

There were 565 sets of vertical velocity measurements combined into forty-six series. The forty-six average curves were all very flat and convex down stream—except near an irregular bank—and were approximately parabolas with horizontal axes; the data determined the parameters only very roughly; the maximum velocity line was usually below the service, and sank in a rectangular channel, from the center outward down to about mid-depth near the banks. Its depression seemed not to depend on the depth, slope, velocity, or wind; probably the air itself, being a continuous source of surface retardation, would permanently depress the maximum velocity, while wind failed to effect this, owing to its short duration. On any vertical the mid-depth velocity was greater than the mean, and the bed velocity was the least. The details showed that the mid-depth velocity was nearly as variable from instant to instant as any other, instead of being nearly constant, as suggested by the Mississippi experimenters.

The measurement of the mean velocity past a vertical was thought to be of fundamental importance. Loaded rods seemed by far the best for both accuracy and convenience in depths under 15 ft. They should be immersed only 0.94 of the full depth. The chief objection to their use, that—from not dipping into the slack water near the bed—they moved too quickly, was thus for the first time removed. A double float with two similar sub-floats at depths of 0.211 and 0.789 of the full depth would also give this mean with more accuracy and convenience than any instrument of its class; this instrument is new. Measurement of the velocity at five eighths depth would also afford a fair approximation.

One hundred and fourteen average transverse velocity curves were prepared from 714 separate curves. These average curves were all very flat, and were convex down stream—over a level or concave bed—and nearly symmetric in a symmetric section. The velocity was greatest near the center, or deepest channel, decreased very slowly at first toward both banks, more rapidly with approach to the banks or with shallowing of the depth, very rapidly close to the banks, and was very small at the edges, possibly zero. The figure of the curve was found to be determined by the figure of the bed, a convexity in the bed producing a concavity in the curve and *vice versa*, and more markedly in shallow than in deep water. Curves on the same transversal, at the same site, and with similar conditions, but differing in general velocity, were nearly parallel projections. At the edges there was a strong transverse surface flow from the edge toward mid-channel, decreasing rapidly with distance from the edge. The discussion showed that it was almost hopeless to seek the geometric figure of the curves from mere experiment.

Five hundred and eighty-one cubic discharges were measured under very varied conditions. The process adopted contained three steps: (1) Sounding along about fifteen float courses, scattered across the site in eight cross sections; time, say four hours. (2) Measurement of the mean velocities through the full depths in those float courses, each thrice repeated; time, say four hours. (3) Computation, say two hours. This process was direct and wholly experimental; each step was done in a time which gave some chance of a constant state of water. From an extended comparison of all results under similar conditions, it appeared that the above process yielded, under favorable circumstances, results not likely to differ more than 5 per cent. The sequel showed that in a channel with variable regimen, a discharge table for a given site must be of at least double entry, as dependent on the local gauge-reading, and on the velocity or surface-slope.

Special attention was paid to rapid approximations to mean sectional velocity. The mean velocity past the central vertical, the central surface velocity, and Chézy's quasi-velocity—i.e., $100 \sqrt{RS}$, where R =the hydraulic mean depth, and S =surface slope—were tried in detail; thus 100, 76, and 83 average values thereof respectively were taken from 581, 313, and 363 detail values. The ratios of these three velocities to the mean velocity were taken out, and compared in detail with Bazin's and Cutter's coefficients. Other formulæ were contrasted also in slight detail. Kutter's alone seemed to be of general applicability; when the surface slope measurement is good, and the rugosity coefficient known for the site—both doubtful matters—it would probably give results within $7\frac{1}{2}$ per cent. of error. Improvement in formulæ could at present be obtained only by increased complexity, and the tentative research would be excessively laborious. Now the first two ratios varied far less than the third; thus their use would probably involve less error than the third, or approximation would be more likely from direct velocity measurement than from any use of surface slope. The connection between velocities was probably a closer one than between velocity and slope; the former being perhaps only a geometric, and the latter a physical one. The mean velocity past the central vertical was recommended for use, as not being affected by wind; the reduction coefficient could at present only be found by special experiment for each site. Three current meters were tried for some time with a special lift, contrived to gripe the meter firmly parallel to the current axis, so as to register only forward velocity, and with a nearly rigid gearing wire. No useful general results were obtained. Ninety specimens of silt were collected, but no connection could be traced between silt and velocity; it seemed that the silt at any point varied greatly from instant to instant, and that the quantity depended not on the mean velocity, but probably on the silt in the supply water. Forty measurements of the evaporation from the canal surface were made in a floating pan, during twenty-five months. The average daily evaporation was only about $\frac{1}{16}$ in. The smallness of this result seemed to be due to the coldness of the water—only 63 deg. in May, with 165 deg. in the sun and 105 deg. in shade. Lastly, it must suffice to say that great care was taken to insure accuracy in both fieldwork and computation.

THE GERM.

By ARTHUR ATKINS.

THERE seems to have sprung up within a few months a tendency to revive the discussion on that hackneyed question, "Shall the germ be retained in the flour?" This question has been more than once answered in the negative by both scientific and practical men, but recently certain prominent persons have come to the conclusion that every one has been wrong on this point, and the miller should by all means retain the germ. Now the nutritive value of the germ cannot be disputed, but there are two circumstances which condemn it as an ingredient of flour. The first is that the albuminoids which it contains are largely soluble, and this means that good light bread from germy flour is impossible. I have not time to go into a detailed explanation of the chemical reasons for this, but they may be found in

a series of articles which appeared in *The Milling World* about a year ago. In the next place, the oil contained in the germ not only discolors the flour, but seriously interferes with its keeping qualities. Now color is only a matter of taste, and if that were the only objection to the germ, it might be admitted, but we certainly do not want anything in our flour to interfere with making light, sweet bread, and will render it more liable to spoil. If our scientists can discover some method of obviating these objections, it will then be time enough to talk about retaining the germ. Meanwhile millers know that germy flour is low priced flour, and they are not very likely to reduce their profits by retaining the germ.—*Milling World*.

WHEAT TESTS.

THERE was considerable complaint last season, on the part of wheat raisers in sections tributary to Minneapolis, on account of the rigid standard of grading adopted by the millers of that city. It was asserted that the differentiation of prices between the grades was unjustly great and out of proportion to the actual difference of value. In order to ascertain whether this was the case or not, the Farmers' Association of Blue Earth County, Minn., decided to have samples of each grade analyzed by a competent chemist in order to determine their relative value. Accordingly specimens were secured, certified to by the agent of the Millers' Association of Minneapolis, and sent to the University of Minnesota for analysis. The analysis was conducted by Prof. Wm. A. Noyes, Ph.D., an experienced chemist, who has recently reported as follows:

"The analyses of wheat given below were undertaken for the purpose of determining whether the millers' grades of wheat correspond to an actual difference in the chemical character of the wheat. For this purpose samples of wheat were secured, which were inspected and certified to by M. W. Trexa on April 13th of this year. The inspection cards contained no statement except the grade of the wheat and the weight per bushel, but the samples were all of Fife, for the purpose of a better comparison. The analyses of the wheat were made during October in this laboratory. In each case the wheat was carefully separated from any foreign substances before analysis. The results of analysis were as follows:

	Grade No. 1.	Grade No. 2.	Grade No. 3.
Weight per bushel	59 lb.	56½ lb.	55 lb.
Grains to weigh 10 grains	366	474	491
	Per ct.	Perct.	Perct.
Foreign matter (seeds, etc.)	0.41	0.20	1.57
Nitrogen	2.09	2.08	2.17
Phosphorus	0.35	0.46	0.46
Water	12.34	11.31	11.85
Ash	1.59	1.92	1.97
Albuminoids (nitrogen multiplied by 6½)	13.06	13.00	13.56
Cellulose	2.03	2.37	2.50
Starch, sugar, fat, etc.	70.98	71.40	70.12

"The analyses require but little comment. The only substances in which there is evident connection between the results of analysis and the grades of wheat are the cellulose, ash, and phosphorus. As regards the last substance, grades two and three seem to have the greatest food value. But it seems quite probable from the results that greater difference would be found between different varieties of wheat of the same kind than is shown here between different grades of the same variety of wheat. However, it does not necessarily follow from this that the different grades of wheat are of nearly equal value to the miller for the purpose of making flour. That is a question which can be best answered by determining accurately the amount and character of the flour which can be made from each grade of wheat. If possible, the investigation will be continued in that direction."

As Prof. Noyes justly remarks, the value of the different grades of wheat can best be determined by a comparison of the results of reducing them to flour, but an intelligent study of the table given above would of itself be sufficient to indicate the justness of the grading. In the first place, even were the percentages of the different components exactly the same in each grade, still the difference in weight would of itself be sufficient to justify a marked difference in price. This requires no proof, for, other things being equal, fifty-nine pounds is worth more than fifty-five pounds. Again, the figures show that No. 3 contained nearly four times as much foreign matter as No. 1. Millers certainly should not be expected to pay for foreign seeds or other substances valueless for their purpose, at the price of wheat. Finally, if the analysis proves anything, it proves that the lower grades contain a decidedly larger percentage of components which it is generally agreed, whether directly or the reverse, ought not to be incorporated with the flour, and are, therefore, of comparatively little value to the miller. This is shown by the relative amounts of cellulose, ash, and phosphorus present. Cellulose, as every one knows, is the woody, indigestible substance which is found in the bran, and the greater the amount of cellulose, the heavier will be the bran in proportion to the flour-producing elements. According to the figures presented, No. 3 contained nearly one-quarter more cellulose than No. 1, while the amount in No. 2 was slightly less than in No. 3. The ash, too, which represents the mineral constituents of the wheat, is directly dependent upon the quantity of bran. Here, too, the lowest grade is shown to yield about one-quarter more than the highest. The larger percentage of phosphorus in the lower grades is suggested by the analyst to indicate their greater food value in this respect. So it would, were we in the habit of boiling our wheat and heating it whole, or of using "whole-wheat meal." But, fortunately or unfortunately, the bread reformers have not yet succeeded in inoculating any considerable portion of the community with their doctrines, and hence the actual food value of any sample of wheat must be ascertained, not directly from the composition of the wheat, but from the composition of the flour made therefrom. Now, as already stated, phosphorus, like the other mineral components, is found almost entirely in the bran. Its presence in greater quantity, therefore, simply adds to the testimony that a larger proportion of the low grade wheat must be rejected than of the higher grade. It should be evident to the complaining farmers that the millers were in the right of the question, on this occasion at least.

It is expected that further analysis will be made, this time of the flour made from the different grades of wheat. If these investigations be properly conducted, we have no doubt that they will simply confirm the evidence of the wheat tests. A chemical analysis alone, however, will not be sufficient. The quantity of flour obtained from a given amount of wheat must also be ascertained and its quality

further tested by means best known to millers, as regards "doughing-up," keeping qualities, color, etc. And then the result can be no less than to show what millers already knew—that the best quality of flour, commanding the top prices in the market, cannot be obtained from an inferior quality of wheat.—*Milling World*.

APPARATUS FOR PRINTING BY THE BLUE PROCESS.*

By CHANNING WHITAKER.

THE blue process is well known to the members of the society, and I need not take time to describe it; but with the ordinary blue process printing frame the results are sometimes unsatisfactory, and now that the process has come to be so commonly used I have thought that an account of an inexpensive but efficient printing frame would be of interest. The essential parts of the apparatus are its frame, its glass, its pad or cushion, its clamps, and the mechanism by which the surface of the glass can easily be made to take a position that is square with the direction of the sun's rays.

The Blue Process Printing Frame in Common Use.—Its Defects.—The pad of the apparatus in common use consists of several thicknesses of blanketing stretched upon a back-board. The sensitized paper and the negative are placed between the pad and the plate glass, and the whole is squeezed together by pressure applied at the periphery of the glass and of the back-board. Both the glass and the back-board spring under the pressure, and it results that the sensitized paper is not so severely pressed against the negative near the center of the glass as it is near the edges. If at any point the sensitized paper is not pressed hard up against the negative, a bluish tinge will appear where a white line or surface was expected. With an efficient printing frame and suitable negatives, these blue lines will never appear, and it was to prevent the production of defective work that I undertook to improve the pad of the printing frame.

The Printing Frame Used in Ordinary Photography.—Very naturally, I first examined the printing frame used in ordinary photography. This frame is extremely simple, and is very well adapted to its use. It is, undoubtedly, the best frame for blue process printing, when the area of the glass is not too large. The glass is set in an ordinary wooden frame, while the back-board is stiff and divided into two parts. A flat, bow-shaped spring is attached by a pivot to the center of each half of the back-board. The two halves of the back-board are hinged together by ordinary butts. Four lugs are fastened to the back of the frame, and, when the back-board is placed in position, the springs may be swung around, parallel to the line of the hinges, and pressed under the lugs, so that the back of the back-board is pressed most severely at the center of each half, while the glass is prevented from springing away from the back-board by the resistance of the frame at its edges. Unless the frame is remarkably stiff, it will resist the springing of the glass more perfectly in the neighborhood of the lugs than elsewhere. It will now be seen that, on account of the manner in which the pressure is applied, the back-board tends to become convex toward the glass, while the adjacent surface of the glass tends to become concave toward the back-board; and that with such a frame, the pressure upon all parts of the sensitized paper is more nearly uniform than when the pressure is applied in the manner before described. With a small frame of this description, a piece of ordinary cotton flannel is used between the back-board and the sensitized paper, and, with larger sizes, one or more thicknesses of elastic woolen blanket are substituted for the cotton flannel. There is an advantage in having a hinged back-board like that which has been described, because, when the operator thinks that the exposure to sunlight has been sufficiently prolonged, he can turn down either half of the back and examine the sensitized paper, to see if the process has been carried far enough. If it has not, the back-board can be replaced, and the exposure continued, without any displacement of the sensitized paper with respect to the negative. This is an important advantage.

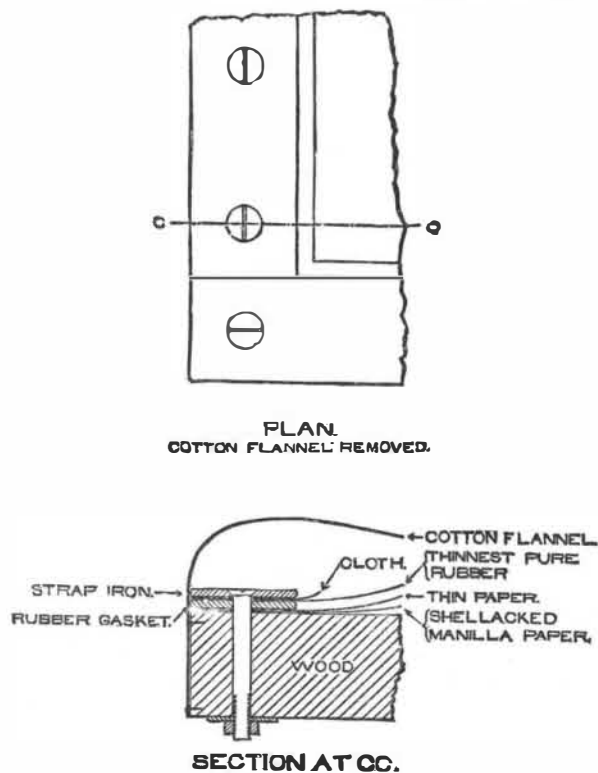
An Efficient Blue Process Frame, for Printing from Large Negatives, or for Printing Simultaneously from many Small Ones.—In order to be efficient, such a frame must be capable of keeping the sensitized paper everywhere tightly pressed against the negative. Again, such a frame, being large, is necessarily somewhat heavy. It should be so mounted that it can be handled with ease; and, in order that it may print quickly, it should be so arranged that it can be turned without delay, at any time, into a position that is square with the direction of the sun's rays.

Undoubtedly, if a sufficiently thick plate of glass should be used, the ordinary photographic printing frames would answer the purpose, whatever the size, but very thick plate glass is both heavy and expensive. Commercial plate glass varies in thickness from one-fourth to three eighths of an inch, and the thicker plates are rather rare. A large plate of it is easily broken by a slight uniformly distributed pressure. But the pressure that is required for the blue process printing, although slight, is much greater than is used in the ordinary photographic process. For the sensitized paper that is used in the blue process printing is, comparatively, very thick and stiff, and it may cockle more or less, while the paper that is used in ordinary photography is thin and does not cockle. Now, it is easy to see that a pressure severe enough to flatten all cockles must be had at every part of the sensitized paper, and that, if the comparatively thin, inexpensive, light weight, commercial plate glass is to be used, it is desirable to have the pressure nowhere much greater than is needed for that purpose, lest the fragile glass should be fractured by it. In each of my large frames I use the commercial plate glass; instead of the cushion of cotton flannel, or of flannel; I use a cushion filled with air of sufficiently high pressure to flatten all cockles, and to press all parts of the sensitized paper closely against the negative; and instead of the hinged back-board I use a back-board made in one piece and clamped to the frame of the glass at its edges. Connected with the cushion is a pressure gauge, and a tube with a cock, for charging the cushion with air from the lungs. Experience shows what pressure is necessary with any given paper, and the gauge enables one to know that the pressure is neither deficient nor in excess of that which is safe for the glass.

The Construction of the Air-Cushion.—The expense of such an air-cushion seemed at first likely to prevent its being used; but a method of construction suggested itself, the expense of which proved to be very slight. The wooden back-board, as constructed, is made in one piece containing no wide cracks. It has laid upon it some thick brown Manila paper, the upper surface of which has been previously shellacked to make it entirely air-tight. Upon this shellacked surface

* Read June 21, 1882, before the Boston Society of Civil Engineers.

is laid a single thickness of thin paper of any kind; even newspaper will answer. Its object is simply to prevent the sheet rubber, which forms the top of the air-cushion, from sticking to the shellacked paper. The heat of the sun is often sufficient to bring the shellac to a sticky state. It would probably answer as well to shellac the under side of the paper, and to use but one sheet, but I have not tried this plan. Around the periphery of the pad, there is laid a piece of rubber gasket about one and a half inches wide, and about one-eighth of an inch thick. In order that the gasket may not be too expensive, it is cut from two strips about three inches wide. One of them is as long as the outside length of the frame, and the other is as long as the outside width of the frame. Each of these strips is cut into two L-shaped pieces, an inch and a half in width, with the shorter leg of each L three inches long. When the four pieces are put together a scarf joint is made near each corner, having an inch and one-half lap. It is somewhat difficult to cut such a scarf joint as perfectly as one would wish, and it is best to use rubber cement at the joints. Over the gasket is laid a sheet of the thinnest grade of what is called pure rubber or elastic gum. Above this, and over the gasket, is placed a single thickness of cotton cloth, of the same dimensions as the gasket, and yet above this are strips of ordinary strap iron, an inch and a half wide and nearly one-eighth of an inch thick. These strips are filed square at the ends and butt against each other at right angles. As the edges of the strips are slightly rounded, they are filed sufficiently to form good joints wherever the others butt against them. The whole combination is bound together by ordinary stove bolts, one-quarter of an inch in diameter, placed near the center of the width of the iron strips, and at a distance apart of about two and one-half inches. Their heads are countersunk into the strap iron. In making the holes for the stove bolts through the thin rubber, care should be taken to make them sufficiently large to enable the bolt to pass through without touching the rubber, otherwise the rubber may cling to the bolts, and if they are turned in their holes the rubber may be torn near the bolts and made to leak. A rough washer, under each nut, prevents it from cutting into the back-board. For the purpose of introducing air to, or removing air from, the pad, a three-eighths of an inch lock nut nipple is introduced through the back-board, the shellacked paper, and its thin paper covering. Without the back-board a T connects with the nipple. One of its

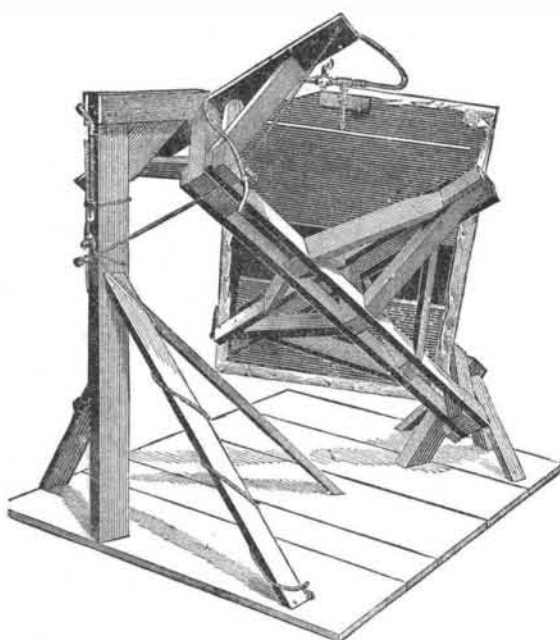


branches leads, by a rubber tube, to the pressure gauge, which is a U-tube of glass containing mercury. The other branch has upon it an ordinary plug cock, and, beyond this, a rubber tube terminating in a glass mouth-piece. When it is desired to inflate the air-cushion, it is only necessary to blow into the mouth-piece. A pressure of one inch of mercury is sufficient for any work that I have yet undertaken. With particularly good paper, a lower pressure is sufficient. Upon the top of the pad is laid a piece of common cotton flannel with the nap outward, and with its edges tacked along the underedge of the back-board. The cotton flannel is not drawn tight across the top of the pad. The reason for employing a cotton flannel covering is this: When the sheet rubber has been exposed for a few days to the strong sunlight, it loses its strength and becomes worthless. The cotton flannel is a protection against the destruction of the rubber by the sunlight. I first observed this destruction while experimenting with a cheap and convenient form of gauge. I used, as an inexpensive gauge, an ordinary toy balloon, and I could tell, with sufficient accuracy, how much pressure I had applied, by the swelling of the balloon. This balloon ruptured from some unknown cause, and I made a substitute for it out of a round sheet of thin flat rubber, gathered all around the circumference. I made holes about one-quarter of an inch apart, and passing a string in and out drew it tight upon the outside of a piece of three-eighths of an inch pipe, I then wound a string tightly over the rubber, on the pipe, and found the whole to be air-tight. This served me for some time, but one day, on applying the pressure, I found a hole in the balloon which looked as if it had been cut with a very sharp knife. That it had been so cut was not to be imagined, and on further examination I found that the fracture had occurred at a line which separated a surface in the strong sunlight from a surface in the shade, at a fold in the rubber. I saw that all of the rubber which had been continuously exposed to the intense sunlight had changed color and had become whiter than before, and that that portion of the balloon had lost its strength. I then returned to the use of the mercury gauge, and took the precaution to cover my pad with cotton flannel, as a protection from the light and from other sources of destruction. This pad is upon the roof of the Institute, and is exposed to all weathers. As a protection from the rain and the snow, the whole is covered again with a rubber blanket. It has withstood the exposure perfectly well for a year, without

injury. The gauge, made from flat rubber, is altogether so cheap and so convenient that I am now experimenting with one of this description having a black cloth covering upon the outside. The balloon is of spherical shape, the black cloth covering is of cylindrical shape, and I hope that this device will serve every necessary purpose. A sectional view of the air-cushion is offered as a part of this communication.

The Frame, which Contains the Plate Glass, is made of thick board or plank, with the broad side of the board at right angles to the surface of the glass. A rabbet is made for the reception of the glass, and four strips of strap iron, overlapping both the glass, and the wood, and screwed to the wood, keep the glass in position. Strips of rubber are interposed between the glass and the wood and between the glass and the iron. The frame is hinged to the back-board by separable hinges, so that the glass can be unbanded from the pad without removing the screws. Hooks, such as are used for foundry flasks, connect the frame with the pad upon the opposite side. A frame made in this manner is very stiff and springs but little, and its depth serves an excellent purpose. The air-cushion and the frame are so mounted that they can be easily turned to make the surface of the glass square with the direction of the sun's rays. It is necessary to have a tell-tale connected with the apparatus, which will show when the surface of the glass has been thus adjusted. The shadow of the deep frame is an inexpensive tell-tale, and enables the operator to know when the adjustment is right. I have now described, in detail, the construction of the air-cushion with its back-board, as well as that of the frame which holds the plate glass, and I think it will be evident that the first cost of the materials of which they are made is comparatively little, and that the workmanship required to produce it is reduced to a minimum. It will also, I think, be evident that a uniform pressure, of any desired intensity, can be had all over the surface of the sensitized paper for the purpose of securing perfect contact between it and the negative. The blue copies that are taken with this apparatus are entirely free from blue lines when the negatives, chemicals, and paper are good.

The Mechanism for Adjusting the Surface of the Glass, until it shall be Perpendicular to the Direction of the Sun's Rays.—I have found many uses for the blue copying process in connection with the work of instruction at the Massachusetts Institute of Technology. Notes printed by it are far better and less costly than those printed by papyrograph. I will not detain you now with an account of the uses that I have made of it. I will merely say that more than a year ago I found that my frame, which has a glass 3 feet \times 4 feet, was



BLUE PROCESS PRINTING APPARATUS.

wholly inadequate to the work in hand, and I tried to increase the production from it by diminishing the time of printing. The glass of this frame was horizontal, except when one of its ends was tilted off from the slides which guided it when pushed out of the window; and I knew that it took three or four times as long to print when the sun was low as it did when the sun was near the meridian. I made plans for mounting this frame upon a single axis, about which it could be turned after it had been pushed through the window, but I saw that no movement about a single axis would give a satisfactory adjustment for all times of the year, and I considered what arrangement of two axes would permit a rapid and perfect adjustment, at all times, with the least trouble to the operator. It was evident that when the sun was in the equatorial plane, the surface of the glass should contain a line which was parallel to the axis of the earth; and further, that if such a glass was firmly attached to an axis which was parallel to that of the earth, it would fulfill the desired purpose. For the glass, being once in adjustment, is only thrown out of position by the rotation of the earth, and if the glass is rotated sufficiently about its own axis, in a direction opposite to that of the earth, it will retain its adjustment. In order to have the adjustment equally good when the sun was either north or south of the equatorial plane, it was sufficient to mount a secondary axis upon the primary one and at right angles to it. About this the glass could be turned through an angle of $23\frac{1}{2}^\circ$, either way, from the position which it should have when the sun was in the equatorial plane.

The Construction of the Adjusting Mechanism.—I desired to have the mechanism as compact and inexpensive as possible, and to have the frame well balanced about the primary axis, in every position. I also desired to have a rotation of nearly 180° about the principal axis. The plan adopted will be most easily understood by referring to the drawing which illustrates it. The axes are composed chiefly of wood. They are built up from strips which are 3 inches \times $\frac{3}{4}$ inch, and from small pieces of 2 inch plank. They are stiffly braced. A pair of ordinary hinges permit the secondary rotation to occur, while a pair of cast-iron dowel pins with their sockets, such as are used in foundry flasks, serve as pivots during the primary rotation.

The Adjustments.—The adjustment about the secondary axis does not need to be made more frequently than once a week, or once a fortnight. In order to prevent rotation

about this axis when in adjustment, two cords lead from points which are beneath the back-board, and as far removed from the secondary axis as is convenient. Each cord passes forward and backward through four parallel holes in a wooden block which is attached to the primary axis. The cords can be easily slipped in the holes by pulling their loops, but the friction is so great that they cannot be slipped by pulling at either end. It takes about twice as long to make the adjustment as would be necessary if a more expensive device had been used; but this device is at once so cheap, so secure, and has so seldom to be used, that it was thought to be best adapted for the purpose. To prevent rotation from occurring about the primary axis when it is not desired, a bar parallel to the secondary axis is attached by its middle point to the primary axis near one end. A cord passes from either end of this bar through cam shaped clamps, which were originally designed for clamping the cords of curtains with spring fixtures. These clamps are cheap. They are easily and quickly adjusted, and are very secure.

The whole apparatus can be located upon the roof of a building, or, if convenient, it can be mounted upon slides, and pushed through an open window when it is to be exposed to the light. If it is to be used upon a roof, a small hut, or shelter of some sort, near by is a great convenience to the operator, particularly in winter.

An Inexpensive Drying Case for Use in Coating the Paper.—When the apparatus is in continuous use, time may be saved by having a convenient arrangement for drying the sheets that have been coated with the sensitizing liquid. I have made an inexpensive drying case which serves the purpose very well. It consists simply of a light-tight rectangular case of drawers. There are twenty-five drawers in all. They are constructed in an inexpensive manner, and are the only parts of the case that are worth describing. They are very shallow, being but $1\frac{1}{2}$ inches deep, and as it appeared that the principal expense would be for the materials of which the bottoms of the drawers should be composed, it was decided to make the bottoms of cotton cloth. This cloth is stretched upon a frame, the dimensions of which are greater than that of the paper to be dried. The stock of which the frame is made is pine, $1\frac{1}{2}$ inches wide, and three-eighths of an inch thick. The corners are simply mitered together and attached to each other by means of the wire staples that are commonly used for fastening together pages of manuscript, and which are called "novelty staples." Eight staples are used at each miter, four above and four below the joint. Two of the staples, at the top and near the ends of the joint, are set square across it, and two others, at the top and near the middle of the joint, are placed diagonally across it. The staples at the bottom are similarly placed. The joint is quite firm and strong, and is likely to hold for an indefinite period with fair usage. The cloth, stretched upon the frame, is fastened to it by means of similar staples. A dark colored cloth not transparent to light is to be preferred. A strip of pine, $1\frac{1}{2}$ inches wide, and three-eighths of an inch thick, forms the vertical front of the drawer, and prevents the admission of much light from the front while the sheet is drying. Two triangular knee pieces, three-quarters of an inch thick, serve to connect the front board with the frame, and four small screws with a few brads are used in attaching them. The lower edge of the front board drops one-quarter of an inch below the bottom of the drawer. My case stands in a poorly lighted room, and paper dried in this case and removed to a portfolio as soon as it is dry does not seem to be injured by the light that reaches it. With the case in a well lighted room, I should prefer to have outer doors to the case, made of ordinary board six or eight inches wide, hinged to one end, and arranged to swing horizontally across the front of the case. These would more completely prevent the admission of light. The opening of any one of the doors would allow three or four of the drawers to be filled, while the rest of the case would be comparatively dark at the same time.*

The Portfolio for Protecting the Sensitized Paper from Exposure to Light.—The sensitized paper is very well protected from exposure to light, if kept in a portfolio or book, the brown paper leaves of which are considerably larger than the sensitized sheets. The sheets may be returned to such a book after exposure, and washed at the convenience of the operator. They can be washed more quickly and perfectly if two water-tanks are provided in which to wash them. A few minutes' soaking will remove nearly all of the sensitizing preparation which has not been fixed by the exposure. If the soaking is too long continued in water that is much discolored by the sensitizing preparation, the sheets become saturated with the diluted preparation, and they may become slightly colored by after exposure. If the first soaking is not too long continued, and if the sheets are transferred at once to a second bath of clean water, which is kept slowly changing from an open faucet, they may remain there until the soluble chemicals have been entirely extracted, and there will be no risk of staining by after exposure. Washing in two tanks is of more consequence when the ground is white and the lines blue, than when the ground is blue and the lines white.

The Grades of Paper that are well Adapted for Blue Process Work.—I have tested many grades of paper, to ascertain if they were well adapted for blue process work. Some grades of brown Manila are very good; others have little specks embedded in their surfaces which refuse to take on a blue tint; still others, when printed upon, have white lines that are wider than the corresponding black lines of the negative. The blue obtained upon bond paper appears to be particularly rich, and the whites remain pure; but bond paper cockles badly, and the cockles remain in the finished print. Weston's linen record is an excellent paper. It is strong, cockles but little, and dries very smooth. A paper that is used by Allen & Rowell, for carbon printing, is comparatively cheap, and is an excellent paper. It is not so stiff as the linen record, and the whites are quite as pure. It does not cockle, neither does it curl while being sensitized. It comes in one hundred pound rolls, and is about thirty inches wide. The best papers are those that are prepared for photographic work. The plain Saxe and the plain Rives both give excellent results. Blue lines on a pure white ground can be obtained on these papers, from photographic negatives, without difficulty. None of the hard papers of good grade require the use of gum in the sensitizing liquid. The liquid penetrates the more porous papers too far when gum is not used, and without it good whites are seldom obtained upon porous paper.

The Best Chemicals for this Work are the recrystallized red prussiate of potash and the citrate of iron and ammonia,

* Since this paper was read, I have seen in the office of the City Engineer of Boston a drying case which is similar in some respects to the one that I have devised. It has been longer in use than my own. The drawers are simply the ordinary mosquito netting frames covered with cotton netting. They have no fronts, but a door covers the front of the case, and shuts out the light.

which is manufactured by Powers & Wightman, of Philadelphia. If the red prussiate has not been recrystallized, the whites will be unsatisfactory, and the samples of citrates of iron and ammonia which have come to us from other chemists than those named, have all proved unreliable for this process.

The Sensitizing Liquid.—Its Proportions.—The blue process was originally introduced from France, by the late Mr. A. L. Holley. I was indebted to Mr. P. Barnes, who was with Mr. Holley at the time, for an early account of it, and I had the first blue process machine that was in use in New England. Since 1876, instruction in the use of the blue process has been given to the students of mechanical engineering of the Massachusetts Institute of Technology, and they have caused its introduction into many draughting offices. The proportions of the sensitizing liquid, as originally given me by Mr. Barnes, were as follows:

Red prussiate of potash.....	8 parts.
Citrate of iron and ammonia.....	8 parts.
Gum arabic.....	1 part.
Water.....	80 parts.

Results of Experiments.—In our use, it first appeared that the gum might be omitted from the preparation when sufficiently hard papers were used. Next, that a preparation containing

Red prussiate of potash.....	2 parts,
Citrate of iron and ammonia.....	3 "
Water.....	20 "

printed more rapidly. This preparation I continue to use when much time may elapse between sensitizing and printing; but, when the paper is to be printed immediately after sensitizing, I use a larger proportion of citrate of iron and ammonia. Before arriving at the conclusion that these proportions were the best to be used, I made a series of purely empirical experiments, beginning with the proportions:

Red prussiate of potash.....	10 parts.
Citrate of iron and ammonia.....	1 part.
Water.....	50 parts.

and ending with the proportions:

Red prussiate of potash.....	1 part.
Citrate of iron and ammonia.....	10 parts.
Water.....	50 "

I found the best plan for conducting these experiments to be: To coat a sheet of the paper with a given mixture; to cut the sheet into strips before exposure; to expose all the strips of the sheet, at the same time, to the direct sunlight without an intervening negative; and to withdraw them, one after another, at stated intervals. I found that with each mixture there was a time of exposure which would produce the deepest blue, that with over-exposure the blue gradually turned gray, and that if a curve should be plotted, the abscissas of which should represent the time of exposure, and the ordinates of which should represent the intensity of the blue, the curves drawn would have approximately an elliptical form, so that if one knew the exact time of exposure which would give the best result with any mixture, one might deviate two or three minutes either way from that time without producing a noticeable result. I have found that, with the same paper, the same blue results with any good proportions of the chemicals named, provided a sufficient weight of both chemicals is applied to the surface; that an excess of the red prussiate of potash renders the preparation less sensitive to light, and very much lengthens the necessary time of exposure; that the prints are finer with some excess of the red prussiate; that an excess of the citrate of iron and ammonia hastens the time of printing materially; that a greater excess of the citrate causes the whites to become badly stained by the iron, while a still greater excess of the citrate, in a concentrated solution causes the sensitized paper to change without exposure to light, and to produce a redder blue or purple, which does not adhere to the paper, but may be washed off with a sponge. I have found that the cheapest method of reproducing inked drawings that have been made on thick paper is not to trace them, but to print the blues from a photographic glass negative; and also, that the dry plate process is well adapted to such work in offices, when one has become sufficiently experienced. Printed matter can almost easily and inexpensively be reproduced by the same means, when a small issue is required on each successive year. For the reproduction of manuscript by the blue process, the best plan that I have found has been to write the manuscript upon the thinnest blue-tinted French note-paper, with black opaque ink—the stylographic ink is very good—and, afterward, to dip the paper into melted paraffine, and to dry the paper at the melting temperature. This operation, if cheaply done, requires special apparatus. For positive printing from the glass negative, I use a multiple frame, by the aid of which I can print from 16 negatives at the same time, upon a single sheet of paper. This frame is interchangeable with the one that contains the plate glass. The negatives are so arranged in the frame that the sheets can be cut and bound, as in the ordinary process of book-binding. The time required for exposure, when printing from glass negatives, varies with the negative; and, in order to secure satisfactory results with the multiple frame it is necessary to stop the exposure of some, while the exposure of others is continued. I insert wooden or cloth stoppers into the frame for the purpose of stopping the exposure of certain negatives. When paraffined manuscript is to be printed from, I find it convenient to have it written on sheets of small size, and to have these mounted upon an opaque frame of brown Manila paper, printing sixteen or more at a time, depending upon the size of the printing frame. Many small tracings may be similarly mounted upon a brown paper multiple frame, and may be printed together upon a single sheet.

SPECTRUM GRATINGS.

At a recent meeting of the London Physical Society, Prof. Rowland, of Baltimore, exhibited a number of his new concave gratings for giving a diffraction spectrum. He explained the theory of their action. Gratings can be ruled on any surface, if the lines are at a proper distance apart and of the proper form. The best surface, however, is a cylindrical or spherical one. The gratings are solid slabs of polished speculum metal ruled with lines equidistant by a special machine of Prof. Rowland's invention. An account of this machine will be published shortly. The number of lines per inch varied in the specimens shown from 5,000 to 42,000, but higher numbers can be engraved by the cutting diamond. The author has designed an ingenious mechanical arrangement for keeping the photographic plates in focus. In this way photographs of great distinctness can be obtained. Prof. Rowland exhibited some 10 inches long, which showed

the E line doubled, and the large B group very clearly. Lines are divided by this method which have never been divided before, and the work of photographing takes a mere fraction of the time formerly required. A photographic plate sensitive throughout its length is got by means of a mixture of eosene, iodized collodion, and bromized collodion. Prof. Rowland and Captain Abney, R.E., are at present engaged in preparing a new map of the whole spectrum with a focus of 18 feet.

In reply to Mr. Hilger, F.R.A.S., the author stated that if the metal is the true speculum metal used by Lord Rosse, it would stand the effects of climate, he thought; but if too much copper were put in, it might not.

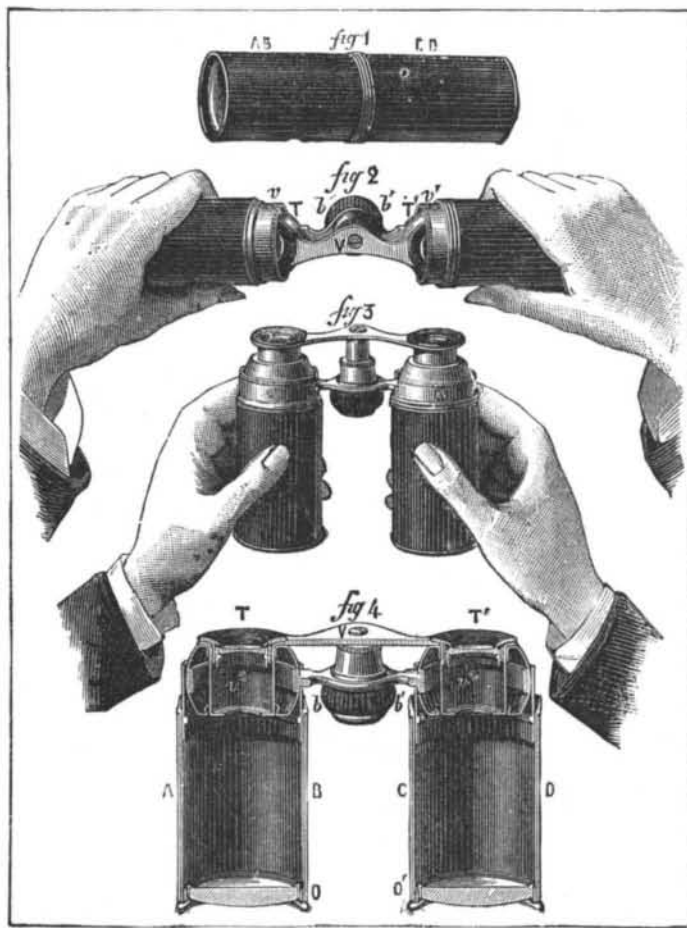
In reply to Mr. Warren de la Rue, Prof. Rowland said that 42,000 was the largest number of lines he had yet required to engrave on the metal.

Prof. Guthrie read a letter from Captain Abney, pointing out that Prof. Rowland's plates gave clearer spectra than any others; they were free from "ghosts," caused by periodicity in the ruling, and the speculum metal had no particular absorption.

Prof. Dewar, F.R.S., observed that Prof. Liveing and he had been engaged for three years past in preparing a map of the ultra-violet spectrum, which would soon be published. He considered the concave gratings to make a new departure in the subject, and that they would have greatly facilitated the preparation of his map.

A NEW POCKET OPERA GLASS.

INASMUCH as high power combined with small size is usually required in an opera glass, manufacturers have always striven to unite these two features in their instruments, and have succeeded in producing glasses which, although sufficiently small to be carried in the waistcoat pocket, are nevertheless powerful enough to allow quite distant objects to be clearly distinguished. Recently, a Parisian optician has succeeded in constructing an instrument of this kind that is somewhat of a novelty in its way, since its mechanism



POCKET OPERA GLASS.

ism allows it to be closed in such a manner as to take up no more space than a package of cigarettes (Fig. 1.) It is constructed as follows:

AB and CD (Fig. 1) are two metallic tubes, in which slide with slight friction two other tubes. Into the upper part of the latter are inserted two hollow elliptical eye-pieces, which move therein with slight friction, and which are united by the two supports for the wheel, *bb'* (Fig. 4), and endless screw that serve for focusing the instrument. The eye-pieces, *TT'*, are held in the tube by means of two screws, *vv'* (Figs. 2 and 4), in such a way that they can revolve around the latter as axes. The lenses of the eye-piece are fixed therein by means of a copper ring. The object glasses are placed in the ends of the tubes, AB and CD, at *oo'*.

When the instrument is closed, it forms a cylinder 35 millimeters in diameter by 11 centimeters in length. To open it, it is grasped by the extremities and drawn apart horizontally so as to bring it into the position shown in Fig. 2. Then it is turned over so that the screw, *V*, points upward, while at the same time the two tubes are pressed gently downward. This causes the eye-pieces to revolve around their axes, *vv'*, and brings the two tubes parallel with each other.—*La Nature*.

ANCIENT GREEK PAINTING.

A LECTURE on ancient Greek painting was lately delivered by Professor C. T. Newton, C.B., at University College, London. The lecturer began by reminding his audience of the course of lectures on Greek sculpture, from the earliest times to the Roman period, which he completed this year. The main epochs in the history of ancient sculpture had an intimate connection with the general history of the Greeks, with their intellectual, political, and social development. We could not profitably study the history of ancient sculpture except as part of the collateral study of ancient life as a whole, nor could we get a clear idea of the history of ancient sculpture without tracing out, so far as our imperfect knowledge permits, the characteristics and successive stages of ancient painting. Between these twin sister arts there had been in

all times, and especially in Greek antiquity, a close sympathy and a reciprocal influence. The method in dealing with the history of Greek painting in this course would be similar to that adopted in the course on sculpture. The evidence of ancient authors as to the works and characteristics of Greek painters would be first examined, then the extant monuments which illustrate the history of this branch of art would be described. In the case of painting, the extant monuments were few and far between, but we might learn much by the careful study of the mural paintings from the buried Campanian cities, Pompeii, Herculaneum, and those found in the tombs near Rome and Etruria. The paintings on Greek vases would enable us to trace the history of what is called ceramic art from B.C. 600 for nearly five centuries onward.

After noticing the traditions preserved by Pliny and others as to the earliest painters, the lecturer passed on to the period after the Persian war. Polygnotos of Thasos was the earliest Greek painter of celebrity. He flourished B.C. 480-460. At Athens he decorated with paintings the portico called the Stoa Poikile, the Temple of the Dioscuri, the Temple of Theseus, and the Pinakothek on the Akropolis. At Delphi he painted on the walls of the building called Lesche two celebrated pictures, the taking of Troy and the descent of Ulysses into Hades. All these were mural paintings; the subjects were partly mythical, partly historical. Thus in the Stoa Poikile were represented the taking of Troy, the battle of Theseus with the Amazons, the battle of Marathon. In the Temple of Theseus came the battle of the Lapiths and Centaurs and the battle of the Amazons again. In the other two Athenian temples he treated mythological subjects. These great public works were executed during the administration of Kimon, to whom Polygnotos stood in the same relation as Phidias did to Perikles, the successor of Kimon. The paintings in the Stoa Poikile were executed by Polygnotos gratuitously, for which service the Athenians rewarded him with the freedom of their city. His greatest and probably his earliest works were the two pictures in the Lesche at Delphi. Of these there was a very full description

in Pausanias. The building called Lesche was thought to have been of elliptical form, with a colonnade on either side, separated by a wall in the middle, and to have been about 90 ft in length. The figures were probably life-size.

According to the list given by Pausanias, there were upward of seventy in each of the two pictures. In that representing the taking of Troy, Polygnotos had brought together many incidents described in the Cyclic epics. Menelaos, Agamemnon, Ulysses, Nestor, Neoptolemos, Antenor, Helen, Andromache, Cassandra, and many other figures, with which the Homeric poems have made us familiar, all appeared united in one skillful composition, arranged in groups. The other picture, the descent of Ulysses into Hades to interrogate Teiresias, might be called a pictorial epic of Hades. On one side was the entrance, indicated by Charon's boat crossing the Acheron, and the evocation of Teiresias by Ulysses, besides the punishment of Tityos and other wicked men; on the other side were Tantalos and Sisyphos. Between these scenes, on the flanks, were various groups of heroes and heroines from the Trojan and other legends. From the remarks of ancient critics, it might be inferred that the genius of Polygnotos, like that of Giotto, was far in advance of his technical skill. Aristotle called him the most ethical of painters, and recommended the young artist to study his works in preference to those of his contemporary Pauson, who was ignobly realistic, or those of Zeuxis, who had great technical merit, but was deficient in spiritual conception. The course will comprise four more lectures, as follows: November 17, "Greek Painters from B.C. 460 to Accession of Alexander the Great, B.C. 336—Apollodoros, Zeuxis, Parrhasios, Pamphilos, Aristides;" November 24, "Greek Painters from Age of Alexander to Augustan Age—Apelles, Protogenes, Theon;" December 1, "Pictures on Greek Fictile Vases;" December 15, "Mural Paintings from Pompeii, Herculaneum, and other Ancient sites."

THE new Iowa State Capitol has thus far cost \$2,000,000, and it will require \$500,000 to finish it. It is 365 feet long from north to south, and measures 274 feet from the sidewalk to the top of the central dome.