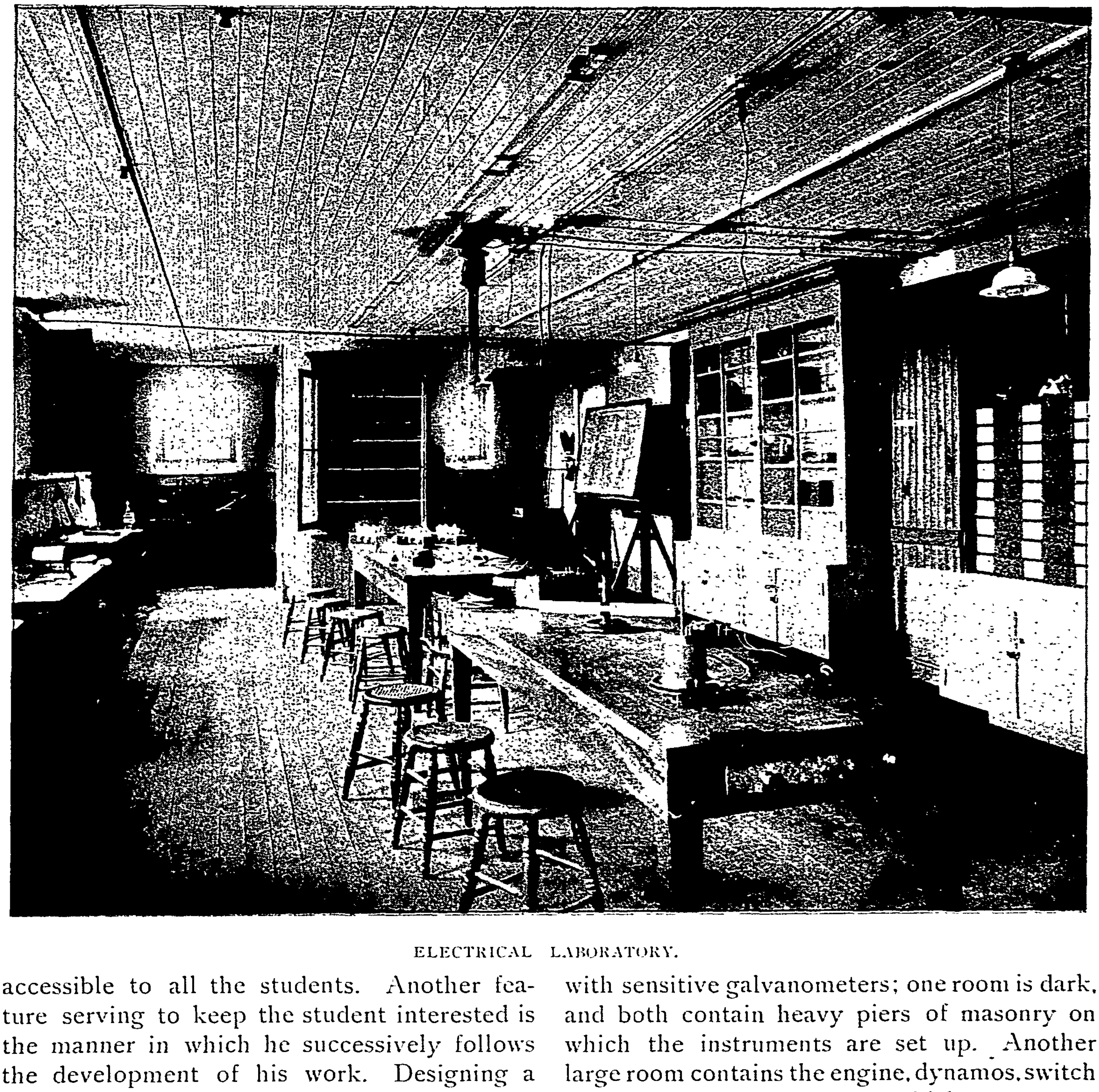
WOODWORKING SHOP.

The student is now supposed to be sufficiently accustomed to work around machines to justify his admittance into the machine-shop. Here, as in the wood-shop, the working drawings are followed out, these calling for exercises upon the lathe, planer, shaper, or milling machine; the work upon the cumbersome machinery is made particularly thorough. After the customary exercises are finished the students take up the construction of some original piece, frequently in connection with their course; for instance, those in the Mechanical Department make small engines, while the Electrical students usually build dynamos.

To create an interest in the work the department is supplied with a number of modern mechanical books and perodicals, which are accessible to all the students. Another feature serving to keep the student interested is the manner in which he successively follows the development of his work. Designing a piece in the drawing room, in the wood-shop he makes the pattern, casts and forges the parts, and finishes them in the machine-shop. Thus he sees that he is the creator of the piece, and consequently feels a special interest therein. STEWART McDONALD.

Electrical Laboratory.

THE illustration on this page shows one of the rooms used for practical electrical work. The instruments and smaller pieces of apparatus are kept in the cases in this room. The bookcase contains files of the leading electrical papers and scopes of the standard works on subjects relating to the application of electricity. Besides this room the department occupies four other rooms on this floor: two in front are arranged for work with sensitive galvanometers; one room is dark, and both contain heavy piers of masonry on which the instruments are set up. Another large room contains the engine, dynamos, switch board, etc., an illustration of which appears on another page. Adjoining the dynamo laboratory is a smaller room which contains an engine shafting, a plating dynamo and buffer, also a power lathe with full sets of tools and attachments for turning wood and iron.



ELECTRICAL LABORATORY.

Some Props for a University Extension.

CHARLES M. B. BRYAN, LITT. B., '97.

IT is always with pleasure that I read any of the articles of the Rev. Rueben Parsons; for he is always thorough in his work, showing an intimate acquaintance with his subject and backing up his opinions with cogent reasons and good authorities. Withal he is impartial, and this virtue always lends a new charm to history. Most men seem oblivious of the fact that there is a mechanical part of history; a science, as it were, on which the art is based and which demands the accuracy of research and the exactness that every other science must obtain. They deal only with the artistic part of the historian's labor, and seem to think that a glittering style will cover multitudes of errors and misstatements. They make themselves, thus, partisans who seek to *make* us believe their views, when their sphere is but to delve into the mists of bygone times and mine the gold of truth that we may see it.

Prejudice is shown most strongly when religious matters are treated in the course of an historical work. Bigots there are of all kinds—bigots without the Church, who malign all that bears the Catholic stamp, and bigots even within the fold who will see no fault and admit no stain in what *their* Church has done. A mean view there is, no doubt,—a view that the historian must take—and this mean seems to have been followed by Father Parsons, despite the prefix to his name.

A good example of his methods and his style is to be found in his articles on "Some Props for a University Extension," which recently appeared in the *Ave Maria*. True, as this work is something of a polemic against a history published by the board of University Extensioners, the author's style is sometimes biting, and perhaps a bit more rough and conversational than the usual smooth diction of his works. He seems himself to be aware of this; for several times he checks himself in the midst of what bids fair to be a fierce denunciation or long argument, with the remark that his work is not polemic but critical. However, I can see that, despite the temptation to launch forth into condemnation of his adversaries, he is mindful of his duty as an historian. I gave myself over, then, to the reading of his writings, convinced that I would find therein bits of curious learning and much *real* history.

Needless it is to say that he completely demolished the fallacious statements of the writers for *Progress*. Many of the assertions were mere resurrections of lies that have been for ages trumped up against the Church, her rulers and her methods, and many were mere distortions of the truth, to fit the arguments of these mock-historians. Father Parsons has reburied these statements beneath such a weight of authority and such strong arguments that there can never rise again in the mind of any one who reads his articles question of the Church's innocence.

The true origin of the temporal power of the Papacy is most clearly shown, and the flimsy statement that it was based on the forged Isidorian Decretals so exposed that it loses all of its seeming probability. In regard to the Eastern Church he shows us many things of which, as he supposes, good Catholics are often ignorant. For my part I know that, although possessed of a shady sort of an idea about Copts and Eutychians, Nestorians and Greeks, I had no notion of the actual number of sects in the so-called Eastern Church nor of the clearness of the lines of demarcation that separate them one from another.

The often-repeated charges against the so-called bad popes are next considered, the great mass of falsehoods torn away, and the little grain of truth left for us to see and judge of. Father Parsons shows how very small this grain really was and how slight a foundation it is on which to rest an accusation as sweeping and as bold as the editors of *Progress* have advanced. St. Louis is next justified, and the utter untruth of the charge that he was cruel and inhospitable to Pope Innocent IV. exposed.

Then having shown the errors that the Extensioners have directly committed he shows that they have been guilty of faults no less serious through omission of the good that Catholics have done. The part of Stephen Langton in the great popular uprising which wrested from King John England's first charter of liberties, is clearly shown, and the injustice of which *Progress* has been guilty in ignoring him made plain.

Other questions that have been often mooted are also most lucidly explained, the series closing with an account of the true nature of the Reformation in England. In all the articles is seen the same scholarly insight and keen cirtical spirit which has won the author the reputation that he bears.

Books and Magazines.

LECTURES ON LITERATURE. By Richard Malcolm Johnston. Akron, Ohio: D. H. McBride & Co.

The latest of the seven volumes which now comprise the Catholic Summer and Winter School Library is a collection of "Lectures on Literature" by Richard Malcolm Johnston. The book is divided into three parts. In the first part he discusses the early English drama, beginning with Nicholas Udall and closing his six chapters on the subject with a treatment of Massinger's Works. In this manner he makes a critical study of the plays of fourteen authors, and while necessarily comprehensive, still gives the reader a wide view of this field of literature and points out very plainly the comparative value of the dramas he takes into consideration. In the second portion of the book, which relates to French literature, Mr. Johnston treats of Montaigne the essayist, then of the exponents of the French Renaissance, of that body of men known as the Pleiade, of Corneille the dramatist, and Boileau the critic and satirist. Following this is a chapter on the Age of Louis XIV. After indicating the influences that strengthened the hold of classicism on French literature, he takes up in succession the lives and works of Racine, Molière, Lafontaine, Bossuet, Bourdaloue, Massillon and Fenelon. The third chapter in this division is devoted to Diderot, Voltaire and Rousseau.

The last part of the book is on Spanish literature. Some critical remarks are made regarding the rise of Ballad Poetry; this is followed by a study of Cervantes, Mendoza and Aleman. Finally, we have a chapter on the Spanish drama. Altogether, the book is one which deserves to be read carefully. Mr. Johnston strengthens his reputation as a literary critic, and has benefited in a special manner those students who are anxious to get a general knowledge of comparative literature.

—The July number of *The Young Catholic*—a journal published by the Paulist Fathers in New York—contains a notable article dealing with the education of the blind in France. The contribution is under the caption, "A Strange College Examination," and is written to show what proficiency is displayed by the blind in reading and writing. Illustrations are given showing the way in which the letters are printed both in the Braille system and in that of Mlle. Multo. Of one of her most remarkable students, *The Young Catholic* has this to say:

"M. Vento was a pupil of Mlle. Mulot in her little school at Angers, France. After he had gone as far as she could take him, he continued his education under Rev. Father Goupille, of the college of the Congregation of the Holy Cross, at Neuilly, who made up his mind that M. Vento should have a university degree, and pass his entrance examination like any other bright young fellow. So he did. The examiners of the Sorbonne were very much surprised to see a blind man before them; but they gave him exactly the same questions as they did the others, and found that he wrote his answers just as quickly." Then follows a letter written by another pupil of Mlle. Multo to the Very Rev. G. Français, C. S. C. The article contains portraits of Mlle. Multo, Rev. Father Goupille and M. Vento. 'Tis a very instructive paper, and will undoubtedly attract a great deal of attention.

—*Harper's* for August has for its frontispiece a full-page color drawing, from a painting by Frederic Remington, to illustrate a story by the same gentleman. Mr. Remington is better known as a worker in black-and-white, though he tells a story with careful attention to details, and has shown that he can mix colors that harmonize. Richard Harding Davis, in an article on the Presidential Inauguration gives a graphic description of the scenes of the last fourth of March, and tells the American people some plain and homely truths. Mr. Davis' position is well taken, and we are tempted to quote from his article, but our space denies us the pleasure. The political life of the Boer people is treated in the tenth paper of "White Man's Africa" by Poultney Bigelow. In sharp contrast with Boer government are shown the mistakes and misgovernment of the British in Africa. The two serial stories, "The Kentuckians" by John Fox, Jr., and "The Great Stone of Sardis" by Stockton, are well sustained. F. Hopkinson Smith writes interestingly of the Hungarian National Millennium Exposition. Other articles of interest are "A State in Arms against the Caterpillar," and the second paper of "The Century's Progress in Physics," treating of ether and ponderable matter. This number of the magazine also contains seven short stories and three poems. In the Editor's Drawer the comedy "A Prearranged Accident" should have been cast in any form but the dramatic. The illustrations of the entire number are excellent.

NOTRE DAME SCHOLASTIC.

Notre Dame, August, 1897.

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EDITORS have changed since the days when Horace Greeley delivered his famous dictum: "Of all horned cattle, the worst is the college graduate." The editor of *The Century* announces that three prizes of $250 may be competed for each year until 1900 by students who receive the degree of Bachelor of Arts at any American college or university during 1897, '98 or '99. One award will be made for the best metrical writing of not fewer than fifty lines; another for the best essay in biography, history or literary criticism of not fewer than 4000 or more than 8000 words; and a third for the best story of not fewer than 4000 and not more than 8000 words. Copy must be typewritten and forwarded to the editor of *The Century* before the first of June following the year of graduation.

A NEWSPAPER man who reported the Harvard-Cornell boat-race, jotted down some of the conversation overheard among the young collegians, "We won't do a thing to them," said a Cornell man, referring to the Harvard crew. "Get onto their jags" was the smart comment of one of Yale's sons. We regret that the older colleges show such signs of degeneration. There was some strength in the ancient college slang—*banger, snab, smear, doggy, mucker, waggle, fresh, flunk, etc.*—but the expressions quoted above are silly to the point of idiocy.

We believe it is Mr. Crawford, the novelist, who says that profanity is the last resort of men who don't know their language well enough to express themselves forcibly in good English; and slang, at the best, is little better than profanity. It is hard to believe in the moral rectitude of a college man who is too indolent to express himself in decent English.

To Students and Parents.

NO announcement could be more welcome to the friends of the University than that its standard of scholarship has been raised still higher and its educational facilities multiplied and improved. Progress has always been the watchword at Notre Dame, but we trust it may be said without undue violence to modesty that no other year in the history of the University has witnessed such a marked advance in the direction of the highest education.

Of the classical, literary and scientific courses it is enough to say that there has been a broadening and deepening of their scope and a strengthening of the teaching staff. The courses of electrical and mechanical engineering have been remodelled with the utmost painstaking and equipped with the latest machinery for illustration and experiment. A special bulletin describing these courses of study in detail has been issued by the University and will be sent to any address on application.

The law course at Notre Dame is reputed by lawyers and jurists to be one of the most comprehensive and practical in the United States. But the "crowding" of the legal profession has enforced a higher standard among college men; hence the requirements for admission to this course have been made more stringent, and the scope of legal studies has been extended.

The enlargement of Sorin Hall (in which the Junior and Senior classes have rooms) to twice its former size tells its own story. There are indications that in a few years the number of graduates in the collegiate courses will be doubled.

A word of warning to parents may not be out of place here. *Students should come to college with a well-defined purpose in mind and, if possible, with a clear view of the profession they are to follow after graduation.* A change of course after one has entered upon his studies is sometimes advisable and necessary; but to make such a change without due deliberation or sufficient reason has a demoralizing effect upon the student and results in a great loss of time. The decision to make a change of course involves such serious consequences for a whole life-time that in no case will it be recognized by the Faculty until the student has obtained the consent of parents and the Prefect of Studies.

The Latin-Americans at Notre Dame.

NOTRE DAME, grown dull and sluggish in her summer sleep, assumed the life and bustle of term-time on Thursday evening, when the Latin-American commercial delegates arrived. One more gala-night had come here in the midst of vacation, when the halls seem deserted and the cobwebs gather on the students' books.

The balcony was decorated with flags of all the nations that the delegates represented; and in the midst of all was an immense banner of the Stars and Stripes draped over the doorway and ushering the visitors into the corridor. When the band finished the march they were playing while the guests were alighting from their carriages, and when all had gathered there under the flags, President Morrissey addressed them as follows:

GENTLEMEN OF THE LATIN-AMERICAN DELEGATION:—In the name of the University of Notre Dame and of the members of the Order of the Holy Cross, under whose fostering care the institution has been raised, it gives me much pleasure to bid you a cordial welcome. Most fitting is it that, after having spent many weeks and days in studying the varied interests and the commercial possibilities of our great country, and in forming judgment of the marvellous growth of our material interests, you should drop in at some of our educational institutions and see whether or not they afford sufficient opportunities to the young men of our day for raising the standard of that commercial progressiveness which the times in which we live and the relations which should unite us demand.

While you have been, no doubt, favorably impressed with the advancement which the cities through which you have passed have made during the few years of their existence, you must have instinctively felt that the maintenance of one country's superiority over another in point of material greatness will depend largely on the kind of men that are to be the successors of those whose energy and indefatigable perseverance made possible that reciprocity of interests which today makes the two Americas join hands in brotherly admiration. To turn out young men that will bring to the further development of our country's industries minds stored and hearts filled with principles of honesty, integrity and true manhood, is the aim of an institution such as the one which has the privilege of entertaining you for a short time tonight.

With your interests are our efforts in the formation of manly character intimately connected; and hence your visit has more than an ordinary significance. It has, indeed, a special appropriateness, and as you go through our institution and see what our resources are for the mental development of those who may be entrusted to our care, may you be firmly convinced that the education which is given under the beneficent influence of religion—the education that ennobles heart as well as head—is the one that will best preserve our interests, be they commercial or otherwise.

Your visit to this home of learning and of religion is one, gentlemen, of which we shall be duly appreciative; and our highest ambition will be realized if we can flatter ourselves that your visit to Notre Dame will not be the least of the many pleasant memories which you shall bring with you to your distant homes. Once more we bid you welcome to Notre Dame.

Mr. Julius A. Arce, a student of the University from Arequipa, Peru, delivered to them in their own language an address of congratulation and welcome to Notre Dame:

SEÑORES DELEGADOS:—Gran placer me proporciona el daros bienvenida mucho mas cuanto que tengo el honor de considerarme vuestro compatriota. Aquí, latino-americanos hemos aprendido á llamarnos compatriotas. Lejos de muestro hogar y viviendo en estrecha unión hemos encontrado nuestras aspiraciones semejantes, nuestros afectos unos, similares nuestros ideales. Nosotros firmamente creemos que no es una utopia la unión de los pueblos latino-americanos y soñamos en el día en que todos unidos formando una grandiosa colectividad marchemos al frente del progreso, á la cabeza de esta gran civilización moderna, de esta apoteosis del trabajo y de la industria.

Feliz idea es la de estrechar nuestras relaciones con este país tan grande en sus adelantos industriales, tan lleno dë vigor y de hombres dotados de esa constancia que hace coronar con éxito las mas arduas empresas.

Nuestras continuas relaciones harán que junto con los productos de sus fábricas y talleres nos llegue esa gran virtud, una de las mas brillantes de los ciudadanos de esta gran República—Energía. Aquí pordoquiera que paseis la vista encontrareis testimonios de élla, vereis que una ciudad se levanta donde pocos años ha salvajes aboríjenes tendían sus tiendas, que una gran capital surge del montón de ruinas de una destruida aldea. Notre Dame, Señores, no es sino el producto de labor y energía. Medio siglo hace bosques poblados por incultos indíjenas ocupaban lo que es hoy la gran Universidad y estos soberbios edificios tuvieron su principio en una humilde escuela fabricada de groseros troncos. Energía—he aquí la palabra mágica, dejadla entrar á nuestro querido suelo y vereis en que corto tiempo tomamos el sitio que nos corresponde por nuestras virtudes legadas de nuestros abuelos los dominadores y verdaderos civilizadores del mundo.

Vosotros por vuestros esfuerzos por el adelanto y fomento del comercio os haceis acreedores á toda nuestra gratitud pues contribuis á que entremos, á grandes pasos, á la senda del progreso á la vía de ser grandes. Los estudiantes latino-americanos de Notre Dame iremos á ayudaros en vuestra noble empresa iremos á secundar vuestros anhelos y en cualquier posición en que nos encontremos nuestro lema será siempre "Pro Deo et Patria." Notre Dame así nos lo enseña, así lo espera de nosotros.

Siento hayais llegado cuando la Universidad ha concluido sus labores y no podais tener la oportunidad de observar como esta gran institución cumple sus funciones de educar. Hubiera querido hubieseis notado por vosotros mismos ese gran distintivo de Notre Dame, ese primordial deseo de su Facultad de formar carácter, porque Notre Dame no solo da instrución sino que se esfuerza por hacer de sus alumnos hombres de constancia y de trabajo, hombres laboriosos de principios firmes y elevadas miras, ciudadanos leales al gobierno constituído, fieles observantes de la ley que sepan respetar la conciencia y libertad de sus conciudadanos.

También siento que á causa de la suspensión de estudios no encontreis sino una muy pequeña parte de los estudiantes latino-americanos, hubieramos querido presenciaceis nuestros esfuerzos para mantener incolumne el nombre de nuestra patria y que contemplaceis la unión y armonía de nuestra pequeña América latina de Notre Dame.

Señores, en nombre de los estudiantes y en particular de vuestros compatriotas os doy bienvenida.

On the part of the delegates Mr. Arthur S. Hitchings of Rio Janeiro gave thanks to the President, and spoke in substance, as an answer to Mr. Arce, the following words in Portuguese:

"Now I will address you in my own language. The welcome of this evening is indeed a surprise, and I assure you we appreciate the honor you do us. If we Latin-Americans desire to become great nations, we must become united; and to foster this union nothing is better than our common religion. In our countries we are apt to grow careless of our duties; but here we see noble examples of faith preserved pure and firm and inculcated into the minds of the younger generation which will soon take charge of your country. It is an example for us to follow."

Then the crowd broke loose and scattered hither and thither through the buildings. Some found rest in the parlor and corridors where the seemingly carelessly-arranged cut-flowers, the tiny, dazzling lights, with their colored shades, the shifting, stirring people filled the quiet halls with unwonted excitement. Some, tired with journeying and sightseeing, sat on the lawn and listened to the band concert, taking advantage of whatever coolness and idle breeze blew up. After an interval of rest the word was given, and all passed into the refectory to dinner. There, as from the first, formality was left in the background. Everyone was free and jovial, and many a jest passed from table to table. Mr. Studebaker had the honor of making the only after-dinner speech.

Out in the open air again smoking and chatting, they whiled away the rest of the evening. When the hour of departure came Mauro Fernandez, of San José, Costa Rica, gathered a small circle of his delegates at one corner of the lawn, and, bringing President Morrissey to them, gave him thanks in a most heartfelt speech. He spoke of their receptions at Yale, Harvard and other large colleges, but never before in all their journey were they received by the faculty, nor did their reception seem so home-like or pleasant. The carriages then rolled up, the *au revoirs*, *adioses*, and good-byes were said, and Notre Dame's distinguished guests had come and gone.

The Department of Drawing.

THE primary object of drawing, as taught at Notre Dame is to cultivate the faculty of attention. What we do not attend to we do not *see;* and since knowledge is exactly the seeing of things in their relations, anything that will help the student to be attentive will help him to acquire knowledge. And nothing, perhaps, serves to train the "mind's eye" better than the practice of drawing. Drawing is, after all and in general, a concrete reproduction of mental images. Hence the more proficient a person becomes in expressing the accurate outlines and proper shadings of the pictures that crowd his brain, the more apt he is to conceive those pictures truthfully.

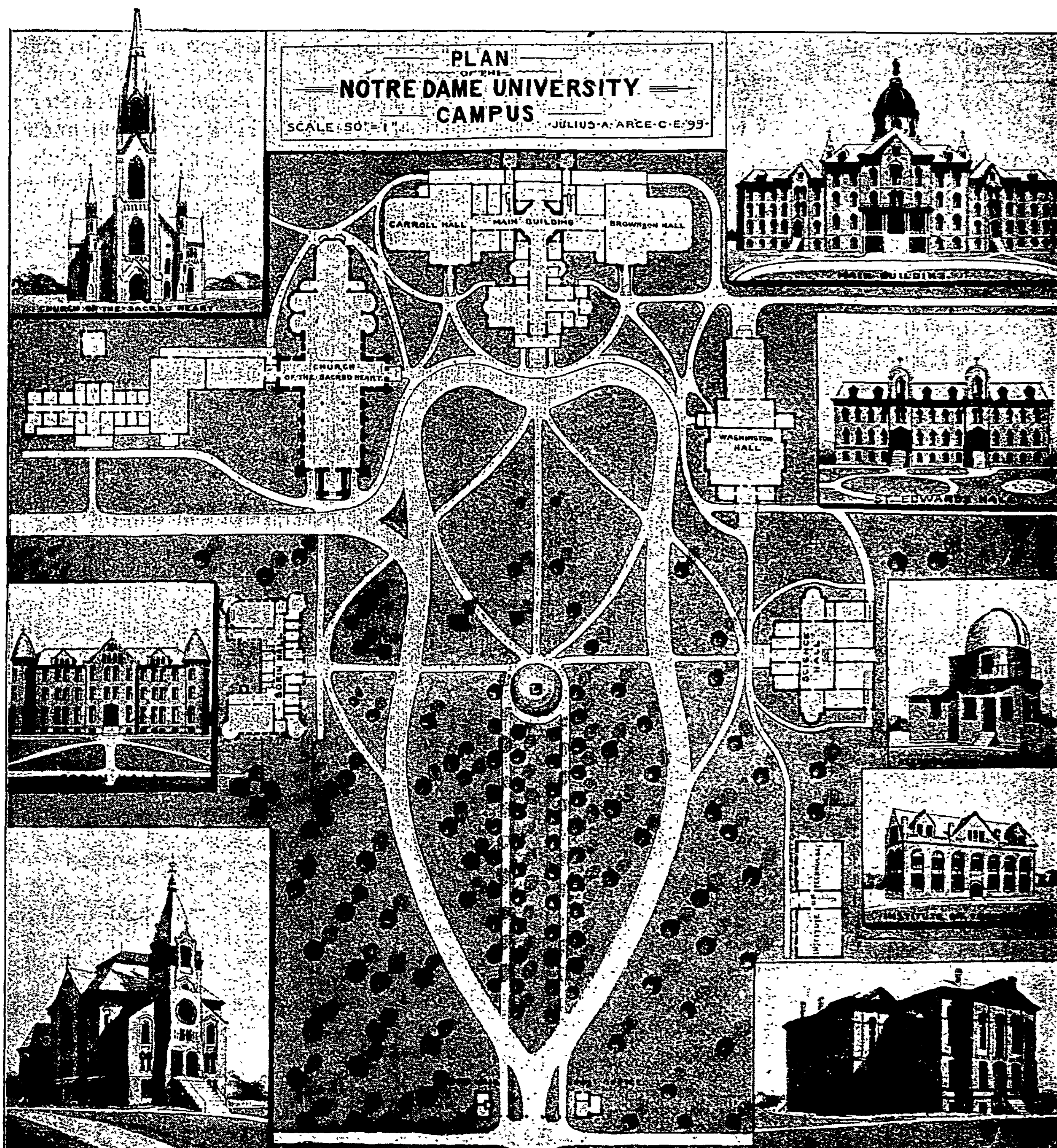
A secondary object of drawing—and none the less important because it is secondary—is its cultivation for commercial and scientific purposes. Technical drawing is absolutely essential for architects and mechanical engineers. It is also invaluable for workers in the sciences, particularly for geologists and biologists. Microscopy and histology are of almost no value unless they are supplemented by drawing. It may be said here that this utilitarian aspect of drawing receives particular attention at Notre Dame.

The preparatory instruction in this department consists of a thorough course of free-hand drawing. In the first place the student is given an extended practice in sketching from flat and shaded copies. He is obliged to be at pains to achieve neatness and accuracy. To this end he receives careful instruction on the use of the pencil, crayon, charcoal and pen, with all of which he works at different times. When a fair technique has been acquired, the student undertakes model and object drawing. He sketches from casts and from nature and is taught the elementary principles of composition and perspective.

After this preparatory study has been completed, those who are taking the course of artistic drawing begin again to copy from flats. They do so in order to attain an especial facility in free-hand execution. They devote themselves to the reproduction of models taken from the masters, and during this practice receive instructions in the theory of art. Afterwards, of course, they resume studies from nature and life.

As a preliminary to mechanical drawing, and principally for the sake of exercise, the student is taught to design and execute neat and simple styles of lettering. This gives him familiarity in the methods of inking with instruments, and he is then prepared to draw to scale various geometrical figures. According to his proficiency he is required to work out projections and plates illustrating problems in general idea of the parts of machines and the manner of putting them together. In connection with this work instructions are given in line-shading, tracing, blue-printing and tinting with India-ink, sepia and water-colors.

The final business of the course consists in the study of kinematics and machine design,



(The original drawing has been reduced. In the above, the scale should read 183′ = 1.″)

mechanical engineering. In addition to this, students in the department of Civil Engineering employ considerable time in topographical drawing.

Descriptive geometry and linear perspective are taught in order to give the student a during which the student is obliged to furnish working drawings for the erection of bridges, arches and various objects in mechanics and engineering. With careful application in these exercises, a moderate degree of skill can be developed.

The Chronograph.

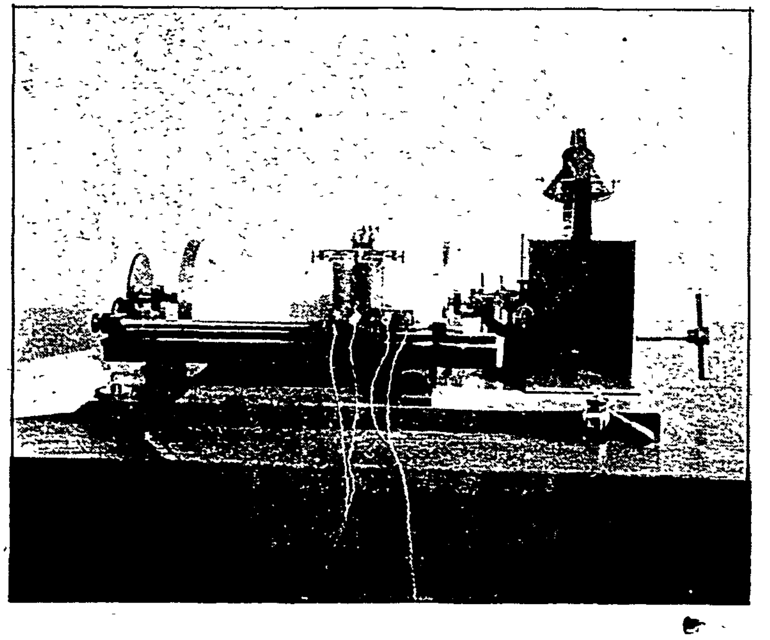
THOMAS A. STEINER.

ONE of the most accurate instruments in the Physical Laboratory and one that will most nearly eliminate the personal errors of the observer, is the chronograph with its electrical connections. This instrument consists of a hollow brass cylinder mounted on fine brass bearings; it is run by clock work and kept at a constant speed by a finely adjusted governor. Along the cylinder is a small track upon which runs a car. This is moved along the cylinder by a finely threaded rod attached by suitable gearings to the cylinder. Fastened to the car are two small electro-magnets with armatures forming two separate circuits; attached to the armatures are two small capillary pens, which are drawn across the paper on the cylinder as the cylinder turns.

Its principle is best shown in determining the acceleration of gravity. The pendulum used in this experiment is an iron ball suspended by a steel wire. At the bottom of the ball is a small piece of platinum-wire. This platinum-wire passes through a drop of mercury, put into a block of wood at the bottom at the middle of each swing. One of the circuits of the chronograph is connected with the pendulum by attaching one wire to the steel wire and dipping the other wire into the drop of mercury. By putting a battery in, this circuit will be made and broken every time the platinum-wire on the ball touches the mercury. The other circuit of the chronograph is attached to a clock or chronometer, or any other device that makes and breaks the circuit accurately every second.

When all the connections are made and the paper put on the cylinder, the chronograph is started. The small pens filled with ink are drawn across the paper making continuous lines, except when either circuit is made or broken; then the corresponding line will have a break in it. Thus the time circuit makes a break in its line every second, and the pendulum line has a break at the middle of each swing. The spaces between the breaks made by the time circuit are, or correspond to, seconds. The spaces in the other line correspond to swings of the pendulum. Thus counting the number of spaces in each line for a certain distance will give the number of swings in a certain number of seconds. From this the time of one swing of the pendulum is easily found, and by applying the formulæ of the pendulum, the acceleration of gravity is readily and accurately ascertained.

This is but one of the many experiments in which the chronograph is used, but it is sufficient to show the accuracy that can be obtained with it. The only difficulty with the experiment just described is to get some device to make and break the circuit exactly at the end of each second. A break circuit chronometer is generally used for this. However, a metronome, or some attachment to a seconds pendulum, may be used: the latter if well contrived will give the better results. The Western Union Telegraph Co., in sending out the time at noon, has an attachment on the standard clock at Washington, which ticks off a number of true seconds over the line. At 11 hours 56 minutes 48 seconds (Eastern time) the clock begins to



THE CHRONOGRAPH.

tick off seconds, omitting the twenty-ninth and the last five of each minute. It also omits ten seconds before the final stroke which is given at twelve o'clock by the seventy-fifth meridian. These seconds are absolutely true seconds. If a Western Union wire were attached to one of the circuits on the chronograph, and these seconds recorded on the paper, they would give the true length of a second on the paper. From this the time circuit used could be standardized.

In spite of the fine adjustments on this instrument the operator has to watch it closely and make many trials before the best results are obtained; for there are so many small things—as failure in the magnets to respond quickly, or weakness in the current, etc.,—that have a great effect on the final result. All in all, it is an instrument whose results can be held as correct.

Personals.

—Rev. Lawrence A. Deering, of Philadelphia, was a guest of his friends at the University for a few days of this vacation.

—Charles Warren Stoddard, Professor of English at the Catholic University, spent June 24 and 25 with his friends at Notre Dame.

—Readers of the SCHOLASTIC will be pleased to learn that Mr. Martin P. McFadden, LL. M., '94, has recently been appointed Assistant Prosecuting Attorney of Chicago.

—Very Rev. Edward R. Dyer, S. S., President of St. Joseph's Seminary of the City of New York, was a guest of President Morrissey during the early part of July. He was accompanied by Rev. J. F. Fenlon of Chicago. It is hoped that they will repeat their visit.

—Among our noted guests during the vacation was Dr. Thomas J. Shahan, Professor of Early Church History in the Catholic University at Washington. He spent a week lecturing at St. Mary's Academy before going to Europe, where he will remain till September.

—Doctor Maurice F. Egan paid us a short visit on Independence Day. He was on his way to Sinsinawa Mound, Wis., where he is to deliver a course of lectures to the Dominican Sisters. Dr. Egan promised faithfully to stop again at Notre Dame on his return East in August.

—Rev. Father Robert, the popular preacher and missioner of the Passionist Order, well known to all the students of the University, was the guest of his many friends here during the month of July. Father Joseph of the same Society joined him for a day or two on his return from the far West.

—Rev. P. P. Cooney, C. S. C., the pioneer temperance advocate of the West, was chief among the prominent delegates of the Catholic Total Abstinence Union who assembled in Indianapolis during the month of July to celebrate the twenty-fifth anniversary of the organization. Father Cooney's reputation for indomitable zeal in the great cause is national, and those who have listened to his earnest words to the local organizations will feel honored in the fact that he was chosen as their representative to the State assembly.

—Rev. John B. Schopp, A. B. '94, and Rev. Patrick Crawley, a student of the same year, who were lately elevated to the priesthood, paid a visit to their *Alma Mater* in July. Both of the reverend gentleman are remembered as diligent students, and they received a warm welcome from their friends among the Faculty. Father Schopp has received an appointment as assistant pastor at St. Michael's Church, Cincinnati, Ohio, and Father Crawley will fill the same position in St. Patrick's Church, Fort Wayne, Indiana. The SCHOLASTIC bespeaks for them useful and happy careers.

—Mr. and Mrs. P. L. Garrity, of Chicago, celebrated the thirty-third anniversary of their wedding on June 22 at their summer home in Morris, Ill. The event was accompanied by a family reunion in which also a great many friends participated. The Chicago *Chronicle* in recording the affair had this interesting bit of history to relate: "Mr. and Mrs. Garrity were married thirty-three years ago in the church at Notre Dame University. Mr. Garrity is an alumnus of the University, and Mrs. Garrity was graduated from St. Mary's Academy a short time before their marriage. They have sent thirteen children to swell the student rolls of those two educational institutions."

—Those among the students and others who have had the pleasure of hearing the Hon. William P. Breen, Class of '77, will not be surprised to learn that he was one of the most entertaining speakers of the Columbian Catholic Summer School during its recent sessions. The subject of his lecture was "Montalembert." The *Madison Democrat* gives a summary of it, and compliments the gentleman thus:

"He is a large handsome man, deeply versed in history and is an orator of power. Mr. Breen's audience on Wednesday evening was not as large as the merit of his lecture deserved. In fact, it could not have been too large. While entirely of a historical nature, his subject admitted of much sentiment, and he was greeted with hearty applause at frequent intervals. He did not read his lecture, as is too frequently done, thus lending a freshness and individuality to it that charmed everyone."

Local Items.

—*Classes will open on Tuesday, September 7.*

—New floors have been put into the Brownson and Carroll study-halls.

—The name of John F. Williams was omitted by mistake from the Premium List.

—The Library is open daily for six hours during the vacation. Mr. Magruder is in charge.

—A new test engine for the department of Mechanical Engineering has been ordered, and will be ready for use in September.

—Professor Green, of the Electrical Department, is here during the vacation superintending the placing of new wires and better lights in Sorin Hall.

—July the seventeenth was the anniversary of the death of Reverend T. E. Walsh, our late lamented president. A solemn Mass of Requiem for the repose of his soul was sung by Father Morrissey.

—The demand for the University catalogue this year has been so great that a number far in excess of former years has been ordered. Those who have not received a copy should make application to the Students' Office.

—St. Mary's Academy has issued an illustrated catalogue this year. It contains pictures of the buildings separately and in groups, and views of the interior of studios and chapels and class-rooms. Besides fulfilling its function as an information-giver, the catalogue will be a souvenir for the pupils and friends of the institution.

—The additions to Sorin Hall are now almost completed. After the carpenters have put the finishing touches to the new rooms, the building will be given over to the furnishers and painters. A hundred collegians will find well-lighted rooms ready for them in September. The choice of quarters will, as in former years, be given to the Seniors.

—The grotto is still unfinished. After it was found some months ago that water got through it, the mound at the rear was taken away and the back newly cemented, covered with asphalt paper and tarred. Rain can not penetrate it now, but the rear is still unfinished. The erection of a new mound would be a welcome relief from the desolate blackness that now confronts the visitor.

—An ornamental stand is being made for the basket-ball championship cup, which will be placed in the Carroll reading-room. A large glass globe will cover the trophy as soon as it is placed in the reading-room. The Carrolls have good reason to be proud of their prize. It will stand as a record of the good work done by the championship team of '97, and will be an incentive for the men of Carroll Hall in future years.

—It was a graceful act that Chief of Police Cassidy performed when the Pan-Americans visited Notre Dame, and all the more courteous because of his position. In many towns less pretentious than South Bend, the head of the police department would not have ridden at the head of the procession only that he might be the first to alight in order to open the carriages and assist the visitors. The city of South Bend is to be congratulated on having at the head of its police force as gentlemanly an officer as Captain Cassidy.

—On the feast of the Sacred Heart there was a grand illumination of the bronze statue on the lawn and the grounds immediately surrounding it. Professor Green arranged an electric search-light, which was focused to cast a strong white light on the statue. The effect was beautiful. The graceful outlines of the statue, under the strong glare, were shown in all their perfection, and at its base hundreds of candles completely covered the mound and shed a mellow light around. Bordering the paths which lead to the mound and distributed around the lawn were candles and other lights without number. The scene was one of fairy-like splendor.

—The old St. Joseph's Hall, for years the dwelling-place of the waiters and apprentices, will soon be piled away amid the old lumber, and the new three-story building at the south-western part of the St. Joseph campus will be ready to receive its students in September. With the old building will disappear the sheds which stand near it and which shut out the view of nobler buildings. The new hall has a frontage of one hundred feet and a depth of fifty. The lowest floor is divided into a lavatory, a play-hall and a dining-room. On the second floor are the private rooms of the director and his assistants and the study-hall for the students. The entire third story is a large dormitory. Seventy serious-minded fellows can find accommodations in the new St. Joseph's Hall which will be as completely equipped as the other dwelling halls.

—Deferring to the wishes of those men of '96-'97 who are now in enforced government employ we give to our readers the names of those only who have been able to retain their liberty and the way in which they are spending their vacation: Arce is preparing a work on the deception practised by the fishes of the St. Joe River on the innocent fisherman; Barry is studying the methods of detective agencies to recover his library; Bryan is raising a crop of hair preparatory to going on the stump for the Populist party; Brennan spends sixteen hours a day in the Congressional library reading works on Erasmus; Browne (he of Massachusetts) is busy dictating to twelve secretaries letters to friends in the West; Cavanagh is valet to the Baroness Blanc; Confer is at the head of a fire department in Wabackville, Pa.; Golden is on the staff of *Puck;* O'Malley is digesting Caspar Whitney's "How to Form an Amateur Football Team"; Hengen is looking after choir boys at Diamond lake; Reardon and Reilly are mastering the mysteries of Baedeker; Bennett is wooing Miss Fortune; Murphy is at the head of a cigarette trust; Sanders tried "To break the bank at Monte Carlo," passed the wrong notes, and is in durance vile; Ney is getting up an expedition to help Greece; Steele is laboring with a recipe for toning down and filing off a laugh; Fagan is working on the old farm in Schenectady; Rosenthal has joined a circus; Weaver is filling an engagement with the "Just the Thing" company in a New York theatre; McNamara is leading the choir "down home"; Miller is giving society a lift in his little village home; Quinn is growing; Lantry has been setting the wheels of progress a-going in quiet Chatsworth by trying to secure John Drew for an unlimited engagement; Ragan is improving his pronunciation of French; Sullivan is vainly trying to disentangle the real from the unreal in the stories Brennan and Cavanagh told him by candle-light. And so the vacation goes merrily on, and the Juniors will be Seniors in September, and the Seniors will miss the morning bell and "duck-on-the-rock," and the ambitions and joys that were will be theirs only in memory.