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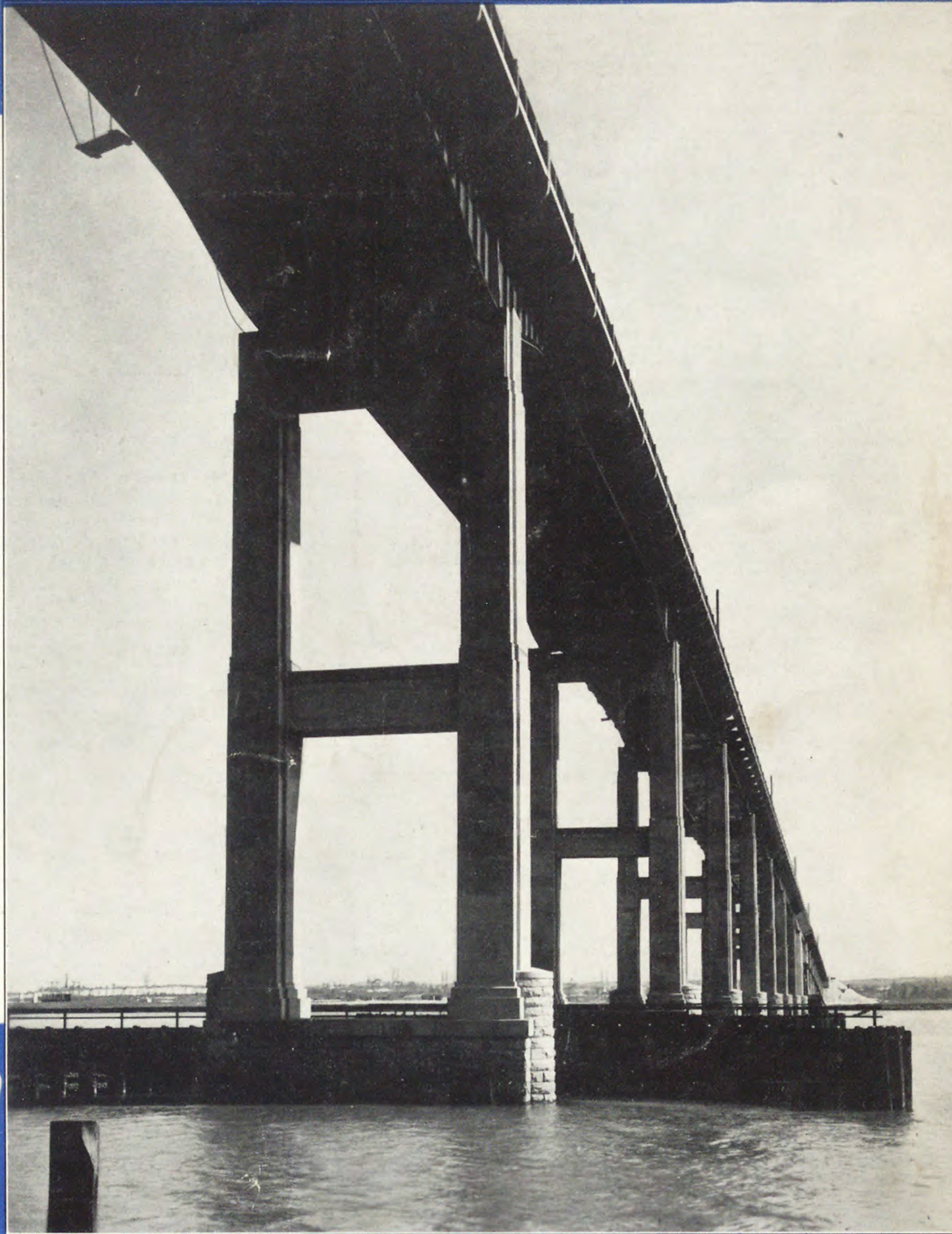

Edison Memorial Bridge at Perth Amboy, New Jersey

"COURTESY N. J. STATE HIGHWAY DEPT."

Newark ENGINEERING NOTES

Readers may be aware of the fact that this issue of the NEWARK ENGINEERING NOTES has not been published as early as planned. All the material which goes to make up the contents of the magazine is contributed by members of our faculty, alumni, and friends.

At this time, our staff is working on greatly augmented schedules. In addition to regular teaching assignments, nearly all these men have classes in the National Defense Training Program, which takes up so much of their time that our editorial board is sorely pressed to obtain articles of the type we like to publish. An appreciation of these factors will probably make clear to readers the difficulty in maintaining publishing dates.

NEWARK ENGINEERING NOTES

A Technical Magazine

for

Chemical, Civil, Electrical, and Mechanical Engineers

▪ ▪

The circulation of 4,000 includes executive engineers with industrial concerns, manufacturers, architects, and engineers in the State of New Jersey as well as public libraries.

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▪ ▪

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DO YOU WANT TO BE ON OUR MAILING LIST?

From time to time you will receive a copy of the NEWARK ENGINEERING NOTES. In case you wish to receive this magazine regularly, the only thing you have to do is to write us and say so. Address your letter to the Editor, Newark Engineering Notes, Newark College of Engineering, Newark, N. J.

THE PRESIDENT'S DIARY

January 15th

Gradually, but nevertheless surely, we are becoming defense minded, and while about some phases of the program in some localities there may be a little hysteria, in the main, definite progress is being made.

It is evident we live in a Democracy. There is much individual effort. Many defense agencies are in the field. All of them are working hard, sometimes without knowing what the other fellow is doing, sometimes even without knowing of the other fellow's existence. Integration takes time, and coöperation is not always easily established. Individuality finds difficulty in giving up its special privileges for the benefit of the situation as a whole. Agencies, like individuals, are jealous of their rights and privileges. Prestige is one of the strongest urges to which flesh is heir.

Much, and I hope we are able to say most, of this overlapping and duplication of function is unconscious and springs from pure ignorance coupled with a desire to be truly patriotic and help with things. A little is associated with a purely selfish motive of profit, but I think the number of conscious profiteers is growing less each day. In this regard, the situation is distinctly better than that of some twenty odd years ago.

There is still a host of unconscious profiteers who in their thinking cannot divorce themselves from the idea of profit which has so long been uppermost in their minds: publicity seekers, those who cannot see how the country can win unless their "better mousetraps" are produced in greater numbers and at a greater profit; people who just naturally—because they have grown used to it—can hang no picture but their own over the fireplace; people whose defense ideas are the only ideas.

Perhaps our three greatest enemies as against coöperation are selfishness, prestige, and more selfishness.

To this there can be only one answer—sacrifice. I have not been in England, but recently an appearance before the Engineering Institute of Canada gave me a chance to talk with men in high places in the Dominion's war effort. Even across the Atlantic from England to our north, sacrifice is welding people together, making the impossible happen and coöperation possible. I sometimes wonder whether we in America, that is, the United States part of it, are not a long way off from sacrifice. Grabbing is easier and more to be desired than giving.

We engineers chafe at this delay, this lack of material coöperation, this lack of what we call efficiency. If we could only get hold of things and manage them—make people work—make people coöperate—how easily and quickly and effectively things *might* be done, and how our defense program might develop. If *we* only had the say and could issue the proper orders at the proper time and get things done. If we could only dictate.

But we are in a Democracy, and that isn't our way. We must discuss and delay and have hearings and let every man have his say for good or ill. That right so to do is the very essence of our way of life. We are fighting, although at peace. Dictatorship, or the right of any group to dictate, is the heart of our struggle. For this we must continue to fight and go down if we must, fighting it. Somewhere along the line, when we are hurt badly enough and the other fellow is hurt badly enough, we will all get together as "one nation indivisible."

I once heard a father say to his very young son just before a spanking, "I'll have to hurt you to make you realize."

If we could only realize without going further than just a spanking.

February 15th

A month has passed and we are, I think, a little nearer indivisibility, but not near enough. I've often wondered if parables weren't the best, the very best teaching technique. In one or two recent talks I've tried to express my idea of the situation and a solution simply as follows:

A man and his wife, both in their fifties, are canoeing and the craft upsets. It is half a mile to shore, and while the man is a fair swimmer, his wife can't help herself very much. The situation is serious. Mr. U. S. Citizen knows that he can make it surely if he were to sacrifice the thing he cherishes most, but if he has to drag and fight for both lives all the way, that his job is a tremendously difficult one. Mr. U. S. Citizen and his wife, Democracy, are in a tough spot, but life without her simply wouldn't be worth living. So he struggles on as we are struggling now. Sometimes Democracy's efforts really hinder, and they hardly ever seem to help. If he could only let her go and spend all his energies in the business of getting to land.

How easy to plunge ahead without her hindrance, leave Democracy to her fate, and gain—what? He just can't sacrifice her and look forward to what the future holds.

So together, the man-power of our Nation and Democracy fight their way to shore.

The struggle teaches that Democracy must be taught how to take care of herself in deep water—she must be taught to swim and not to struggle.

* * *

To this we should address ourselves. To teach and strengthen Democracy to the utmost. By continued and continual insistence that every man and woman in this land assume the personal responsibility to share and take part in the *practice* as well as in the *preaching* of Democratic ideals.

To make our government a composite of all of us and to ensure to her the best that is in each of us is to make her strong. To do less is plain neglect of duty. Once a great English Admiral at the start of a decisive battle hoisted the signal flags which read, "England expects that every man will do his duty." Shall we in America expect or wish to do less?

ALLAN R. CULLIMORE

February 24, 1941

MOVE OVER, MR. FIELD MAN

By Marvin B. Scher, C.E.

B.S. 1937, in Civil Engineering, Newark College of Engineering

U. S. Geological Survey

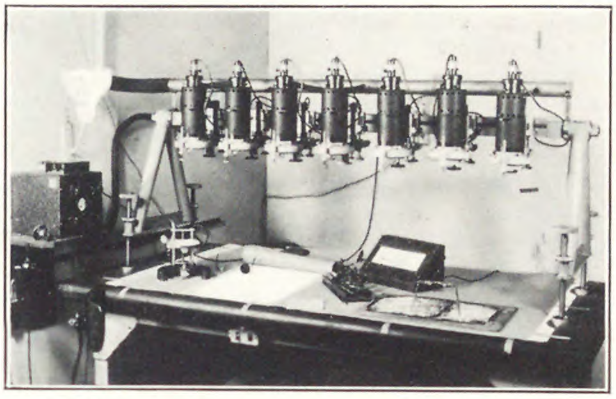
Since 1917 the United States Geological Survey has been an active agency in the promotion of the use of aerial photographs for mapping purposes. A large percentage of topographers are now familiar with mapping methods employing photographs of both aerial and terrestrial natures. The student in surveying has heard of the radial line method for transferring data from an aerial photograph to a topographic or planimetric map. More recent is the development of instruments using the principle of stereoscopy to create miniature optical replicas of the landscape in which the mapping is accomplished by means of measurement and observation. The Multiplex Aeroprojector is one of the most interesting of these developments, and its use by the Geological Survey emphasizes its importance among the present day stereoscopic mapping instruments in the United States.

To the young engineer graduate with topographic aspirations, the multiplex operator may appear to be a dull figure when compared to the rough-and-ready, outdoor, high-booted, pipe-smoking, plane-table topographer. The operator does his mapping indoors in a dark, windowless room with the only illumination coming from two small light projectors. The older topographer, who might be slightly tired of moving himself and his family all over the country with each change of season, and of exposing himself to all kinds of weather conditions, may welcome the opportunity to establish a home of more permanent nature for his family and appreciate definite working hours under more constant and more favorable conditions. Mapping with the multiplex does offer these advantages, and the likes and dislikes of the individual determine which type of mapping is more interesting to him.

The Multiplex Aeroprojector is a means by which a faithful stereoscopic optical model of the terrain to be mapped may be projected, oriented, observed, and measured. Since it is necessary during certain of the operations involved in working with the equipment to have the room lights on and at other times off, each complete unit is located in a separate small office in order that each operator may use his lights according to his needs without hampering the work of another. In the Chattanooga office, where the U. S. Geological Survey is engaged in mapping the Tennessee Valley, there are fifteen of those small offices, each similarly equipped. The main features of each complete unit are several adjustable light projectors suspended on a horizontal bar, which in turn is supported by adjustable uprights. The uprights rest on a very heavy flat slate table, the surface of which may be considered perfectly plane. The measuring instrument is a small movable tracing table. Each room is equipped with a transformer and rheostats for controlling the intensity of light of each projector.

The purpose of each projector is to duplicate in the office the relative position of the aerial camera at the instant of one particular camera exposure. The seven-inch square negative, which is made with a wide-angle precision aerial camera of four-inch focal length, is greatly reduced in the photographic laboratory by means of a special reduction printer onto a 45 x 60 millimeter glass plate. This diapositive, as it is called, is supported on a glass platform in the projector, and when projected by this instrument causes a cone of rays to emanate which is essentially identical with the cone of rays which formed the image in the aerial camera. The effect of slight displacements in the pencil of rays, due to distortion inherent in the lenses employed, can be determined and compensated in the use of the Multiplex Aeroprojectors so that the resulting maps are not adversely affected by their presence. The projector has two adjustments which are used to line up the principal point of the diapositive with the principal point of the projector. The projector has six motions or adjustments, all of which must be used in obtaining its proper orientation. Three of these motions, which are called the X, Y, and Z motions, give the projector its proper relative space location. X is a motion "along the bar" or in the direction of the flight of the airplane and is parallel to sea level; Y is a motion "to, or away from, the operator" or perpendicular to X but in the same horizontal plane; Z is the "up or down motion" which adjusts the projector to its proper flight height. The three remaining motions are tip, tilt, and swing. The tip motion affects the projector just as the camera might have been affected had the plane been climbing or descending at the instant of exposure. The tilting motion would angle the projector in a plane perpendicular to the tip motion and would have an effect on the projector similar to that on the camera had the plane been in a banked position. The swing motion is necessary to orient the projector to the same relative azimuth of the camera in the plane. Each projector has a lamp house containing a light source and a condensing lens system. The lamp house also has a slot in which a red or a blue light filter may be inserted to color the projected light. The bulbs used in the lamp house are rated as 20-volt, 100-watts, and intensity of their light may easily be regulated by the rheostats in the transformer.

The heavy slate table, which is plane to within two or three thousandths of an inch, is used as a reference surface and is considered to be parallel to sea level. The adjustments on the uprights supporting the horizontal bar are such that the entire bar may be raised, lowered, tipped, or tilted. The map sheet is taped to the heavy slate table and is, therefore, automatically parallel to

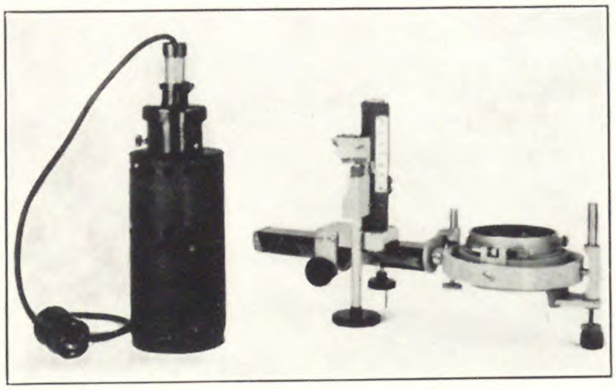


Assembly of Equipment in Typical Multiplex Office

sea level. After the projectors are adjusted with respect to each other the optical models are oriented as a unit by means of adjustments of the uprights until they satisfactorily comply with the elevations of object points as determined by field survey parties.

The tracing table is an ingenious device for observing and measuring in the optical model. It has a circular projection screen which is coated white with magnesium oxide, thereby making it an excellent reflecting surface for the rays emanating from the projectors. It is on this platen that the optical model is observed. In the center of this platen there is a tiny luminous point which is the measuring point and which is referred to as the "floating dot." Directly below the "dot" is a pencil point which may be raised from or lowered to the drawing paper as desired. The table moves freely over the map sheet, and any point in the optical model may be investigated and measured for elevation. The platen may be moved up or down by a controlling screw device. A vertical scale with vernier reading attachment on the table enables the operator to set the platen at any vertical setting or to read any particular elevation he chooses. There is, of course, a simple chart to convert the reading of the scale to actual feet of elevation. Elevations are read by so adjusting the dot that it appears to be in contact with the object being observed.

The first comment of a visitor looking at the optical model formed by the multiplex equipment is that it is a view similar to that which one might expect to observe from an airplane.



Wide-Angle Projector

This impression is created only by the size of the images, and is incorrect, as the stereoscopic perception of the ground from an airplane 12,000 feet high or more, using the normal eye base, is negligible. The multiplex is, in a sense, a means of placing one eye at one camera station and the other eye at the point of the next camera exposure, which may be several miles distant, thus greatly enhancing the stereoscopic effect. The operator works in one optical model at a time, a model being formed by the overlapping sections of two successive pictures, one of which is projected in blue light, and the other in red. The operator observes the reflection of the blue and red rays on the platen of the tracing table with corresponding blue and red filters in front of his eyes. This enables him to observe the two successive pictures simultaneously and individually. The combined effects of both pictures result in a stereoscopic perception of the terrain.

While this paper deals primarily with the operation of the multiplex instrument, some knowledge of the preparatory work preceding the multiplex operation is necessary to a complete understanding of its performance. Before the mapping project can be started, decisions governing the mapping scale, contour interval, and the aerial camera to be used, must be made. These decisions will be based on the accuracy needed, the cost of the multiplex operation itself, the available funds, the amount of horizontal and vertical ground control required and its cost, the type of terrain, and the purpose and the need of the final map. Flight strips over the desired area to be mapped must be planned and the desirable flight height ascertained. The Geological Survey has learned that the flight height must be about 600 times the designated contour interval with the instruments now in use, if the accuracy is to comply with the specifications for a map of good quality. The specification used at present requires that the errors of 90 per cent of the tested elevations shall not exceed one-half a contour interval.

The type of the aerial camera to be used is governed by its optical characteristics and its metrical excellence. The success of multiplex mappnig is greatly dependent upon the close maintenance of the correct ratio of the principal distance of the aerial camera to the principal distance of the multiplex aeroprojectors. It is just as important for the focal plane of the camera to be perpendicular to the camera lens axis as it is for the diapositive to lie in a plane perpendicular to the projector axis. The Geological Survey is now using both the normal and the wide angle type of multiplex projectors. The normal type projects a 70° cone of rays and is generally employed in construction of planimetric base maps which are to be contoured in the field by plane table methods. They are not so economical in use as the wide angle type, due to their restricted field of view. Since the wide angle projectors are of later design and project a 90° cone of rays, they require a different type of camera. The Survey employs a single lens precision type camera of 21 centimeters focal length and 18 x 24 centimeters negative size for use in conjunction with the normal type projector. A Zeiss single-lens wide-angle camera with a focal length of 10 centimeters and a negative size of 18 x 18 centimeters is recommended for use with the wide-angle type projectors.

When the preliminary planning is complete, the aerial photographs are taken as the airplane flies over a designated strip of land. The exposures are timed at intervals which will allow each picture to overlap the preceding one by approximately 60 per cent. The negatives of these pictures are placed in a reducing camera for the purpose of printing the small diapositives. These reduced transparent glass positives of the original negatives must be made by a technician skilled in such work, and the reducing camera must have been adjusted with great care to assure a maximum sharpness of image and a size such that the desired angular cone of rays will be projected. The negative is held flat by a heavy glass plate, and its principal point is made to coincide with the axis of the reducer lens.

Preparation of the map sheet includes the drawing of the proper latitude and longitude projection lines for the particular sheet and the plotting of all available horizontal control points.

The multiplex operator is ready to begin work when he has received the diapositives, the map sheet, and information regarding vertical control. The diapositives are placed in order in their respective projectors, each of which is to represent a camera station. Relative orientation, which must first be achieved before stereoscopic perception is possible, is obtained when one projector bears the exact similar relationship to its adjacent projector as the camera station it represents in space had to its adjacent station. This is obtained by observation in the model and by manipulation of all six of the projector adjustments. This operation and, in fact, all multiplex work, requires a high vision acuity on the part of the operator. A systematic method of adjustments and operations has been established, and as the operator becomes more experienced, he becomes more adept at "guessing" what motion is more likely to be most effective in gaining the particular orientation. When relative orientation is obtained there will be no "Y-parallax" in any part of the model. Y-parallax is the displacement of corresponding red and blue image points in the Y direction and manifests itself in the "fuzziness" or lack of stereoscopic perception. The displacement of the corresponding red and blue images in the X direction gives the observer the perception of relief.

When all the Y-parallax is removed the operator observes a clearly defined stereoscopic optical model. The model at this stage is usually of incorrect scale and bears no relationship to a datum plane. The process of scaling the model and of leveling it to a plane parallel to sea level is called absolute orientation. The operator attains this orientation by adjusting the optical model to fit the horizontal and vertical control already plotted on the map sheet. The amount of adjustment necessary to obtain the orientation is determined by horizontal and vertical measurements in the optical model with the floating "dot." The scale is adjusted by increasing or decreasing the distance between the projectors in the X direction. The model is leveled by tipping and tilting the supporting bar through the necessary amounts until the control points appear to be at their proper horizontal scale positions and elevations. It is desirable to have the vertical control points, the elevations of which have been determined by field survey methods, in each of the four corners of the model. Road and fence intersections, corners of large buildings, isolated trees and other such definite features make good control points.

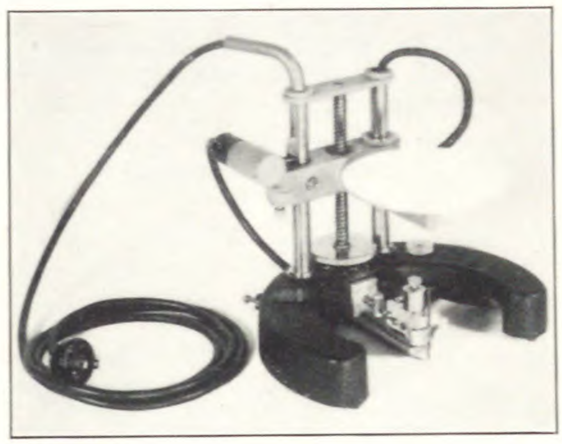
When absolute orientation is achieved the stereoscopic optical model is a true reduced replica of the actual terrain which was photographed. All horizontal and vertical distances in the model are to the scale of the map. The optical model may be considered rigid and physically solid. When the platen of the tracing table is moved up or down within the perception range of the model, the corresponding red and blue images on the plate move closer together or farther apart in the X direction. Since the operator is wearing the colored light filters in front of his eyes he does not observe the shift of images or any change in the shape of the model. Raising the table has the effect of making the "dot" appear to rise in the model. In this manner the "dot" may be raised or lowered relative to the model at will. To read a particular elevation in the model the operator raises or lowers the table until the "dot" appears to be at the elevation of the point to be determined, and the vertical scale is read at that setting.

Delineation of the culture in the model is normally the first mapping step. With the pencil point in contact with the sheet, the operator traces roads in the model with the floating "dot," keeping it always at the apparent elevation of the road as its meanders are traced out. Similarly, the horizontal projections of other cultural features such as railroads, trails, transmission lines, property lines, and all visible buildings are delineated on the map sheet. Although property lines do not appear on the final published map, they are invaluable to the field parties which make a necessary completion survey and are customarily shown on the original drawing. The outlines of all water bodies and the courses of all visible drainage are likewise traced. Timbered sections are located by tracing their outlines. Contours are traced by keeping the "floating "dot" fixed in height and in contact with the apparent surface of the ground while it is guided over the model. The tracing table is set for each contour line at the proper converted scale elevation, and if the "dot" is not allowed to float over or dig in the model, the pencil point will trace a meandering line which is a contour. When one contour is completed, the table is raised or lowered the scale amount of the contour interval, and the next contour is traced.

A field completion survey is necessary after the multiplex operator has completed his work. All roads must be classified, and State, County, and other important division boundaries must be located. Omitted houses, which were not visible to the operator, must be added, and all erroneous delineation due to misinterpretation in the optical model must be redrawn in the field. The completion survey is also responsible for obtaining information regarding and verification of local names and the position of various bench marks on the map.

The necessary educational qualifications of a multiplex operator are much the same as those of a surveyor or a plane table topographer. Since this new method of topographic mapping is still comparatively in the infant stage, it is difficult to predict just what will be expected of the operator in the future. The present operators engaged in the multiplex mapping of the Tennessee Valley Area are either topographic engineers with years of experience in field methods of mapping or young civil engineering graduates with no prior topographic experience other than the course offered in college curricula. If the future operators are to understand the optics and the analytical photogrammetry involved in the process, the same standard must be maintained. Not enough weight can be placed on the necessity of a topographic sense. The ability to interpret the terrain and to draw the respective contours in a manner which correctly represents the configuration of the terrain is important. The younger men must take their hats off to the experienced field topographers in this respect. Accuracy of drafting is, of course, essential. Neatness of drafting is desirable.

The accuracy of maps made by means of the aeroprojectors is dependent upon several features. Errors caused by distortion of photographs due to lens design have already been greatly reduced, if not eliminated. Further development of this mapping process will encourage further improvements in the increasing mechanical precision of the aerial camera and the perfecting of diapositive emulsions and film bases. The personal factor may be troublesome when there is difficulty in interpreting the model at a point of control. The ratio of the distance between camera stations to the flight height bears a definite relationship to the precision of stereoscopic measurements; therefore, means of assuring uniform overlap of the photographs must be sought. The clearness of the optical model is dependent somewhat upon the photographic qualities of the terrain.



The Tracing Table

The maps made in the Chattanooga office of the Geological Survey are subjected to a field inspection by the Tennessee Valley Authority to determine their accuracy. These field tests are made by running a meandering transit-level traverse between two points of known vertical and horizontal positions. A comparison of the instrumental and map profiles thus obtained reveals the accuracy of the maps in the hills, lowlands, open and heavily timbered areas. The results have shown that for 1:10,000-scale maps having a contour interval of 20 feet, made from aerial photographs exposed at 12,000 feet altitude, over 90 per cent of the errors of tested elevations fall within one-half of the contour interval, and that the average error of interpolated elevations is about four feet. The multiplex maps have proved to be of great accuracy, particularly in the matter of planimetric detail.

The multiplex has proved itself best adapted to mountainous areas and rolling country where a 20 or 40 foot contour interval is sufficient to show the nature and the characteristics of the terrain. The planimetric base maps prepared by the multiplex for completion by the plane table have been praised by the field men who use them. No other method of mapping areas of low relief excels this combination for accuracy, speed, and cost. Since multiplex production rates are completely independent of weather conditions, production schedules are much more easily planned and maintained. The scale of the original drawing is necessarily larger than that customarily used by the Geological

(Please turn to page 9)

FORMULAS FOR THE SOLUTION OF CATENARY PROBLEMS

By JOSEPH JOFFE, A.B., B.S., M.A., Ph.D.

Professor in Chemical Engineering, Newark College of Engineering

(Reprinted with permission from *Civil Engineering* for May, 1940)

Equations of the common catenary involve transcendental functions and frequently have to be solved by approximate methods. In this article Newton's method for the solution of equations is used to derive formulas by means of which catenary problems may be solved accurately and systematically. In the discussion that follows, only the catenary with supports at the same level (Fig. 1) will be considered.

The problems may be separated into three types, in which: (1) the span, a, and the sag, b, are given; (2) the span, a, and

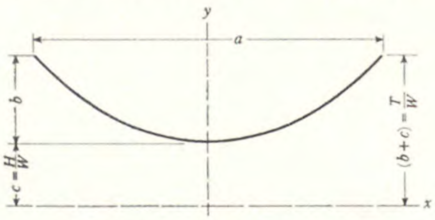


Figure 1. The Catenary

the length of the cable, L, are given; (3) the span, a, and the tension, T, at the point of support are given. In all three cases, w, the weight or load per unit length of cable, is also given. The solution in each case consists in first finding c from the equations of the catenary, c being defined as H/w, where H is the minimum tension in the cable. A preliminary value of c must be obtained either by trial or by assuming the curve to be a parabola as a first approximation.

Consider the case where the span and sag are given. From the equation of the parabola we have $c_1 = \frac{a^2}{8b}$. Applying Newton's method, if $c = c_1$ is an approximate solution of the equation $f(c) = 0$, it follows that a more accurate solution is $c = c_2$ where

$$c_2 = c_1 - \frac{f(c_1)}{f'(c_1)} \qquad (1)$$

The equation of the catenary may be written as

$$\cosh \frac{a}{2c} - 1 - \frac{b}{c} = 0 \qquad (2)$$

Applying Eq. 1, we have

$$c_2 = c_1 + c_1 \frac{c_1 \cosh \frac{a}{2c_1} - c_1 - b}{\frac{a}{2} \sinh \frac{a}{2c_1} - b} \qquad (3)$$

Since c_3 may be obtained from c_2 by applying Eq. 1 a second time, we have in general:

$$c_{n+1} = c_n + c_n \frac{c_n \left(\cosh \frac{a}{2c_n} - 1 \right) - b}{\frac{a}{2} \sinh \frac{a}{2c_n} - b} \qquad (4)$$

We solve the following illustrative problem with the aid of Eq. 4: $a = 500$ ft., $b = 80$ ft., $w = 6$ lbs. per ft.; to find the minimum and maximum tensions in the cable.

$$c_1 = \frac{500^2}{80 \times 80} = 391$$

$$c_2 = 391 + 391 \frac{391 \left(\cosh \frac{500}{782} - 1 \right) - 80}{250 \sinh \frac{500}{782} - 80} = 402.6$$

$$c_3 = 402.6 + 402.6 \frac{402.6 \left(\cosh \frac{500}{805.2} - 1 \right) - 80}{250 \sinh \frac{500}{805.2} - 80} = 403.4$$

$$c_4 = 403.4 + 403.4 \frac{403.4 \left(\cosh \frac{500}{806.8} - 1 \right) - 80}{250 \sinh \frac{500}{806.8} - 80}$$

i.e., $c_4 = 403.4 - 0.19 = 403.2$.

The value of $c = 403.2$ may be checked by substitution in Eq. 2:

$$\cosh \frac{500}{806.4} - 1 - \frac{80}{403.2} = 0$$

or, $1.1984 - 1 - 0.1984 = 0$.

It follows that the minimum tension $H = wc = 6 \times 403.2 = 2{,}419$ lbs., and the maximum tension $T = w(b + c) = 6 \times 483.2 = 2{,}899$ lbs.

To derive a formula for the case where the span and length of cable are given, we proceed as before, using the equation

$$\frac{L}{c} - 2 \sinh \frac{a}{2c} = 0 \qquad (5)$$

Applying Eq. 1,

$$c_{n+1} = c_n + c_n \frac{2c_n \sinh \frac{a}{2c_n} - L}{a \cosh \frac{a}{2c_n} - L} \qquad (6)$$

Finally, for the case where the maximum tension and span are given, we use the equation:

$$\frac{T}{wc} - \cosh \frac{a}{2c} = 0 \qquad (7)$$

Applying Eq. 1,

$$c_{n+1} = c_n + c_n \frac{c_n \cosh \frac{a}{2c_n} - \frac{T}{W}}{\frac{a}{2} \sinh \frac{a}{2c_n} - \frac{T}{W}} \qquad (8)$$

Two, or at the most three, applications of Eq. 4, 6, or 8 are usually found sufficient in the solution of the three types of problems on the catenary discussed above. In those cases where the ratio of sag to span is small, after a preliminary value of c is obtained on the assumption that the curve is a parabola, a single application of Eq. 4, 6, or 8 may be sufficient.

Comments by Bedross Koshkarian, Professor in Theoretical and Applied Mechanics, Newark College of Engineering

Dr. Joffe's three formulas for catenary calculations are very neat and interesting indeed. However, inasmuch as the ordinary tables on hyperbolic functions give the values of these functions for arguments consisting of only three significant figures a more accurate determination of cosh u and sinh u involved in these formulas necessitate interpolation, by Sterling's formula say, which will take considerable time. This circumstance, in addition to the necessity in general of "two, or at the most three, applications" seems to make the formulas of doubtful advantage over other methods of calculation.

The solution of the three cases of catenary problems, considered by Dr. Joffe, by means of infinite series seems to have a decided advantage over the successive approximation method. For the solution of the problems by infinite series, our readers are referred to the *Mechanics* of Professor James E. Boyd.

To show the power of the solution by infinite series, let us take Dr. Joffe's illustrative example.

To derive the infinite series required for this case, let us take the equation of the catenary in the form

$$y = c \cosh \frac{x}{c}$$

which may be put in the form

$$\frac{y - c}{x} = \frac{\cosh \frac{x}{c} - 1}{\frac{x}{c}} \quad \text{(9)}$$

But

$$\cosh \frac{x}{c} = 1 + \frac{1}{2!}\left(\frac{x}{c}\right)^2 + \frac{1}{4!}\left(\frac{x}{c}\right)^4 + \frac{1}{6!}\left(\frac{x}{c}\right)^6 + \ldots \quad \text{(10)}$$

putting (10) in (9), we get

$$\frac{y-c}{x} = \frac{1}{2!}\left(\frac{x}{c}\right) + \frac{1}{4!}\left(\frac{x}{c}\right)^3 + \frac{1}{6!}\left(\frac{x}{c}\right)^5 + \frac{1}{8!}\left(\frac{x}{c}\right)^7 + \ldots \quad \text{(11)}$$

By reversion of the series (11), we obtain

$$\frac{x}{c} = 2\left(\frac{y-c}{x}\right) - \frac{2}{3}\left(\frac{y-c}{x}\right)^3 + \frac{26}{45}\left(\frac{y-c}{x}\right)^5 - \frac{622}{945}\left(\frac{y-c}{x}\right)^7 + \ldots \quad \text{(12)}$$

which is the series given by Professor Boyd, and which may be used whenever sag and span are given.

In our problem sag $= y - c = 80$ ft.; $x = 250$ ft.

$$\text{Hence } \frac{y-c}{x} = \frac{80}{250} = .32 \quad \text{(13)}$$

putting (13) in (12), and using only three terms, we get

$$\frac{x}{c} = \frac{250}{c} = 2(.32) - \frac{2}{3}(.32)^3 + \frac{26}{45}(.32)^5 = .6201$$

$$\text{Hence } c = \frac{250}{.6201} = 403.16$$

After the parameter c is found, we may proceed as Dr. Joffe.

When the span and length of cable are given, the series to be used is

$$\left(\frac{x}{c}\right)^2 = 6\left(\frac{s}{x} - 1\right) - 1.8\left(\frac{s}{x} - 1\right)^2 + \frac{576}{700}\left(\frac{s}{x} - 1\right)^3 - \frac{312}{700}\left(\frac{s}{x} - 1\right)^4 + \ldots$$

and when maximum tension and span are given, the series to be used is

$$\frac{x}{c} = \frac{x}{y} + \frac{1}{2}\left(\frac{x}{y}\right)^3 + \frac{13}{24}\left(\frac{x}{y}\right)^5 + \frac{541}{720}\left(\frac{x}{y}\right)^7 + \frac{70345}{40320}\left(\frac{x}{y}\right)^9 + \ldots$$

Our readers will find applications of the last two series in Professor Boyd's work.

MOVE OVER, MR. FIELD MAN

(Continued from page 7)

Survey in its plane table work. This is due to the limited ceiling at which commercial airplanes can fly and other limitations. The desired publication scale is secured by a photographic reduction prior to engraving the map. This not only reduces drafting errors, but facilitates the drawing of what would ordinarily be congested detail.

The multiplex operator's rate of production of topographic maps is dependent upon the characteristics of the terrain being mapped, the scale and contour interval of the map to be made and other factors, including the operator's personal aptitude for the work. According to the latest production records of Mr. T. P. Pendleton, Engineer in charge of the Geological Survey's Chattanooga office, production of maps at an original scale of 1:10,000 is proceeding at an average rate for all operators of about 11 square miles per man per month. This probably exceeds what could be done by a plane table party, providing an equally excellent product was obtained. One of the marked advantages of the multiplex method is the uniform accuracy obtained throughout the map, even in remote and highly inaccessible regions. In such places the stereoscopic methods are distinctly superior to the usual ground methods of mapping.

The cost of maps made with the multiplex instrument also compares favorably with the cost of maps of equal accuracy made by field survey methods, and there is a reasonable expectation of further reducing costs as the instrumental equipment is further perfected.

Comments by James M. Robbins, Associate Professor in Civil Engineering, Newark College of Engineering

Mr. Scher is to be commended for his excellent description of the Multiplex Aeroprojector and of the use of the instrument in the preparation of planimetric maps.

It became evident some twenty years ago that there were tremendous possibilities in aerial methods of surveying. Progress in the development of instruments and procedures has been rapid during the intervening years. For many purposes maps produced by these methods are superior in accuracy and more economical in cost than maps prepared by other methods. It is inevitable that continued improvements will be made and that aerial methods will be more widely employed in the future—not to the exclusion of ground methods, but in conjunction with them and under the particular conditions to which they are so excellently adapted.

Recalling Mr. Scher's earlier activities in the surveying field, I remember him as one who developed early that "topographic sense" so necessary to the successful mapper, whether he be sighting through an alidade or the multiplex.

METHODS OF SUBSURFACE EXPLORATIONS

By D. C. Frost, C.E., M.Ed.

Instructor in Civil Engineering, Newark College of Engineering

Closely allied to geology and of growing importance in the design of substructures is the science of sub-surface exploration. The paradox of a carefully and skillfully designed superstructure placed on a substructure or foundation designed by "rule of thumb" is self-evident. In spite of this, little was done for many years beyond superficial and inaccurate determination of the probable bearing power of roughly classified soil types as rock, gravel, silt, sand, or hard-pan. In 1905 Dr. C. P. Berkey with other geologists showed the value of adequate sub-surface investigation as an essential part of the location, design, and construction of the Catskill Water Supply of the City of New York. While this was by no means the first investigation, it will forever remain as the first large-scale demonstration of the economy of a careful and thorough subsurface investigation. Of this Dr. Berkey said:[1]

> In this project virtually nothing was taken for granted. Every new step was the subject of special investigation with the avowed purpose of determining the conditions to be met; and when these were determined, the plan of construction and design of the structure were brought into conformity with them. In this manner specifications could be drawn with sufficient accuracy to avoid most of the dangers, mistakes, and special claims commonly attending such work. Very few features or conditions were discovered in construction that were not indicated by the exploratory investigations, and such as were proved to be of minor significance and were cared for at moderate expense.

As indicated by this statement of Dr. Berkey's, preliminary investigations are made with two objects in view:

1. To determine the geological structure, underground water and other underground conditions which may affect the work under consideration.

2. To determine materials to be encountered with a view toward costs and choice of possible locations.

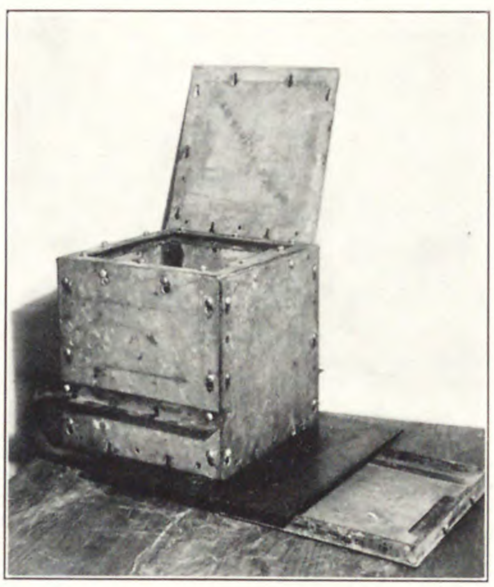
A reason often advanced for the lack of proper investigation in construction, particularly of hydraulic structures, is the cost involved. While the economics of design is predominant in

Section of 36" Diameter Calyx Drill Core

the minds of engineers, this means of avoiding difficulties and affecting savings is often overlooked. As an example of costs for investigation the following is offered as typical of a large structure. Boulder Dam, located on the Colorado River in Nevada, was built at a total cost of $76,770,396.12. The total cost of all geological and exploratory work was $826,081.00 or about 1.1 per cent of the cost of the dam.[2] Tunnel costs quoted[2] are somewhat higher. The benefits derived from such investigation often amount to a much higher value than the costs involved.

There are many methods of investigation which serve the varying needs, ranging from the use of a crow-bar to locate ledge outcroppings to magnetic and electric methods requiring special geophysical apparatus. The use and application of some of these methods will be explained in the following paragraphs.

Reference will be made to "disturbed" and "undisturbed" samples in the following discussion. Without entering into a discussion of soil mechanics it might be explained that many soil



Core Box

tests may be made on an "undisturbed" sample. Results of such tests are more valid than similar tests made on remolded specimens, as they are more indicative of the true conditions which may be encountered. It will be evident from this discussion that the optimum sample to be secured is in its original state. Hence calyx drilling and sampling spoons, in an attempt to secure, as nearly as may be, an undisturbed sample. *There is, however, no sample which is entirely undisturbed.*

Sounding Rod — Pricking

The simplest method of exploration, and also most limited in application, is the use of a sounding rod to determine depths of overburden above known rock strata. In shallow ground this method of "pricking" or "sounding" gives some information, but no qualitative results may be expected. This method may be advantageously used in highway location where ledge outcropping is suspected. Shallow pits may be dug along the proposed

[1] Legett, "Geology and Engineering," p. 148. McGraw-Hill (1939)
[2] Ibid. p. 87

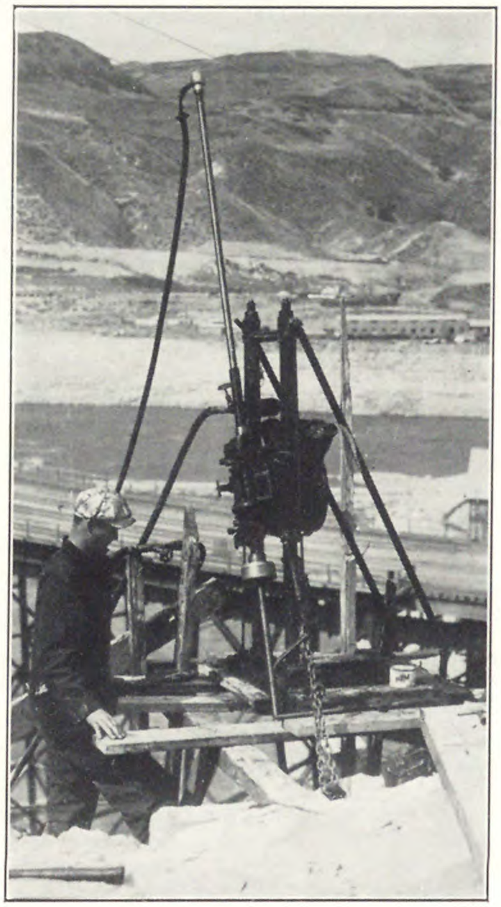
centerline, and depth to ledge determined by driving a metal rod to rock. This centerline may be plotted and grade established with a minimum of rock excavation.

Augers

The worm type auger is also of limited application. In very stiff clay samples may be recovered and it also may be used in cleaning out drive pipe and casings. Augers range in size from two to three and one-half inches in diameter. Samples recovered by this method are not "undisturbed" and therefore complete tests may not be made on samples. Augers may be used at depths as great as thirty feet. The auger has its application where soil types are to be determined, particularly in a cohesive material.

Wash Borings

In taking wash borings excavation is accomplished by introducing water inside a pipe casing. The pipe is forced downward as the hole is deepened. The wash material is caught in a container at the surface, and rough approximations of material encountered are made. The results may be misleading, and, as in



Core Drilling Machine

the case of underground water, do not give a true picture of the sub-surface conditions. A tendency for grain sizes, in assorted material, to be segregated, and for the finer materials to be washed away, prevails. A soil profile may be approximated but modifications of this method are more accurate. One modification which is quite satisfactory is to use the wash boring method, and at intervals to lower a special sampling tool into the hole to secure a sample of the material encountered. Samples thus secured may be disturbed or undisturbed according to the sampling device used and the care exercised.

Dry sample boring is another name applied to this modification of wash borings. Its main feature is that an undisturbed sample for further test is obtainable. The cost per foot is greater, but results are more valuable.

Core Drilling

The methods mentioned are satisfactory for soils, but for rock it is necessary to use core drills, which allow subsequent examination of the rock type. Core drills are of three types: the so-called diamond drill, which has diamond chips embedded in a binder; shot drills, which cut by means of hard chilled steel shot; and drills with removable steel cutters. Complete sections of core are not always obtained, and in this case the skill of the drill operator in determining the relative elevations at which various strata are encountered is of great importance. A core box, divided into sections to keep the cores in their relative positions, is used in the field.

Core drilling in rock not only serves to determine the type of rock but the holes may be filled with water, under pressure, to determine whether there is danger of seepage, either through faults, joint planes, or through the rock itself if it is pervious. With holes of a diameter of 4 inches or greater a lighted periscope may be lowered into the hole, and appearance of the rock walls will supplement the core examination. A still further use for core holes is for grouting after construction is under way.

A recent development in core drilling is the use of calyx type machines, which cut diameters up to 36 inches. These have been used to advantage at the sites of the Grand Coulee and Norris Dams, as well as the Watts Bar Dam, on the Tennessee River. The removal of the core, especially when it needs breaking, is a particular problem, blasting sometimes being necessary. When these large diameter holes have been drilled to the required depth and properly cleaned out, the geologists and engineers may be lowered by means of a portable lighted cradle and may make a careful inspection of the foundation material in place. Sampling of rock material in place may be carefully made in this way. At the Watts Bar Dam investigation a sealed, telescoping casing and cofferdam arrangement was used to allow the full use of the 68-foot-deep rock penetration under 10 feet of water. This unique arrangement allowed complete inspection of the bed rock.

Test Pits and Test Caissons

For explorations in relatively shallow soil areas, test pits or test caissons may be sunk, and both disturbed and undisturbed samples secured. Disturbed samples evidently may be taken as wanted. Undisturbed samples may be secured by using a galvanized cubical bottomless box which is placed at the point where a sample is desired. Excavation outside the box is continued until the box sinks, enclosing the desired sample. A knife edge is then slid across the bottom in slots provided, and the sample is thus cut free. Top and bottom covers are screwed on, and the sample is ready for laboratory examination. Similarly, cylindrical sections may be obtained.

Geophysical Explorations

There have been many developments in recent years in applying Gravimetric, Magnetic, Seismic, and Electric methods. Applications of these types of geophysical explorations in Canada, Europe, and the United States, have been satisfactorily made with respect to tunnels, dam sites, and highways. This phase of geological investigation has not been used as widely yet as it will be in the future. Industrial uses in the determination of oil wells and sand and gravel deposits have to date far outstripped the application to engineering structures, but the groundwork has been laid for a great deal of future expansion.

THE FUNDAMENTAL PRINCIPLES OF ELECTRICITY IN MODERN TERMINOLOGY

By PAUL C. SHEDD, B.S.

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There is considerable evidence that the methods now commonly employed in presenting the fundamental principles of electricity to students of electrical engineering are in serious need of rather extensive revision.

Some progress has already been made in this field, and a large number of possibilities for improvement will suggest themselves to the thoughtful teacher. One of the chief difficulties is that there are so many alternatives that each individual, having had his own individual experience, will prefer his own individual method of presentation. If progress is to be made, however, the most promising of the various solutions will have to be considered. The material in this paper consists of proposals which appear to offer considerable hope of simplification and unification. Perhaps the method outlined here can be used as a basis for clarification of the methods of presentation, after modifications suggested by the experience of others have been incorporated in it.

It is believed that a good deal of the material usually presented in an introductory course can very profitably be omitted entirely, and more time and thought spent upon the actual physical and mathematical principles involved.

Space prevents an elaboration of all the reasons underlying the proposals advanced in this paper. But it is hoped that an examination of the resulting structure of electrical theory embodying these suggestions, which follows the enumeration of the suggestions themselves, will bring out in rather a striking way many of the reasons for the proposed changes. It is suggested that simplification can be effected in seven ways:

First, by abandoning the cgs electrostatic and electromagnetic systems of units. A single system of units, the meter-kilogram-second-coulomb (mksc) system, can be employed throughout, both in electrostatics and electromagnetism. This system uses the well-known electrical units—ampere, volt, ohm, watt, and so on. All the confusion of thought and expenditure of time the student now encounters in acquiring (usually) only a partial mastery of the complicated conversions necessitated by the use of three different systems are entirely eliminated.

Second, by abandoning the artificial and useless concept of the unit point-pole, and emphasizing the true analogies and the true differences between electric and magnetic fields. The concept of unit point-pole arises by false analogy from that of unit point-charge. Electric lines of force emerge from and converge toward points. Magnetic lines of force do not; they form closed paths. Students can readily see the difference between the conditions of the electric field, where lines originate in a small sphere surrounding a point-charge, and the conditions of the magnetic field, where any small sphere, no matter where located, must have an equal number of lines entering and leaving. It is not necessary to understand the concept of the divergence of a vector in order to understand this.

Third, by simplifying the concept of lines of force. For an introductory course it is simple and convenient to use the lines to indicate the *directions only* of the vectors being considered, and to use algebraic equations to indicate their *magnitudes only*. This complete separation of the functions of the geometric lines and the algebraic equations prevents confusion. It permits the lines to retain their geometric significance, and they are not required to take on the quasi-quantitative attributes of the number of lines per square centimeter, or of the tubes of force formerly (and still occasionally) employed. The concept of 4π lines of force emanating in all directions from a unit point-charge is consigned to the oblivion it deserves.

An alternative method, in many ways superior to the above, is first to introduce the student to the simple concepts of the vector and scalar products of two vectors. Then *vector equations* can be used instead of the algebraic ones, giving both the magnitudes and directions of the vectors involved. The concept of lines of force can then be eliminated entirely, and a source of considerable bewilderment for the student is avoided. This also results in equations that appear simpler and more attractive, since all the terms $\sin\theta$ and $\cos\theta$ in the equations below disappear. And only one rule for the relative directions of three vectors is required, instead of the several now used.

Fourth, by simplifying the definitions of the important electrical concepts and the units in which they are measured. In the first place, there will be only *one* definition for each term, instead of the two (or even more) now given in some cases. Each definition will be in the form of a *simple* algebraic equation, plus rules giving the directions of any vectors involved. Such cumbersome definitions as those of the cgs electrostatic unit of charge and the cgs electromagnetic unit of current disappear entirely.

Fifth, by simplifying the notation. Each concept is to have its own individual symbol, its own individual unit of measurement, and, except for the four fundamental concepts (distance, time, mass, electric charge), its own individual definition in strictly mathematical terms.

Sixth, by reducing the number of independent basic phenomena to a minimum, namely two. All the electrical phenomena studied in an introductory course can be stated in terms of (1) the four fundamental concepts; (2) some fifteen or twenty simple defining equations; (3) the basic phenomenon of electrostatics; (4) the basic phenomenon of electromagnetism; (5) a number of equations mathematically derived from the above.

Seventh, by presentation of material in a logical and continuous manner, a chain of ideas, rather than as discontinuous nibbles of more or less random bits of information.

Let us now examine the resulting structure of electrical theory embodying these suggestions.

1. *Fundamental concepts.* A fundamental concept is one which cannot be defined mathematically in terms of simpler ones.

In this system, the number of fundamental concepts needed is four; namely, distance, d; mass, M; time, t; and quantity of electricity or electric charge, Q, and they are measured in meters, kilograms, seconds, and coulombs, respectively.

2. *Definitions from mechanics.* The following defining equations from mechanics are needed:

(1) Velocity $v = d/t$ meters per second.

(2) Acceleration $a = v/t$ meters per second per second.

(3) Force $f = Ma$ kilogram-meters per second per second (newtons).

(4) Work $W = fd\cos\theta$ meter-newtons (joules).

(5) Torque $T = fd\sin\theta$ newton-meters.

(6) Power $P = W/t$ joules per second (watts).

3. *Electrostatics.* Any electric source-charge Q_1 exerts forces on electric charges placed at various points at various distances from the point at which the source-charge originates. Since the concept of action at a distance and the mechanical concept of the ether are rejected, the charge is considered as existing, in some form or other, at any point in space. Provisionally, it is to be represented at the point P at a distance d from Q_1 by a vector D, called the *electric displacement*, having a magnitude:

(7) Electric displacement $D = Q_1/d^2$ coulombs per meter square.

The direction of D is away from the point-source Q_1 if Q_1 is positive; toward the point-source if Q_1 is negative.

Any test-charge Q_2 placed at a point P in the space surrounding the source-charge Q_1 will be acted upon by a force f. The *field strength* at the point P is defined as a vector ε whose magnitude is defined implicitly by the equation:

(8) $f = \varepsilon Q_2$

ε is measured in newtons per coulomb, and the direction of ε is the same as that of f.

The *basic phenomenon of electrostatics* can now be formulated by the equation:

(9) $D = K_0\varepsilon$

where K_0 is a universal scalar constant, defined by equation (9). In contrast with the previous equations, which are merely definitions, equation (9) is a *law of nature*, determined experimentally. The value of K_0 has been found by experiment to be approximately $1/9 \cdot 10^{-9}$ mksc units.

If the charges Q_1 and Q_2 are immersed in a medium composed of atoms, the electric forces distort the configuration of the atoms of the medium. These in turn exert forces upon the charges Q_1 and Q_2, which are superposed upon, but do not change, the forces already existing. The resultant force, that is the force exerted by Q_1 plus the forces exerted by all the atoms of the medium, is less than the force existing if the medium were not present. The numerical factor by which the force is reduced is called the dielectric constant of the medium. It should not be confused with the universal scalar constant K_0.

4. *Electromagnetism.* If a source-charge Q_1 is moving with velocity v_1, it sets up a magnetic field H at a distance d from Q_1, which field is a vector having a magnitude:

(10) Magnetic field $H = \frac{Q_1}{d^2} v_1 \sin\theta$ mksc oersteds.

The direction of H is given by the well-known right-hand screw rule.

If a test-charge Q_2 is moving with velocity v_2 in a magnetic field, it is acted upon by a force f. The magnetic induction, B, is a vector whose magnitude is defined implicitly by the equation:

(11) $f = BQ_2v_2\sin\theta$.

B is measured in mksc gausses, and its direction is given by Fleming's left-hand rule.

The *basic phenomenon of electromagnetism* can now be formulated by the equation:

(12) $B = \mu_0 H$.

where μ_0 is a universal scalar constant, defined by equation (12). Like equation (9), equation (12) is a *law of nature*, determined experimentally. The value of μ_0 has been found by experiment to be approximately 10^{-7} mksc units.

If the magnetic field passes through a magnetic medium, the magnetic forces line up some of the molecular magnets of the medium. These in turn superpose their magnetic fields upon the original field. The resultant magnetic induction, that is, the magnetic induction of the original field plus that of all the lined-up molecules of the medium, is greater than the induction existing if the medium were not present. The numerical factor by which the magnetic induction is increased is called the relative permeability of the medium. It should not be confused with the universal scalar constant μ_0.

Compare equations:

(7) $D = \frac{Q_1}{d^2}$ with (10) $H = \frac{Q_1}{d^2}(v_1\sin\theta)$

(8) $f = \varepsilon Q_2$ with (11) $f = BQ_2(v_2\sin\theta)$

(9) $D = K_0\varepsilon$ with (12) $B = \mu_0 H$

5. *Additional definitions.* The following additional defining equations are needed:

(13) Electric current $I = Q/t$ coulombs per second (amperes).

(14) Electromotive force $E = W/Q$ joules per coulomb (volts).

(15) Resistance $R = E/I$ volts per ampere (ohms).

(16) Inductance, L $E = L\frac{I}{t}$ volts per ampere per second (henrys).

(17) Capacitance $C = Q/E$ coulombs per volt (farads).

(18) Magnetic flux $\varphi = BA\cos\theta$ mksc-gauss-square meters (webers).

(19) Magnetomotive force $F = Hd\cos\theta$ mksc-oersted-meters (mksc gilberts).

(20) Magnetic reluctance $R = F/\varphi$ mksc gilberts per weber.

(21) Magnetic moment, m $T = mH\sin\theta$ newton-meters per mksc oersted.

6. *Mathematical derivations.* The other important equations in elementary electricity can be derived mathematically from the above. Outlines of the derivations of some of the important relations are given below as examples. For brevity, the physical reasoning has been omitted.

(a) Coluomb's equation:

Combining equation (7) with equation (9):

(22) $\varepsilon = \frac{Q_1}{K_0 d^2}$

Combining equation (22) with equation (8):

(23) $f = \frac{Q_1 Q_2}{K_0 d^2}$

(b) Combining equations (1) and (13) with equations (10) and (11):

(10a) $H = \frac{I_1 d_1}{d^2}\sin\theta$

(11a) $f = BI_2 d_2 \sin\theta$

(c) Combining equations (4) and (8) with equation (14):

(24) $E = \varepsilon d\cos\theta$

(d) Maxwell's equations, for the simplified case of constant fields moving with constant velocity:

Combining equation (7) with equation (10):

(25) $H = Dv\sin\theta$

Combining equation (11) with equation (8):

(26) $\varepsilon = Bv\sin\theta$

(e) Faraday's equation, for a conductor moving at right angles to a magnetic field:

Combining equation (26) with equation (24):

(27) $E = Bvd\cos\theta$

Substituting equations (1) and (18) in equation (27):

(28) $E = \varphi/t$

To one thoroughly familiar with the conventional treatment of this material, the methods proposed above will quite likely at

(Please turn to page 25)

THE VALUE OF LIBRARIES TO ENGINEERS

By IRA A. TUMBLESON, A.B., B.S., M.A.
Librarian, Newark College of Engineering

Since the engineering profession is one which requires a high degree of accuracy and precision it follows that the engineer must make use of the best sources of information as the basis for his solution to problems. Our reservoir of useful data is a growing thing; hence, the engineer must be ever on the alert if he is to become a part of the progress in his field of practice.

Technological changes are coming about at an ever-increasing pace. New inventions, new discoveries, and improved methods of accomplishing things present themselves from day to day, adding to the problems of the professional man. The only satisfactory way in which he can keep up with events in his own and allied fields, and perhaps have an active part in them, is through the use of the printed records that report what is new as it happens. The effect of authorship and the distribution of printed matter upon our civilization is impressive not only from the standpoint of quantity produced but also from the viewpoint of its broad influence.

Print as a Means of Communication

Five hundred years after the invention of printing from movable type finds us regarding the printed word with about the same commonplace as we regard the air we breathe. Prior to the time of the printing press there had been a number of great teachers, scientists, and men of wisdom, but lacking adequate means of communication, their influence was not widely felt. Perhaps they are more generally known and better understood today through wider distribution of the few writings they left than they were to their contemporaries. At the time of the beginning of printing there were but few authors; and, because hand written books could not be produced rapidly and cheaply, very few people had had any occasion to learn to read. Lack of authors and readers together with the technical difficulties of the new process made progress slow at first. It gradually speeded up, however, until now books, periodicals, and newspapers are produced in many millions of copies every year.

Within that period of five hundred years mankind has acquired a store of knowledge much greater than that of any previous similar period. Scientific discoveries and industrial progress, in fact popular education itself, appear to bear a direct relationship to the quantity and distribution of written information. This accumulation of knowledge both stimulates new investigations and forms the basis for further progress. As Professor Low writes in his *Science in Industry*:

> "Printing was one of the most revolutionary inventions because it made possible the distribution of knowledge and learning to a theoretically unlimited number of people. Before printing, word of mouth was the only way of passing information on a large scale. There were books, of course, but as these had to be hand written they were both rare and expensive.
>
> "Quite apart from its entertainment value, printing has had the most far-reaching consequences in education. It was the invention that had to precede others, because there could be no real science until the theories and discoveries of notable men could be widely distributed. The lack of communication and of books mean that a particular art or science might be highly developed in one country, whereas, little was known of it in another."

The swift interchange of ideas by means of print is responsible for a greater degree of coöperation and collaboration among men of science and industry. Great discoveries of the past have been mainly creations of the combined efforts of several men rather than that of one man as we so often give credit. True, one man's efforts may bring about some long sought result, but others, perhaps of earlier generations, have contributed vital factors making the ultimate result possible. Lacking this important means of communication many of the technological improvements enjoyed during the past one hundred years might remain yet to be discovered.

Sources of Book Information

Today there are numerous agencies at work investigating new scientific theories, new industrial processes, and better methods of doing things. Most of these agencies have a well-defined publishing program organized for the purpose of recording and communicating their findings to a wide audience. Each of the major fields of knowledge has one or more such agency whose function it is to foster research or in some way add to the available fund of knowledge pertaining to its respective field. Engineering with its numerous societies, its many college experiment stations, private industrial research laboratories, and government research agencies, not only in this country but in other countries as well, affords an excellent example of coöperative effort. The men who make up the membership of these groups are the leaders in their particular specialties. These are the men who supervise much of our original investigation and contribute greatly from their personal experiences to our general informational resources.

Some idea of the volume of technical data published currently in engineering and allied fields may be gathered from the preface to the list of *Technical Publications Reviewed* in *The Engineering Index*, 1938, which states as follows:

> "This alphbetical list of current technical publications received by the Engineering Societies Library and reviewed by *Engineering Index, Inc.*, includes the publications of five hundred engineering, scientific, and technical societies, twelve hundred engineering and industrial periodicals, and approximately six hundred publications of government bureaus, engineering experiment stations, universities, and other research organizations."

The number of new publications added each year and the comparative thickness of succeeding volumes of the Index testify to the ever increasing amount of printed matter issued.

Such publications as are mentioned in the preceding paragraph many times present what is new in a science or an industry. They give the original ideas and present in fullness that which three or four years later may or may not be incorporated in less complete form in books. In either event the value of the original articles remain useful years later. Consequently, this form of written matter, because of its boundless subject scope and timeliness, has come to be more highly regarded for research purposes than the more familiar book.

How the Library Serves

Libraries constitute an important connecting link between the author and the research worker or the more casual seeker of information. They serve not only as storage places for vast files of books and magazines, but also as the medium through which an inquirer can determine what has been previously accomplished in a certain line of investigation and where data on it may be found. The latter service is achieved largely through the use of indexes and bibliographies prepared especially to bring out valuable sorces of information which otherwise would be hopelessly hidden within a maze of pages.

Needless to say, all libraries do not contain the thousands of periodical and book titles published each year. No library, not even our National Library, has them all. The combined holdings of our large libraries and our special libraries, however, are not likely to leave much wanting. The needs of the clientele of each library is the guiding factor in the selection of the material that library is to contain. In the larger communities containing several libraries a coöperative effort has begun to purchase books and magazines within subject scopes in such a way that excessive duplication of less popular titles may be avoided. Hence the community as a whole benefits either through the saving of money or by securing a greater variety of materials without additional expense. The resources of many of our libraries today are made available beyond the limits of local clientele through inter-library loans, photostat reproductions, and films. Some of the more specialized libraries offer, in addition to those mentioned above, a translation service. By means of these special services it is not at all uncommon for men stationed in foreign countries to obtain the data they need through their libraries back home.

One hundred years ago an engineer could maintain a private library which would meet his needs fairly satisfactorily; but today with the many special fields, the over-lapping of fields, and the varied applications of data from apparently unrelated fields the professional man can read but a small part of the current publications in his line. The care of the literature covering a comparatively small subject scope has become a full-time job in itself. Modern practice finds the community library, or some form of group-supported library, more suited to the needs of the times. To be sure, every engineer should have a private library for his own use, but he should also be familiar with a large library for his more detailed studies. The private library might best be made up of handbooks, texts, and a few periodicals relating directly to his work rather than be an attempt toward completeness in ever so small a field.

A little preliminary search to determine what some one else has done toward the solution of a problem will often save one a considerable amount of time and expense. The would-be inventor whose claims for a patent are rejected because they have been previously patented might have saved himself both time and money by a careful search as a beginning step. The man who is threatened with labor trouble may find how other similar situations were handled. The properties of a new alloy may appear in a journal but not yet included in the handbook. Would it not be easier to have a look in the literature than to set up tests?

Unfortunately, the use of abstracts, indexes, catalogs, and bibliographies is to many an irksome task. At least these library tools are so looked upon until a person has had occasion to use them with a definite purpose in view—thereafter their value as timesavers is most often fully appreciated.

The best aids to the use of technical literature are prepared by indexers who are familiar with the technique of indexing and the subject matter indexed. The most comprehensive index to current engineering sources is the *Engineering Index* mentioned earlier. It is sponsored by the United Engineering Societies. The indexers review over two thousand current technical titles of interest to engineers. Important articles are classified by subject, annotated, printed on 3"x5" cards and mailed out to subscribers weekly where they are filed for reference use. The cumulation of the entries at the end of each year are published in book form and remain as permanent keys to the published writings for that particular year. Most of the libraries that cover the engineering field subscribe to one or both of these services.

Another index service found in most reference libraries is the *Industrial Arts Index*, which covers only the better known engineering periodicals in the English language and a select list of business and trade journals. It appears in annual volumes with monthly cumulative supplements. While it duplicates some of the work of *Engineering Index*, its broader scope makes it somewhat better to use for data in the social aspects of engineering.

In addition to the general engineering indexes there are two abstract journals whose annual indexes are comprehensive within their fields. They are *Chemical Abstracts* and *Science Abstracts*. The former includes the fields of theoretical and applied chemistry, and the latter, in two parts, covers section A—Physics and section B—Electrical Engineering.

Libraries are maintained to help you in your work. Through them you may acquaint yourself with the achievements of other men and thereby avoid duplicating work already accomplished. Your own efforts may then be directed toward something else that needs to be done.

* * *

"Backgrounds, seen with clear eye and appraised with sense, give bearings for the leagues to come. The past is not dead, but only foolishly forgotten or light-mindedly ignored; it is present in all that is today or will be tomorrow, living on in the present and future as men long dead survive in the bodies and traits of their descendants. The experience of the past is the only trustworthy guide to the present; and if it can offer us no leading into the future, then we are indeed undone."—A. G. Keller., *Man's Rough Road*.

THE SECOND RIVER JOINT SEWER

An Example of Municipal Coöperation

By Edward S. Rankin

Division Engineer, Division of Sewers, City of Newark

Some thirty years ago, in 1908 to be exact, the writer prepared a paper on the joint construction and operation of sewage works,* in which he advocated the designing of sewer systems for an entire drainage area, instead of, as was usually done at that time, for single municipalities, and for coöperation between municipalities in the construction of joint sewerage works. A fairly comprehensive survey of the entire country was made to determine the number of localities in which such a plan was in operation. The number of instances found could be counted on the fingers of one's two hands.

Three years ago a similar survey was made for a different purpose and, although the survey was not so comprehensive as the first one, 25 examples of such joint action were found. This increase is probably due in large measure to the rapidly growing feeling against stream pollution and the insistence on sewage treatment, for it is a well-known fact that the larger the treatment plant, the lower the cost per million gallons treated; hence, it becomes more economical for several neighboring municipalities to combine in the treatment of their sewage than for each one to operate its own plant.

The Second River Joint Outlet Sewer is a good example of such coöperation, receiving, as it does, the sewage from the whole or part of seven municipalities in Essex County lying in the Second River valley, namely Belleville, Bloomfield, East Orange, Glen Ridge, Montclair, Newark and Orange.

In 1893, the City of Orange constructed a system of sanitary sewers discharging into the Passaic River through an outfall running down through the valley close to and parallel with the Second River. Rights in this outlet were sold to the towns of Bloomfield and Montclair, which also constructed their own sewer systems at that time. In 1895, Glen Ridge was separated from Bloomfield and acquired part of the latter's rights.

In 1908, the City of Newark built a system of sewers in a small section of the northwestern part of the city draining into Meadow Brook, a branch of Second River. Rights in this sewer were sold to Belleville, Bloomfield, and East Orange with permission to use it for such parts of these municipalities as lay within the Meadow Brook watershed. Not much attention was paid in those days to stream pollution, and the outlet of the system extended along the bank of the brook, discharging into it at a point some distance below any residence or other buildings.

When the Passaic Valley sewer was put into operation in 1924, the Orange outlet was connected with it and the commissioners turned their attention to the pollution of the tributaries of the Passaic, including Second River. Their decisions made it necessary to provide another outlet for the Meadow Brook sewer. Application was made to Orange for permission to connect with their outfall, which was refused on the ground that this sewer was already overcharged. Investigation showed this to be true and that this sewer was also a source of pollution, for it overflowed in times of heavy rains into Second River, which condition required its enlargement in the very near future. The alternative was the construction of an independent outlet paralleling the Orange sewer. It was also found that Belleville was discharging part of their sewage into the stream, thus requiring a third parallel line. The logical solution was for all to combine and construct one sewer large enough for all seven municipalities. With this idea in mind several meetings of the engineers were held and a general plan formulated which was submitted to representatives from the governing bodies, approved by them after a full discussion, and on May 21, 1928, the Second River Joint Meeting was organized. The organization was effected in accordance with the Revised Statutes of the State of New Jersey, 1937-40:63-116. The original act was passed in 1899 to permit the construction of a joint outlet sewer through the valley of the Elizabeth River. This sewer has been in operation for nearly 40 years and serves eleven municipalities in Essex and Union Counties.

The Second River Joint Meeting consists of one member from each of the seven governing bodies, each having one vote. Its officers are a chairman, a secretary and treasurer, and two full time inspectors, who patrol the sewer daily and do the necessary cleaning and ordinary repairs. Since shortly after the completion of the sewer, the secretary and treasurer has also acted as consulting engineer.

As all the sewage is discharged into the Passaic Valley sewer, there are no treatment problems to contend with.

The two most important questions to be decided in any joint project of this kind are: first, the capacity required by each municipality, from which the size of the sewer can be determined, and second, how the cost shall be divided. This second question involves not only the construction cost but also the cost of maintaining and operating the sewer when completed.

To answer the first question, the engineers had already in their preliminary meetings arrived at their approximate needs. These were submitted to an independent engineer engaged by the Meeting for his suggestions, and a compromise and final figure for the total required capacity arrived at.

The second question which, as noted above, is really two questions, is more difficult to agree upon, being more of a political than an engineering problem. Among the 25 examples of joint action in the construction of sewage works which have been collected, several different methods of allocating the cost of construction are found. The favorite method, though in the opinion of the writer the least equitable, is on the basis of ratables. This follows the method embodied in the Federal income tax—taxation in accordance with the ability to pay. This was the method adopted in the construction of the Passaic Valley sewer and is a good example of its inequity, the two extremes in the cost per million gallons of capacity being $98,000 and $4,100. The argument for adopting this method was that it was the only way by which some of the municipalities could be induced to join the project. Other bases used in the apportionment of cost are: population, either present or future; area; water supply, and estimated flow.

The method used in determining the Second River sewer payments was the estimated flow from each municipality 30 years in the future. As the volume of flow determines the capacity required, this seems to the writer by far the most logical and most equitable method. To determine this flow several factors must be taken into consideration—population, trend of growth, water supply,leakage and storm-water. The last two factors are important and a liberal allowance should be made for them.

The second part of this question has also been solved in many ways. Of these the measured flow from each municipality is the most popular and the most equitable. Other methods in the order of their popularity are ratables, capacity owned, population, water consumption, number of house connections, lineal feet of sewer, and, in some cases, combinations of two or more of the methods named. A professor in one of our engineering colleges suggests that the cost of sludge treatment should be based on the amount of suspended solids received from each municipality, and an engineering magazine recommends that the cost of treatment should be in proportion to the B.O.D. of the sewage received from each. These are refinements which would involve considerable extra expense for constant testing, and seem hardly warranted. The Second River commission, while recognizing the equity of the flow method, decided on allocating the cost on the basis of capacity owned. This decision was due to the fact that on account of the many laterals connecting with the main sewer, the cost of installing and reading the many meters required would not warrant the expense involved.

The Second River Joint Sewer, serving a population of about 140,000 people, was built at a total cost of $639,000, with a capacity of 75 m.g.d., or $8,520 per million gallons. The average flow at this time is approximately 12.5 m.g.d. which, of course, is greatly exceeded during storms.

The average maintenance cost for some years past has been $8,000 per year or six cents per person, and $1.75 per million gallons. If each of the municipalities had been obliged to dispose of its own sewage independently the cost would have been far greater.

Comments by H. N. Cummings, Professor in Civil Engineering, in charge of Department, Newark College of Engineering

Edward Stevens Rankin, member of the American Society of Civil Engineers and Past President of the American Society of Municipal Engineers, "speaks with authority" in this article. Mr. Rankin has devoted over fifty years of his life to the service of the City of Newark. For many years he has been Division Engineer in the Engineering Department of Newark, in charge of the Division of Sewers. He is Secretary of the Joint Meeting for eleven municipalities in Essex and Union Counties, and Secretary, Treasurer and Consulting Engineer of the Second River Joint Meeting. In the course of his long career as an engineer he has found time to write many interesting historical books and articles, among which are "The Running Brooks" and "Indian Trails and City Streets." The present article is a valuable contribution to the literature of sanitary engineering history.

Mr. Rankin is a member of the Civil Engineering Advisory Committee to the Board of Trustees of the Newark College of Engineering.

*Proceedings of the American Society for Municipal Improvements, 1908.

Comments by James M. Robbins, Associate Professor in Civil Engineering, in charge of Courses in Sanitary Engineering, Newark College of Engineering

In this interesting article, Mr. Rankin again calls attention to the desirability of considering sewerage from a regional viewpoint. In a densely populated river valley where the entire watershed is covered with residential or industrial communities very considerable economies can be effected by constructing joint trunk sewers, as described in this paper, and joint disposal plants where treatment is necessary.

Along our larger rivers where the densely populated areas are more widely spaced, with intervening rural districts, regional consideration of all the water resources of the valley is still essential, but the economy of a single joint sewer and disposal plant tends to decrease with increasing distances between towns. Long outfall sewers are expensive and may deliver septic sewage to the treatment plant. It is, therefore, possible that short collection systems and several small disposal plants may prove more economical in spite of the higher treatment costs per million gallons in the smaller plants. Recent construction in the Raritan Valley, where we have a number of highly industrialized but widely spaced communities, is indicative of a situation where greater economy can be realized by the construction of several plants.

The writer agrees fully with Mr. Rankin that the most equitable basis for apportioning construction costs of a joint sewer is that of estimated required capacity. Operating charges based on actual flow from each municipality are equitable but frequently costly when many meters must be installed. Basing the charges on owned capacity is generally equitable and simpler in operation.

With respect to treatment plants we find the cost of certain treatment devices, such as sedimentation tanks, chemical precipitation equipment and aeration tanks, to be largely dependent on volume of flow rather than on strength of sewage. Here the flow from each municipality provides a basis for cost apportionment.

With other types of treatment, particularly with reference to sludge digestion and drying, trickling filter installations, and operating costs with coagulation tanks, strength rather than volume is a controlling factor. Tributary population figures afford a fair basis of apportionment in this instance if highly concentrated industrial wastes are expressed in terms of their population equivalents.

S. P. E. E. AND N. C. E.

The Society for the Promotion of Engineering Education was founded for the purpose of "promoting the highest ideals in the conduct of the engineering education and the maintenance of a high professional standing among its members." Year book for 1941 of the Society states that of a total number of 3222 members there are 103 members located in New Jersey, of whom 37 are members of the teaching staff of the Newark College of Engineering.

Mr. Allan R. Cullimore, President of the Newark College of Engineering, is on the Council of the Society as an elective member with his term expiring in 1943. A Section of the Society is a part of the organization formed within a prescribed territory by one or more institutions within that territory. Professor Frank D. Carvin, head of the Department of Mechanical Engineering of the Newark College of Engineering, is the secretary for 1941 of the Middle Atlantic Section of the Society. He has been on the membership committee since 1934.

A Branch of the Society is an organization formed by members of the Society within a particular engineering institution. The Newark College of Engineering is one of the eleven active branches of the Society. The Branch is directed by the following officers: Professor Frank N. Entwisle, Chairman; Professor Paul E. Schweizer, Treasurer; Professor Harold N. Cummings, Secretary. One of the aims of the branches as stated in the Constitution of the Society is "to extend the interest in, and the discussion of, questions relating to the teaching of engineering students." To foster the aims of the branch, President Cullimore suggests to the officers of the branch that a program of informal discussions of problems relating to engineering education be instituted. For this purpose a steering committee was selected, consisting of Professor Frank N. Entwisle, chairman, Professor Edward G. Baker and Professor Paul O. Hoffmann. This committee asked the younger members of the instructing staff of the college to coöperate with them in the formation of several discussion groups. This coöperation was generous and wholehearted to the extent that five forum groups, consisting of from six to eight members each, are now functioning. The topics under discussion at the present time are: Teaching and Grading, Guidance and Student Personnel, Class Procedure, Class Management, and Curriculum. The various forum groups are guided in their discussions by permanent chairmen. The chairmen are: Mr. George C. Keeffe, Class Management; Mr. Pompey Mainardi, Curriculum; Professor William Jordan, Testing and Grading; Mr. Paul Nielson, Guidance; Mr. Kenneth A. MacFadyen, Classroom Procedure. The members of the forum groups feel that a definite need is being filled in the discussion of problems connected with engineering education, and that the discussions will tend to sensitize the instructors to the problems confronting them in their tasks and will serve to maintain and improve the professional standing of the engineering instructor.

(Reported by Paul O. Hoffmann, Assistant Professor in Mechanics, Newark College of Engineering.)

AMERICAN SOCIETY OF CIVIL ENGINEERS

The Newark College of Engineering Student Chapter of the American Society of Civil Engineers has held three meetings this year. Mr. Lee Purcell, of the North Jersey District Water Supply Commission, spoke on the Wanaque Water Supply at the January meeting, and Mr. Guy Kelcey, of the Safety Signal Corporation, addressed the group in February.

Mr. Purcell discussed the construction, operation, and history, with the aid of motion pictures, of the large Wanaque Water Supply System which serves Newark and neighboring towns. The presentation of the construction of the Raymond Dam, overflow weir, and the methods of water treatment were particularly enjoyed by the Chapter members present.

Mr. Guy Kelcey, in the February meeting, spoke on the Channalization of Traffic and showed diagrams and slides to augment his points. Mr. Kelcey's address, pitted with humor, pointed out how channalization will make intersections safer for both pedestrian and driver and will accommodate larger flows of traffic.

At the regular March meeting of the student chapter of the Society Peter Skurla, of Irvington, addressed the group. Skurla, a senior student of the Newark College of Engineering, spoke about "The Construction of a Concrete Deck Girder Bridge." Mr. Skurla, speaking from his experiences of last summer, explained all of the necessary procedures leading up to the actual construction work and then went into detail on each phase of the construction. Each step in the construction of this reinforced concrete structure, spanning both a railroad and a stream, was explained and illustrated with photographs. In addition to actual construction problems, Mr. Skurla discussed personnel, labor problems, and unit costs. This carefully planned lecture was one of the most enjoyable of the present year.

Mr. Garratt, of Nutley, a contact member of the American Society of Civil Engineers, spoke to the seniors concerning their transfer from student membership in the Society to junior membership, upon their graduation.

(Reported by David Donald, A. S. C. E.)

CONFERENCE ON LAND SURVEYING

The Third Annual Conference on Land Surveying, sponsored by the Land Surveyors Committee of the New Jersey Society of Professional Engineers, was held at the Newark College of Engineering on Saturday, January 25, 1941.

This series of conferences was inaugurated in 1939 to provide a forum for the discussion of modern practice in land surveying. Under the able leadership of Professor Philip Kissam of Princeton University these meetings have aroused widespread interest in the profession. Many exceptionally meritorious papers have been presented by engineers and surveyors of note. These have been published in successive issues of the *New Jersey Engineer.*

The group attending the recent conference was welcomed by Mr. Allan R. Cullimore, President of Newark College of Engineering, who gave the work of the Committee the wholehearted backing of the administration of the College.

Arthur Noak, State Supervisor of the New Jersey Geodetic Control Survey, presented a progress report on the work of that organization. He outlined the large amount of work which has been accomplished during the past seven years. This includes the setting of more than 10,000 triangulation and traverse monuments and benchmarks throughout the State. The adjusted elevations and Transverse Mercator coördinates of most of these are now available for use in public or private work.

Mr. Noak stressed the need for further education as to the use of these valuable data by surveyors and title companies and the need for State appropriations to continue the project and to provide for the dissemination of the data as WPA funds become exhausted. The paper was discussed by Professor Kissam, who originally instigated the work and supervised it during the early years.

S. Herbert Taylor, Camden County Engineer and present President of the New Jersey Society of Professional Engineers, presented an outstanding paper on "Property Surveys for County Roads."

The subject of "Metropolitan Title Surveys," with particular reference to work of this nature in New York City, was discussed by Homer N. Bartlett, of Bartlett, Ludlam and Dill, of Brooklyn, and by Stephen P. Belcher, City Surveyor, New York Title Company. These two papers were particularly valuable, emphasizing the difficulties arising from poor practice followed during the original layout of certain sections and the procedures which are necessary in present day surveys of valuable properties.

Fred W. DeCamp, Practicing Attorney and Title Examiner, of Newark, spoke on "Surveys and Titles, Surveyors and Title Officers." His discussion was an exceptionally fine contribution to an understanding of the legal phases of land surveying.

Professor William S. LaLonde, Jr., of the College, opened the afternoon session with a paper on "Control Surveys for Engineering Construction." Professor LaLonde emphasized the necessity of using precision methods in controlling alignment and grades on large bridge and tunnel projects and in connection with the construction of industrial plants.

Benjamin A. Sleeper, Surveyor General of West Jersey, followed with a most interesting historical paper on "The Office of the Surveyor General of the Western Division of New Jersey."

The next paper, by George D. Whitmore, Chief, Surveys Section, Maps and Surveys Division of the Tennessee Valley Authority, discussed "Property Surveys by Photogrammetry." Mr. Whitmore spoke particularly of the application of aerial methods to the surveys of parcels of land to be acquired by the Authority before flooding of the several reservoirs in the valley.

In the last paper of the day, Edward Evaul of the U. S. Soil Conservation Service spoke on "The Engineer and Soil Conservation." In this field there is much work for the surveyor and engineer in mapping, layout of terraces, soil classification surveys, and in the application of hydraulic principles to the problem.

In spite of a heavy snowstorm the meeting was well attended, over one hundred members and guests being registered. It is to be hoped that even more will attend future conferences, for they appear to fill a definite need in the advancement of the profession.

(Reported by James M. Robbins, Associate Professor in Civil Engineering.)

S. Herbert Taylor, of Camden, N. J., President of the New Jersey Society of Professional Engineers, discussing the design of surveying instruments with Professor Robbins, of Newark College of Engineering.

Three of the speakers at the Conference. Left to right—Homer N. Bartlett of Brooklyn, Stephen P. Belcher of Maplewood, and Benjamin A. Sleeper of Burlington.

Professor LaLonde of Newark College of Engineering explaining the work offered in advanced geodetic surveying at summer camp, with the aid of photographs, to S. Herbert Taylor, and Professor Philip Kissam, Chairman of the Land Surveyors Conference.

PROFESSOR J. ANSEL BROOKS RETIRES

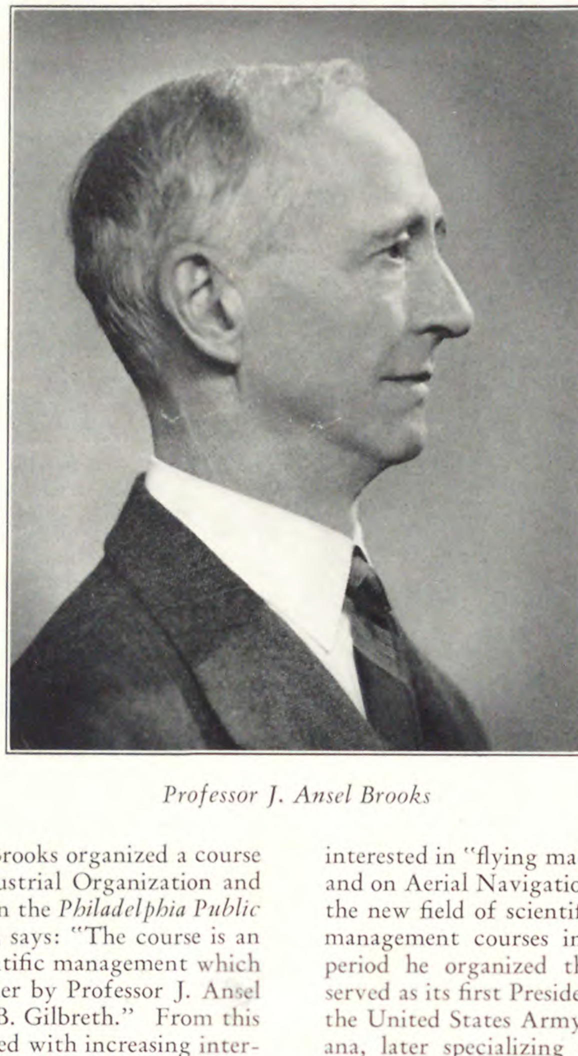
By PROFESSOR HAROLD N. CUMMINGS

In Charge of Civil Engineering Department, Newark College of Engineering

In 1923, a man walked into the office of the College here and announced himself as "Brooks, from the New York Office of the Veterans' Bureau." He had come on a routine visit of inspection, to look over the work we were doing in training disabled ex-service men for rehabilitation. We had seen all kinds of inspectors come and go—some good and others not so good. This one turned out to be the best of the good ones. In fact, he was good enough so that when in the summer of 1924 it became necessary to select a new head of the Mechanical Engineering Department of the young College, J. Ansel Brooks was appointed Professor of Mechanical Engineering and put in charge of the department.

To understand how well Professor Brooks qualified for his appointment, it is necessary to recall the objective that President Cullimore had set up for the College and to review the early career of the man Mr. Cullimore had selected to head the Mechanical Engineering Department. One of the objectives aimed at in the development of the Newark College of Engineering has been the providing of more than ordinary training in the field of management alongside of the highest grade of standard engineering training. In the early 20's this was perhaps a pioneer idea—certainly very few engineering colleges were aiming at providing technically trained men for executive positions as such. Scientific management was in its early childhood and was still struggling for recognition. Frederick W. Taylor and Frank B. Gilbreth were fully as well known as any others in the early days of scientific management, and Professor Brooks had been associated with them while he was a professor at Brown University, in organizing and conducting classes and giving lectures to groups of business men in New England. In January, 1914, Professor Brooks organized a course of lectures at Brown University in Industrial Organization and Management. An article that appeared in the *Philadelphia Public Ledger* under date of January 17. 1914, says: "The course is an outgrowth of the summer course in scientific management which was conducted in Providence last summer by Professor J. Ansel Brooks of Brown University and Frank B. Gilbreth." From this as a beginning, Professor Brooks continued with increasing interest and activity in the field of college work in management up to February 15, 1918, when he left Brown University to serve as Captain in the Aviation Section of the Signal Reserve Corps. Here, then, is the special qualification of the man for the work that President Cullimore wanted done in the Newark College of Engineering.

In addition to his background in management, he was a graduate of Yale University, a mechanical engineer, and an experienced teacher with four years' service as Instructor at Yale and fourteen years as Assistant and later Associate Professor at Brown University. At the time of his appointment to our faculty, classes were small and a separate department of Industrial Engineering was not justified. However, Professor Brooks organized the course in Industrial Management as one of the courses given by the Mechanical Engineering Department, the work being given to students in all of the four professional departments. As the College grew in size and the class-hour teaching load in the department increased rapidly, a separation of the management work from the strictly mechanical engineering work seemed at last justifiable. When College opened in September, 1934, Professor Brooks began his seven-year career as Professor of Industrial Engineering and head of the Department at Newark College of Engineering. Under his charge were put not only the courses in Industrial Management, but those in Economics, Accounting, Business Law, and Staff Control. The importance of this Department in the professional training of students at Newark is suggested by the fact that some twenty percent of the semester hours of the junior and senior curricula of all students in the College are scheduled in the Industrial Engineering Department.



Professor J. Ansel Brooks

Now that Professor Brooks has retired from active service on the faculty of Newark College of Engineering, a brief sketch of his life is in order. Although born in Worcester, Mass., he spent his school and college days in Connecticut. After graduating from Yale University, he returned for graduate work and received the degree of Mechanical Engineer. Later he attended the Sorbonne in Paris, France. From 1899 to 1903 he was an Instructor on the teaching staff of Yale University, and from 1903 to 1917 he served as Assistant Professor and Associate Professor in the Mechanical Engineering Department of Brown University at Providence, R. I. While at Brown he became intensely interested in "flying machines," and gave many lectures on flying and on Aerial Navigation. About 1910 or thereabouts he entered the new field of scientific management and soon was organizing management courses in and around Providence. During this period he organized the Providence Engineering Society and served as its first President. In 1917 he left Brown and served in the United States Army Air Service at Guersten Field in Louisiana, later specializing in production of Handley-Page planes. After the war he spent four years in private practice as consulting engineer, a year with the Veterans' Bureau in charge of educational rehabilitation work in New York and New Jersey, and then in September, 1924, began his work at Newark College of Engineering. In addition to his departmental work, Professor Brooks has taken an interest in the extra-curricular activities of the students. He organized the first professional student chapter at the College, the student branch of the American Society of Mechanical Engineers. After the Department of Industrial Engineering was formed, he organized the student chapter of the Society for the Advancement of Management.

(Please turn to page 25)

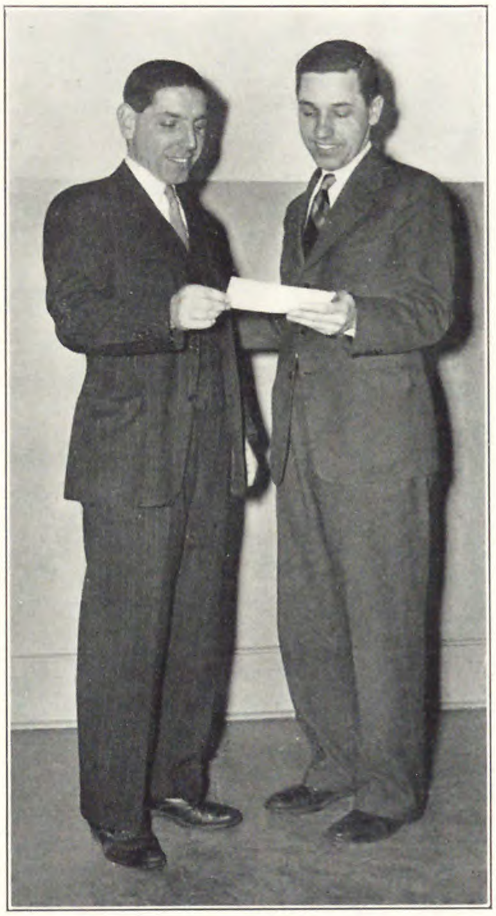
THEIR "IMPOSSIBLE" CAMERA O. K.

Stereoscopic Gadget Is Sold to Firm That Had Scoffed

Reprinted from The Sunday Call, Newark, N. J., January 19, 1941

Four months ago Eastman Kodak camera officials assured two New Jersey brothers their stereoscopic camera idea was impractical. Yesterday the brothers received a $1,000 check, the first in a series of payments for rights to use their invention. The check came from Eastman Kodak.

The brothers are Pompey and Marcus N. Mainardi, both graduates of the civil engineering course at the Newark College of Engineering. Pompey, 29, is a mathematics instructor at the college. Marcus, 28, teaches physics at Park Ridge High School in Bergen County. The pair live in Paterson.



Pompey (left) and Marcus N. Mainardi look happily at $1000 check they received yesterday as initial payment for use of camera gadget they invented. Both are graduates of Newark College of Engineering.

The Mainardi device is an adapter which slips over the lens of an ordinary camera so it can simultaneously snap two photographs of the same object. The photos are just different enough so that, when viewed through a holder which the brothers also invented, they give an illusion of the third dimension.

Heretofore most serious stereoscopic work has been done with a double camera. Single-camera adapters have been on the market for many years, but the Mainardi brothers assert that theirs is the first to produce double pictures with no distortion.

Royalties for 17 Years

The contract with Eastman Kodak provides that the New Jersey engineers will receive a five per cent royalty on the sale of their device for 17 years. It guarantees a minimum of $1,000 a year. The signed contract and the first check arrived simultaneously.

The Mainardi brothers worked on their invention three years before perfecting it. They have been camera fans since boyhood. They built a stereoscopic adapter patterned after the commercial type, but were dissatisfied with the distortion in the resulting photographs.

Applied Optical Laws

The Mainardis inquired, but could not learn what the optical principle was that caused the slight difference in the size of the "double" pictures which resulted in distortion. So they set to work with pencil and paper and applied the optical laws they had learned in physics. They discovered the reason.

Still on a theoretical basis, they figured out how an adapter could be built which would make accurate pictures possible. Their most difficult task, of course, was actually to build such a device. Last summer the gadget was perfected.

The Mainardi boys wrote the Eastman Kodak Company to ask whether the concern was interested in manufacturing rights to the adapter and viewer. They offered to come to Rochester for an interview.

"Couldn't Be Done"

They received a reply saying, in effect, that the company's engineers had thoroughly investigated the possibilities of single-camera adapters and decided they were impractical. If the boys wanted to stop in for a chat with the Eastman Kodak engineers, however, it would be all right.

"We drove up to Rochester as soon as we got the reply," Pompey said. "About three minutes after we started talking the company engineers became enthusiastic about our idea."

The brothers said they could not release details concerning the adapter until after the patent interests on their device had been safeguarded.

PROMOTIONS AND APPOINTMENTS

Mr. Allan R. Cullimore, President of the Newark College of Engineering, has announced the following promotions at the College: Professor J. Ansel Brooks, formerly Professor in Industrial Engineering and Head of the Department, has been appointed Professor Emeritus in Industrial Engineering; Professor Robert Widdop, formerly Associate Professor in Industrial Engineering, has been appointed Professor in and Head of the Department of Personnel Relations; Professor George D. Wilkinson, Jr., formerly Associate Professor in Industrial Engineering, has been appointed Professor in and Head of the Department of Industrial Engineering; Professor Edward G. Baker, formerly Assistant Professor in Mathematics, has been appointed Associate Professor in Mathematics; Professor Frank A. Busse, formerly Instructor in Civil Engineering, has been appointed Assistant Professor in Personnel Relations; Professor Paul L. Cambreleng, formerly Instructor in Industrial Relations, has been appointed Assistant Professor in Personnel Relations; Carl Konove, formerly a Teaching Fellow, has been appointed Assistant Instructor.

New appointments include the following: Dr. Russell S. Bartlett as Research Fellow in charge of the Joint Survey of the Society for the Promotion of Engineering Education and the Engineers' Council for Professional Development. Dr. Bartlett received his Bachelor of Arts degree from Yale in 1917 and his Ph.D. in Physics in 1924 from Yale. Dr. Bartlett was a member of the faculty of Yale University as Assistant Professor in Physics and during the eight years prior to coming to Newark, taught Physics at the Phillips Exeter Academy. Dr. Paul J. Selgin, to

Instructor in Physics. Dr. Selgin was graduated from the University of Milan in 1934 with the degree of Doctor in Electrical Engineering and in 1939 received his Master of Science degree in Communication Engineering from Harvard. Walter Selkinghaus, to Instructor in Mechanical Engineering. Mr. Selkinghaus was graduated from the Newark College of Engineering in 1933 with a Bachelor of Science degree in Mechanical Engineering. He spent some time as Metallurgist with the Crucible Steel Corporation and five years as an Instructor in Mechanical Engineering at the University of North Carolina from which he received his Master of Mechanical Engineering degree in June, 1940.

The staff of the Newark College of Engineering has steadily been increasing as the following table will show:

	1938	1939	Spring 1940	Fall 1940	Spring 1941
President	1	1	1	1	1
Professor Emeritus	—	—	—	—	1
Professors	9	10	11	12	13
Associate Professors	7	9	10	9	8
Assistant Professors	16	16	14	16	17
Instructors	20	18	21	20	22
Assistant Instructors	10	12	6	7	8
Teaching Fellows	—	—	4	3	3
Research Fellow	—	—	—	—	1
Research Assistants	—	—	2	2	2
Special Lecturers	7	8	10	9	12
Departmental Assistants	9	11	8	10	11
Others	2	2	2	2	2
Totals	81	87	89	91	101

PLASTIC AGE REACHES CANNON SHELLS

Lighter Substitute May Save Metals — Dr. Taylor, Adviser to Army, Tells Use

Reprinted from front page Newark Evening News, January 7, 1941

Dr. T. Smith Taylor

Uses of plastic materials in making certain articles of ordnance have been outlined for the U. S. Army by a National Research Council committee of which a Newark College of Engineering professor is a member. He is Dr. T. Smith Taylor of the Physics Department.

Plastics can be used in ways that will release metals and machine tools from ordnance manufacture to other branches of the defense program, Dr. Taylor explained yesterday in discussing his work for the army. A property of plastic materials that is particularly valuable for ordnance uses, he said, is that of receiving fine designs in casting.

Ordnance makers must use special materials, such as aluminum, which require separate machine operations for threading, and so forth, Dr. Taylor said. Substitution of plastics in such cases, he said, would save considerably on metals and machines which are scarce.

Lightness an Advantage

The lightness of plastic materials in comparison with metals is an advantage in making parts of shells, he said, because plastics would be used only at the rear end which should be lighter than the forward penetrative and explosive end.

There is plenty of strength in certain plastics to bear the shock of the explosion which hurls a shell, he explained. Plastics are better suited than some metals to bear such shocks, he said, pointing out that plastic gears are used where it is desired to absorb the shock of starting heavy machinery.

A limitless supply of materials for making of plastics is available, he added. Phenol (carbolic acid) formaldehyde is the base for many plastics of the type that harden under heat while coal tar products and cellulose are materials for plastics that soften under heat. Requirements for ordnance materials cover temperatures ranging from —50 degrees to 140 degrees Fahrenheit.

Processes and machinery for making plastics are on hand in quantity, he said. Fewer skilled men would be needed to operate plastic presses, he said, than to do the machining of metals for which the plastics could be substituted.

Long Experience

Dr. Taylor has had long experience in the plastic field. After teaching at Yale and the University of Illinois, he was with Westinghouse and for 10 years was head of the physics laboratory of the Bakelite Corporation. In 1937, while professor of physics at Washington and Jefferson College, he was selected by the American Society for Testing Materials to give the Edgar Marburg lecture, the outstanding scientific address of the society's annual convention. His lecture was on plastics.

He was selected by the National Research Council to advise the army on the use of plastics in ordnance manufacture along with John F. Townsend of the Bell Telephone system and Myron Park Davis, chief chemist and metallurgist of the Otis Elevator Company. Townsend is chairman of the committee.

In addition to teaching physics in the engineering college, Dr. Taylor is working with students taking graduate work at the institution and is giving a defense course in materials and how to test them. He lives at 45 Grover Lane, Caldwell.

AMERICAN CHEMICAL SOCIETY

The newly formed chapter of Student Affiliates of the American Chemical Society had its first meeting on Thursday evening, February 6, in Room 30A. The chapter was formally welcomed to membership in the Society by Dr. Randolph T. Major, Chairman of the North Jersey Section of the American Chemical Society, and Director of Research and Development for Merck & Co., who talked on the advantages of membership in a technical society and on coöperation in scientific work. The meeting continued with an exhibition of glass ware by the Corning Glass Works and a two-reel film showing the manufacture of glass by the same company.

PROFESSOR WIDDOP BECOMES DEPARTMENT HEAD

Robert Widdop, a graduate of the Newark College of Engineering in the class of 1924, has been promoted from Associate Professor in Industrial Engineering to Professor of Personnel Relations and has taken up the work of organizing and administering the new Department of Personnel Relations. This department has been set up to serve a need that arises from the growth of the college as a whole and the corresponding need for expansion of the administrative organization of the faculty. Just as in 1934 the Department of Industrial Engineering was set off from its parent, the Mechanical Engineering Department, so this Personnel Relations Department has now been set off in its turn from its parent, the Industrial Engineering Department. Professor Widdop had the general responsibility for the personnel and "orientation" work that was being carried on within the Industrial Relations Department in addition to his duties as Director of Industrial Relations. This orientation work was considerably increased when the curriculum was revised a few years ago by the addition of scheduled hours in this field to the Freshman and Sophomore curricula and by the increase in the number of hours on the Senior schedule. And now, following the retirement of Professor Brooks from active duty as head of the Industrial Engineering Department, the necesasry reorganization has taken place, with Professor Widdop taking into his new department the non-technical work that was being developed under Professor Brooks' leadership. This work has been integrated with the activities in the field of Industrial Relations and is already large enough to require a staff of seven men serving under Professor Widdop's direction.

Professor Robert Widdop

A man charged with responsibility for the success of a dedepartment of Personnel and Industrial Relations should have a broad background of experience. This seems to be peculiarly true in the case of Professor Widdop. Born in Philadelphia, his school-day life was a composite of American, English, and Canadian experience. Two years before the United States entered the first World War he went into the Ingersoll-Rand plant as a machine operator, working on shell parts. A year later he enlisted in the army and saw service in border patrol on the Mexican border with the Fifth United States Cavalry. After the United States entered the war he was transferred to the Second Ammunition Train, attached to the Twelfth and Fourteenth Field Artillery of the Second Division, and was in one of the first contingents of troops sent to France. As a member of this outfit, he went through such engagements as those in the Argonne, at Soissons, Chateau Thierry, etc., and was finally gassed and burned so seriously that he was hospitalized and invalided home. He is one of the youngest—perhaps the youngest—veteran of the World War now resident in New Jersey who saw any considerable amount of active service in France.

In 1919 Professor Widdop came to the Newark College of Engineering, took some preparatory work, then matriculated as a student in Mechanical Engineering. After graduating in 1924, he spent three years in production and maintenance work with the Edison Portland Cement Company and the Penn-Dixie Corporation, and then returned to the college as Superintendent of Plant and Equipment. In 1930 he joined the faculty as Assistant Professor in Mechanical Engineering, later taking charge of the courses in Engineering Drawing. In 1935 he became Associate Director, and in 1936 Director of Industrial Relations and Associate Professor in Industrial Engineering.

At the present writing, Professor Widdop is not only carrying on the constructive work required in organizing a new department in the college, but is organizing and administering the entire college program of intensive "Engineering Defense Training" courses. This program, which was assigned to the college last fall, has required the planning of course outlines, arranging for large increases of instructional staff, selecting students from among two thousand applicants, arranging for considerable space facilities in off-campus institutions, and finally getting classes under way for a group of students now numbering between five and six hundred.

(Reported by Professor Harold N. Cummings, in charge of Civil Engineering Department, Newark College of Engineering.)

THE COVER DESIGN

The picture on the cover is a view of the recently completed Edison Memorial Bridge which was designed and built under the direction of Morris Goodkind, New Jersey State Bridge Engineer. Mr. Goodkind, who is also a member of the Civil Engineering Department Advisory Committee to the Board of Trustees of the Newark College of Engineering, recently gave an exceedingly interesting paper on "The Construction Features of the Edison Memorial Bridge" to the Newark College of Engineering Student Chapter of the American Society of Civil Engineers. At this time he showed the chapter some splendid color motion pictures and slides taken of interesting phases from the construction work on this bridge.

DR. FREEHAFER LECTURES

Dr. J. E. Freehafer of the Mathematics Department of Newark College of Engineering read a paper on "The Application of Functions of a Complex Variable to Aerofoil Theory" at a meeting held on Friday, February 28th, at the Newark College of Engineering.

NEW HEAD OF THE INDUSTRIAL ENGINEERING DEPARTMENT

On February first George D. Wilkinson, at the age of 29, became head of the Department of Industrial Engineering at the Newark College of Engineering. Professor Wilkinson was graduated from the Newark College in 1933 with the degree of B.S. in Mechanical Engineering. In 1937 he received the degree of Master of Science in Industrial Engineering from Columbia University, and has now completed the required academic work for the Doctor's degree in Industrial Engineering.

After his graduation in 1933 Professor Wilkinson remained at the College for a year as an assistant in the Mechanical Engineering Department. Then, after a year in industry, he returned

Professor George D. Wilkinson

to the College as an instructor in Industrial Engineering. Three years later he was promoted to Assistant Professor, and in 1940 to Associate Professor.

This rapid rise, in seven and one-half years, is the result of two important facts: first, the opportunity for advancement existed at the College; second, Professor Wilkinson possessed the required qualifications for advancement. While in College he showed promise of future achievements. He was a conscientious student, and his scholastic record placed him in the top group in his class. He was elected a member of the Honorary Society of the Trunnion, and won second prize for a paper presented at a meeting of the members of eighteen Student Branches of the American Society of Mechanical Engineers. Also, in his senior year, he received the Charles T. Main Award presented by the American Society of Mechanical Engineers. The yearly competition for this award is open to the members of all Student Branches of the Society, about eighty Branches in 1933.

When Professor Wilkinson was graduated from College he already possessed several important requirements for advancement: excellent character, pleasing personality, and the ability and willingness to accomplish much work well done. Since graduation he has repidly prepared himself to meet other necessary requirements for advancement and leadership. He has continued to grow intellectually, to acquire experience, and to assume responsibility.

Professor Wilkinson, as head of the Industrial Engineering Department, has the full confidence of his colleagues and the respect of his students. Furthermore, confidence in his ability is evidenced by the fact that he has received the following appointments:

Educational Inspector in Production Supervision in the Engineering Defense Training Program conducted by the Newark College of Engineering.

Member of the Executive Committee, member of the Motion Study Committee, Northern New Jersey Society of Industrial Engineers.

Member of the Sub-Committee on Visual Education, Society for the Promotion of Engineering Education.

Professor Wilkinson is a member of the following societies:
American Society of Mechanical Engineers
Society for the Promotion of Engineering Education
American Association of University Professors
The Society of the Trunnion
Alpha Kappa Pi
Torch Club

(Reported by J. Ansel Brooks, Professor Emeritus, Industrial Engineering.)

ODD'S BOMBKINS

Reprinted from Monthly Magazine of the Oranges and Montclair, East Orange, N. J., January, 1941

He'll leave Martian scares to Orson Welles but Odd Albert, 42 Chestnut Street, East Orange, Assistant Professor of Structural Engineering at the Newark College of Engineering, proposes that all human habitations henceforth be built with bomb-shelter basements. Instead of having a rumpus room, Mr. Albert simply proposes 'bompus-rumpus" rooms, in which a family could be safe from bombs and still carry on their lives in normal manner. Mr. Albert, who has done considerable research on the subject, has designed the cellar of the future with foot-thick reinforced concrete, so that even if the building is wrecked or burned, the occupants could continue to live in this shelter. Thus the problem of homeless people, the great tragedy of modern warfare, could be eliminated.

After the first shock of hearing Mr. Albert's suggestion that we harbor a little bomb shelter in our home against rainy days to come, we have come to the conclusion that there is nothing odd about the idea except Mr. Albert's first name.

LA LONDE LECTURES AT ROBERT TREAT HOTEL

The Junior Chapter of the Essex County Engineering Society held its monthly meeting at the Robert Treat Hotel, Newark, on Thursday, December 5, at 8:15 P. M. After a business meeting, which included election of officers for this chapter for the coming year, Professor William S. LaLonde gave an illustrated talk on "The Construction of Open Coffer Dams." The pictures shown by Mr. LaLonde were those taken during the construction of the Lincoln Memorial Bridge, upon which both he and Professor Robbins worked.

Movies of the Yellowstone National Park in natural colors were then shown.

Preceding Mr. LaLonde's talk, there was an informal session on "Public Speaking for Young Engineers," in which the members participated freely.

MEASURES ELECTRIC "LAG"

Wide Range Timer Developed by Newarker Valuable in Defense Work

Reprinted from Newark Evening News, February 4, 1941

The increased tempo of scientific research stimulated by national defense industries has brought to public eye the brain child of a mathematics professor.

He is Elmer C. Easton of 34 North 11th Street. Graduate of Barringer High School, Lehigh University, class of 1931, and master of science, Lehigh, '33, he is well on his way to a doctorate in science at Harvard University.

His development is a precision instrument which will measure the delay or "lag" between the application of voltage and the resultant spark. Challenging the imagination, the instrument will measure electrical impulses over a range of one-millionth of a second to five ten-thousandths of a second.

Minimizes Efforts

Professor Easton minimizes his efforts, reporting that the theory behind his "timer" is as old as electricity itself. The importance of his development, however, can be judged from the

Elmer C. Easton

fact that he presented a paper entitled "A Timer for Spark Breakdown Studies" in December before a combined meeting of the American Physical Society and the American Association for the Advancement of Science in Philadelphia.

Interviewed in his office at the High Street school, Easton told how he had developed the "timer" while working for his doctor's degree. Because his time is taken up completely with his teaching activities, Easton spends his summers working in the high voltage laboratory at Harvard University under Dr. J. D. Cobine. For the last three summers he has been developing the timer there, where it is at present.

Easton holds memberships in Phi Beta Kappa, Eta Kappa Nu, honorary society in electrical engineering, and Sigma Xi, honorary society in research.

Request of Dr. Tonks

Practical value of the development is seen in the recent request of Dr. Lewi Tonks of the research laboratory of General Electric Co. in Schenectady. Professor Easton believes Dr. Tonks is using sparks for switching purposes in research on a defense problem and may be able to use the apparatus to make possible more extended and more accurate measurements.

Easton thinks the primary value of his timer in relation to defense work will be in ballistics. His timer can be used to measure the flash by which a bullet leaving the muzzle of a gun is photographed. It can be used first to determine how long the bullet was exposed and secondly it can be a factor in determining the muzzle velocity of a bullet.

Valuable in Welding

A second value of the development, Easton says, is its ability to measure the "shot" of an electric welding unit. Recent advances, spurred by the needs of defense industries and especially in the field of aviation, have been made in electric welding.

Devices similar to Easton's are on the market today, the major difference in them being the speed limit. Remington Arms, for example, has produced a timer with a range limit to one-thousandth of a second.

Easton explains that his instrument resulted from research in spark breakdown. His studies included spark reactions to compressed nitrogen used recently as an insulation medium for high voltage machines.

PRODUCTION PROBLEMS

Reprinted from Newark Evening News, Editorial, Dec. 19, 1940

Lag in production for the national defense has evoked a chorus of varying and contradictory explanations, some strongly suggestive of buck passing, when what is required is dispassionate and expert appraisal. An example is set by President Allan R. Cullimore of the Newark College of Engineering. Speaking as adviser in the North Jersey area for the training of technicians, he says:

> There is no one factor which is causing delay in carrying out the defense production program. There is a series of factors which tend to slow up production. You cannot generalize and say it is a shortage of skilled labor, or a lack of supervisory personnel or the short week, or something else. The fact is each plant has its own specific problem or problems of meeting the increased demands suddenly thrust upon it. That problem varies with the plants.

Here is logical reasoning by an understanding mind. Mr. Cullimore also sees the difficulties and complexities involved in sudden expansion of plant and facilities as well as the natural confusion of the average manufacturer when faced with contracts far larger than any handled before. It is because he "has not been geared to the task." Likewise, it might be added, the same fault affects the worker in many instances. But largely, as Mr. Cullimore indicates, maximum production of a plant is a test of skill in management.

The head of the Newark College of Engineering was citing the problems found in this area, but by no means peculiar to it. Their solution, as has been repeatedly demonstrated, rests in major part on the performance of government, producer and artisan. Generalities, voicing criticisms of the other fellow, will get nowhere. There must be more coöperation and coördination and at the same time realization of the gigantic task that lies ahead.

PROFESSOR PAUL E. SCHWEIZER ELECTED

The New Jersey Chapter of the American Society for Metals has selected Professor Paul E. Schweizer of the Department of Mechanical Engineering, Newark College of Engineering, as a member of the Executive Committee for the year 1941-42.

THE ENROLLMENT AT N. C. E.

By Paul L. Cambreleng, A.B.

Assistant Professor in Personnel Relations, Newark College of Engineering

In considering the material that should go into this article, it seemed wise to begin with the fact that your reporter, formerly Registrar, is now Director of Admissions. This change is in keeping with two definite trends. It is interesting to note that similar changes have taken place in other institutions.

The first trend indicates that admission to the college is no longer the clerical task of adding up credits with the selection of freshmen depending entirely on that summation. It has been the feeling at Newark College of Engineering that we should consider such factors as health, personal appearance, extra-curricula activities, recommendations of the principal, and reasons for the choice of engineering, in addition to the academic standing of the applicant. We have tried to make our contact with the prospective freshman a step in a guidance program rather than a bookkeeping procedure, where the fate of the applicant is decided without consideration of his potentialities. The new office, Director of Admissions, falls under the supervision of the Personnel Relations Department in which is included pre-college guidance, admissions, orientation to the college and to industry, personal counseling, personnel relations problems, placement and follow-up. From this arrangement it can be seen that the procedure of admissions is but one point in a continuous guidance program.

The second trend is quite apparent and comes in the form of an increase in the total number of applications for admission. This growth has made it necessary to separate the clerical work of the Registrar from the service functions of admissions. Much of the growth in the total number of applications is to be found in the number of individuals desiring a basic training in engineering for educational purposes rather than professional training and in the number of out-of-state individuals applying for admission, either as prospective freshmen or transfer students.

Those of us who have worked on the problem of pre-college guidance are keenly aware of the interests of the freshmen and sophomores in high school. We find that an increasing number of these young people have arranged through their high school counselors to spend several hours visiting the laboratories of the college and taking up problems of selection of courses and the requirements for admission to an engineering school. Visitations of this nature permit changes in high school courses to meet the requirements of admission to the college and to give the visitors some idea as to the demands that will be placed upon them as students in an engineering school. This type of pre-college guidance may not necessarily increase the total number of applications to the college but it will assist the applicants in making a wise choice.

The number of applications for admission received for this academic year totals 525. The table below gives comparative figures for the last four years. This does not include enrollment figures for students in the Engineering Training courses for National Defense.

	Freshmen	Upper Classmen	Advanced Students	Total
1940-41	292	705	178	1175
1939-40	294	647	51	992
1938-30	239	610	39	888
1937-38	227	590	18	835

The following list gives the total enrollment of students in the various courses, as well as those enrolled in the Engineering Defense Training courses.

NEWARK COLLEGE OF ENGINEERING REGISTRATION ANALYSIS AS OF FEBRUARY 27, 1941

Civil Engineering	84
Industrial Chemistry	274
Electrical Engineering	199
Mechanical Engineering	435
Freshmen (undecided)	5
Matriculated Students	997
Advanced and Graduate Courses	120
Civilian Pilot Training	35
Auditors	23
Total	1175
Engineering Defense Training	505
Grand Total	1680

PROFESSOR ELMER C. EASTON TO TALK

On Friday, March 28, at 3:00 P. M., Professor Elmer C. Easton will give a talk on "Operational Calculus." This talk which is sponsored by the Mathematical Department of Newark College of Engineering is the second to be delivered this year on advanced mathematical analysis.

THE FUNDAMENTAL PRINCIPLES OF ELECTRICITY IN MODERN TERMINOLOGY

(Continued from page 13)

first appraisal appear more difficult than the older methods. But it should be remembered that the student has no firmly implanted preconceptions to interfere with his grasp of the new material, both the new and old approaches being nearly equally unfamiliar to him. A re-consideration of the new method, on this basis, will undoubtedly demonstrate that its directness, simplicity, and economy offer many advantages. Once a difficult idea is mastered, it makes the rest much easier to understand. With the older methods, only too often, when once a difficult idea is grasped, it merely makes the whole subject that much more confusing.

PROFESSOR J. ANSEL BROOKS RETIRES

(Continued from page 19)

Throughout a period of over forty years of service, he has found time to travel widely, lecture on many subjects, and participate actively in such professional organizations as the American Society of Mechanical Engineers, the Society for Promotion of Engineering Education, the Montclair Society of Engineers, the Society for the Advancement of Management, the American Association for the Advancement of Science, the Providence Engineers' Society, and the Yale Engineering Society.

WHAT OUR READERS SAY

To the Editor:

I have been getting NEWARK ENGINEERING NOTES from time to time but due to a change in address I am not sure whether all of them reach me. Therefore, I would greatly appreciate it if you would have my address changed to The Celotex Corporation, Calicel Division, Marietta, Ohio.

In enjoy this paper so much that I would feel it a great loss if I were to miss any of the copies.

Sincerely yours,
R. KRABLIN, JR., '37
Research and Development
The Celotex Corporation
Calicel Division

Marietta, Ohio, November 12, 1940.

To the Editor:

I have been much interested in reading an article by Mr. H. K. Sels and Mr. R. C. R. Schulze on "The Alternating-Current Network Analyzer of the Public Service Electric and Gas Company" which appeared in the May, 1939, issue of the ENGINEERING NOTES.

Is there any chance that additional copies of this number are still available? If so I would like very much to have a copy. If any reprints were made for the Public Service Company some of these might still be available.

If possible, I would like to be on your mailing list to receive the NOTES regularly as they frequently contain technical articles of much interest.

Thank you very much.

Yours very truly,
R. W. WARNER, Chairman
Department of Electrical Engineering
The University of Texas

Austin, Texas, August 15, 1940.

To the Editor:

The NEWARK ENGINEERING NOTES affords me an excellent opportunity for keeping in contact with N. C. E. and its associates; an association which I value highly.

My colleagues and I have found NEWARK ENGINEERING NOTES extremely interesting, educational and elucidating.

Please include my name in your permanent mailing list. I shall be looking forward to subsequent issues with a great deal of anticipation.

If it is possible, I would appreciate receiving Vol. 4, No. 1, of November, 1940.

Very truly yours,
GIOVITO J. MILAZZO, '39
Jr. Marine Engineer
U. S. Government
Philadelphia Navy Yard

Philadelphia, Pa., January 2, 1941.

To the Editor:

I am considering building an extension on my basement underneath a sun-porch. In view of your study of air raid shelters, I thought it would be interesting to find out what it would cost me to make this extension a project or experiment in the construction of such a shelter. I am not hysterical about the likelihood of an attack on Maplewood, New Jersey, whose chief wartime industry appears to be Orange Screen Company, but I think we all have in mind the changing conditions in the world and might as well adapt ourselves to them.

If you have any written material, I will be glad to have it, or I can stop in at your office some evening or Saturday afternoon, if that is at all convenient.

Sincerely,
EDMUND B. SHOTWELL
Patterson, Eagle, Greenough & Day

New York, N. Y., January 2, 1941.

To the Editor:

Please send us a copy of NEWARK ENGINEERING NOTES which describes bomb shelters, also advise us as to cost of this publication.

Yours very truly,
ALBERT HENDERSON, Consulting Engineer
The Cemenstone Company

Pittsburgh, Pa., December 30, 1940.

To the Editor:

I wish to subscribe for the NEWARK ENGINEERING NOTES for the year 1941. I would also like to obtain all the copies of 1940. I would appreciate your advising me as to the cost.

Yours truly,
THEODORE FUSS

Nutley, N. J., November 18, 1940.

To the Editor:

I have read with interest your suggestion on building of bomb-proof cellars on new homes.

We at the seashore cannot have cellars and I will appreciate your interest if you will advance some plan that we may adopt for bomb-shelter purposes.

Yours truly,
HENRY C. LAPIDUS, Editor
The Leader

Wildwood, N. J., December 3, 1940.

To the Editor:

I have just read with much interest your article "Bomb Shelters as Recreation Rooms" in the NEWARK ENGINEERING NOTES. This article certainly contains some timely and practical suggestions.

Very truly yours,
SUE E. KROG, Assistant Librarian
Rose Polytechnic Institute

Terre Haute, Indiana, December 31, 1940.

To the Editor:

I have recently seen a copy of NEWARK ENGINEERING NOTES and was pleasantly surprised that such an interesting and informative magazine was being published by the school.

The engineering articles written in the magazine are of interest to all engineers and the information supplied on current activities of Newark College of Engineering graduates are of personal interest to all alumni.

If you have any back issues of the magazine on hand, I would appreciate your mailing them to me together with a bill for the amount of postage, or, if that is impossible, I will gladly advance the postage in order to receive these copies.

In any event, please place my name on your current mailing list so that I may receive the magazine monthly.

Very truly yours,
EDWARD F. HOUSTON, '38
Wright Aeronautical Corporation

Paterson, N. J., November 29, 1940.

To the Editor:

I am a Turkish engineering student taking graduate work and studying various engineering products in this country. I am very much interested in the NEWARK ENGINEERING NOTES.

Yours very truly,
H. TASKIN

Columbia, Mo., September 9, 1940.

To the Editor:

I would be pleased to be put on your mailing list to receive future issues of NEWARK ENGINEERING NOTES. The recent issue of this publication has just come to my attention and I am very pleased with the general make-up and content of the publication.

Very truly yours,
P. L. HOOVER
Head of Electrical Engineering Dept.
Case School of Applied Science

Cleveland, Ohio, September 20, 1940.

To the Editor:

I have just received a copy of your most interesting publication, and am writing to thank you for it.

I am at present studying Chemical Engineering at the Lima School of Engineers, and found the NOTES most helpful. I would be very grateful indeed if you could put my name upon your regular mailing list. Thanks.

With best wishes for the continued success of NOTES.

Yours sincerely,
H. HARMAN

Lima, Peru, S. A., January 14, 1941.

To the Editor:

Regarding your request to this office on June 17, the *California Engineer* has placed your library on its mailing list.

We welcome and appreciate this exchange in engineering publications.

Very truly yours,
EARL D. SERDAHL, Editor
California Engineer,
University of California

Berkeley, Calif., August 22, 1940.

To the Editor:

Kindly add my name to your mailing list for the NEWARK ENGINEERING NOTES.

Very truly yours,
HAROLD K. HUGHES,
Department of Physics,
University of Newark

Newark, N. J., January 20, 1941.

To the Editor:

Please send me two catalogs of the Newark College of Engineering and any other pertinent information which would interest a student contemplating entering the College. These catalogs are intended for an acquaintance of mine who plans to enroll in an eastern engineering school this fall.

I am a graduate of the College in Civil Engineering, Class of June, 1935. For two years past I have not received the bulletin entitled ENGINEERING NOTES. Inquiry is made if that publication has been discontinued. If not, I wish to be replaced on the mailing list.

Very truly yours,
THEODORE LEBA, JR.
Construction Engineer
S. & W. Construction Co.

Alexandria, La., February 19, 1941.

To the Editor:

I would like my name placed on your mailing list for the NEWARK ENGINEERING NOTES, as I feel your magazine would be of great interest to me.

Sincerely yours,
LT. AMELIO D'ARCANGELO
Argentine Navy

Brookline, Mass.

8000