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Portrait by Bachrach

CARROLL A. FARWELL
President

Boston Society of Civil Engineers
1945-46

JOURNAL OF THE

BOSTON SOCIETY OF CIVIL ENGINEERS

Volume XXXII APRIL, 1945 Number 2

EDUCATION FOR CIVIL ENGINEERING

PRESIDENTIAL ADDRESS BY PROF. HARRY P. BURDEN*
BOSTON SOCIETY OF CIVIL ENGINEERS, MARCH 21, 1945

Fourteen years ago, a retiring President of the Society, Colonel Lewis E. Moore, presented as his address "A Suggestion for Engineering Education." I was very much impressed by his able presentation of his subject and have read his paper on more than one occasion since that time. It should be evident to most engineers and to every teacher of engineering that Colonel Moore had spent many hours in serious study of engineering curricula.

I should like to quote a brief paragraph from his introduction, as follows: "Judging from the attention lately paid to the subject of engineering education, something must be seriously wrong with it. Generally speaking, it seems to me that the results, if they are judged by the place which the engineer takes in the community, are not satisfactory."

It is not my purpose, today, to take issue with this statement, but to call attention to the fact that during the last fourteen years the amount of consideration given to engineering education has not only continued, but has increased, and to discuss briefly with you some of the reasons for this attention and some of the results of so much of this attention.

Ever since I can remember and long before that, there has been continuous discussion of the problems of engineering education both within and without the teaching profession. Not all of this discussion is an indication that "something must be seriously wrong with it."

*Dean of Engineering, Tufts College, Medford, Mass.

Much of the criticism has been initiated within the teaching profession (and sponsored by the Society for the Promotion of Engineering Education) and I should like to make the comment that, in my opinion, no professional group has been so self-critical, nor has devoted as much effort, time, and thought, to improving its product as has the engineering teaching group. In many ways, it is a good sign that the discussion of the problems of engineering teaching goes on endlessly rather than a sign that something must be seriously wrong. The point I should like to make at the moment is that while engineering education is still far from perfect, it has not stood still, and those whose duty it is to serve the public in this field are constantly endeavoring to improve it. In the succeeding paragraphs I propose to comment upon some of the factors entering into the problem and to note in some instances what is being done about them.

STUDENTS

It may be well to consider, first of all, the raw material with which we have to deal. I think it is fair to say that rather generally the students accepted for admission to an engineering college are more carefully selected now than in the past. This may be explained in part by the fact that except for the war period the number of applicants for admission has been greatly in excess of the number accepted. In a great many instances, the number of applicants is four, five, six or more times the number that may be accepted. Methods of selection of students have been developed which are more effective than those formerly used. These methods are still susceptible of improvement, but progress is being made all the time. Student guidance in the secondary schools is a contributing factor toward the improvement in the quality of entering students but has not been developed, in general, even to approach its potentialities. Here is one place where you as citizens or possibly in some instances as members of School Boards could render a worthwhile service to the community and to the engineering profession. The Engineers' Council for Professional Development has repeatedly pointed this out and has suggested that individual engineers and engineering societies offer their services to the secondary schools in order to present to students the opportunities and the responsibilities of the engineer. Many schools now conduct "Career Institutes" or "Guidance Institutes" and are seeking each year men who are willing to appear before the students to present a true picture of each of the professions. Why not see the school principal or guidance counselor in your town and offer your services? I feel sure that, in most instances, you will receive a hearty welcome.

Faculty

Colonel Moore expressed concern with respect to administrative heads and their methods of selecting and promoting teachers. It is regrettable that there has all too often been too much emphasis placed on the research and the volume of writing produced by the individual teacher. He did not say that research initiated by the teacher having a desire to extend his own knowledge and to add to the knowledge of engineers and the community at large was a detriment per se. Admittedly, all too often, the selection and promotion of a teacher has been based to too great an extent on the volume of his publications. At the same time, the desire and the ability to carry on research and to write, frequently is to be found in an individual who has outstanding ability to teach. This is one man we are always seeking, but I believe that most administrators are ready today to reward ability to teach even if the research and publications are relatively scant or even entirely missing. There is a possibility that a man who is solely a teacher, and a good teacher, may fail to keep abreast of his field and cease to be a good teacher. Given two men having about the same ability to teach (this is something exceedingly difficult to evaluate) the administrator would select the man who has the ability to carry on research or write because he recognizes that the research worker is practically certain to keep up with new developments.

Teaching Techniques

It is an easy task to write a set of specifications for an engineering teacher. It is much more difficult to select a teacher from a group of applicants from those specifications. As a rule, a teacher begins as a young man, frequently directly from graduate school, where quite possibly he has been employed as a graduate assistant. He has had an opportunity to observe the teaching methods at both the undergraduate and the graduate level. He has also had the opportunity to pursue his studies in some specialized branch of his major field well beyond the scope of his undergraduate work. Usually, he has participated in research. This may have been limited to work on his thesis but often may have extended to a research project conducted as a departmental project or as research conducted by members of the staff on an industrial project. Often, as a teaching fellow, he has had some experience in conducting laboratory classes. Frequently, he decides now, or perhaps after a year or two of engineering experience, that he wishes to make teaching his life work.

The young man secures a teaching position and is assigned to his classes. If he becomes a member of a department in a large institution, his course work is laid out in most instances in considerable detail. In a small institution, he must often assume nearly complete responsibility for the entire course. In all probability, he has received no direct instruction in teaching techniques. Consciously or unconsciously, he has acquired or will develop his own techniques, which may to some extent be patterned after those he has considered good in his earlier experiences. Formal instruction in teaching techniques has long been given for secondary school education and some attempts made at the college level, but it has not been effective in the latter instance. A few states have required teachers in state universities to acquire a certain number of college credits in education for eligibility to teach in the state university, but the consensus of opinion among those engineering teachers who have been obliged to meet such a requirement is not favorable.

The Army and Navy programs in the colleges have placed increased emphasis on the use of visual aids in class room work. Undoubtedly there will be a carry-over effect in this regard in post-war teaching. It is a case of emphasis rather than new development, but its effectiveness has been demonstrated so clearly that we may expect to find considerable growth in this direction.

Curriculum

In every college and university in the country we find one or more post-war committees at work. This is so largely because the normal patterns in education have been so completely disrupted. It has been necessary during the war for the colleges to train men in large numbers to do specific tasks, to meet specific needs of the armed forces and of industry. Special programs varying from single intensive courses of a few weeks duration to a sequence of courses extending over several months have been in operation in the colleges. In the fields of medicine, dentistry, and engineering the Navy, in July, 1943, began to give young men a complete college course. Men who had already begun their college work were allowed to continue in curricula in operation in those colleges selected for Navy training. New students, selected by nation-wide tests, were started on special curricula adopted by the Navy after consultation with leading educators. I should like to note at this point that the Navy had a well-conceived plan; it was well organized and directed and continues today along the original lines. I have had no personal experience with the Army Specialized Training Program and therefore do not feel competent to discuss it except in general terms.

It is natural that, having had new and interesting experiences in the field of education, college faculties and faculty committees should consider whether to return to pre-war programs or to design new curricula in an endeavor to make new contributions to educational progress. (I realize, as do many of you that many college administrators and college professors expect to solve any of the world's problems by changing the curriculum).

In engineering, definite trends were well developed just prior to the war. The 1940 report of the SPEE on Aims and Scope of Engineering Curricula advocated increased concentration on basic elements, and parallel integrated sequences of scientific-technological and humanistic-social subjects. To carry out the recommendations of this report would necessitate the elimination of some of the specialized work at the upper level of undergraduate work.

The 1944 Report of the SPEE Committee on Engineering Education After the War reaffirms the recommendations of the 1940 Report. Most of the post-war faculty committees are really studying the feasibility or ways and means of carrying out the recommendations of these reports.

Recently the Committee on Engineering Education of the ASCE has made a progress report to the Societies Board of Direction. A copy has been sent to each of 114 engineering colleges whose civil engineering curriculum was included in the study, for comment. Two suggestions have been made and I quote:

Suggestions

1.—"Your committee suggests that the American Society of Civil Engineers encourage engineering schools to devote 20% of the time of Civil Engineering curricula to the study of humanistic-social subjects, and, in cases where it is feasible, to have the subjects coordinated so that the student may have a rather thorough acquaintance with one or more areas within these fields."

2.—"It is suggested that the Civil Engineering curriculum may reasonably be subdivided into subject groups, so far as time is concerned, approximately as follows: humanistic-social subjects, 20%; physical sciences, including geology, 15%; drawing, 4%; mathematics, 10% not including trigonometry; mechanics, hydraulics and strength of materials, 11%; engineering subjects, other than civil, 10%, and civil engineering subjects, 30%."

It is interesting to note that while the suggestions as to division of time in the various subject groups are approximate medians of the factual data, there is a rather wide spread in individual institutions. This is illustrated in the table below:

	Humanistic-Social Studies	*Physical Sciences*	*Drawing*	*Mathematics (Except Trigonometry)*	*Mechanics Hydraulics and Strength of Materials*	*Other Engineering*	*Civil Engineering*
Min.	6.6%	9.5	1.4	6.3	6.3	0.0	17.3
Sug.	20.	15.	4.	10.	11.	10.	30.
Max.	28.1	22.6	7.6	16.7	14.7	14.7	42.3

It should be noted that the suggestions offered by the ASCE Committee are made in a progress report, not a final one, and that the Board and the Committee are seeking comment and constructive criticism as a guide to future action.

It is not the intention of SPEE, ECPD, the Boards of State Licensing and Registration of Engineers or the ASCE to bring about a strict uniformity of curriculum in civil engineering in engineering schools, but it is obvious that with all of these agencies at work in much the same direction there will be a tendency for more close agreement with median values.

All of the national agencies which have been studying the problem of engineering education have agreed on the recommendation that 20% of the student's time be devoted to the humanistic-social studies. It is reasonable to assume that an increase in the amount of time allowed to these studies will be effected in the near future in many of our engineering schools. This will be an interesting experiment and it must be viewed in this light, as in itself we shall have only the beginning of a solution of the problem. Many students embark on an engineering career because in the secondary schools they have enjoyed mathematics and the physical sciences and have, at the same time, disliked courses in English, foreign languages, and history. It will be a real challenge to attempt to arouse an interest in and an enthusiasm for study in the humanities and the social sciences.

The solution of the problem will vary in different colleges depending on whether we have a technological institution or an engineering college associated with a liberal arts college on the same campus. It is interesting to note that, in general, colleges of the technological institute type have been the first to report progress. The Social Relations Program at the Carnegie Institute of Technology has an integrated treatment of subject matter extending throughout the four years which was begun in 1938. President Doherty believes that it has achieved about 70% of its objectives and these were identical with those stated in the 1944 SPEE report.

If we are to succeed in giving our engineering student not only a sound basis for practicing the profession of engineering but at the same time make of him an educated citizen able to take a part in the social, civic, and cultural life of the country, then we must support this plan. Our college administrators must give enthusiastic support, we must provide the best teachers to be found, and we must make clear to the student that the humanistic-social stem of the curriculum is as vital a part of his education as is the technological.

BASIC PRINCIPLES OF PHOTOGRAMMETRY

By Prof. Charles O. Baird, Member*

(Presented at a joint meeting of the Boston Society of Civil Engineers and Highway Section, B.S.C.E., held on February 28, 1945.)

Photogrammetry may be defined as that science of making accurate measurements on photographs. This broad definition of this term, therefore, covers any recorded photographic evidence in a wide and varied field of applications, of which the compilation of a map or plan probably is of major importance.

The optical axis of a camera is defined as an imaginary line passing through the optical center of the lens and perpendicular to the camera's negative. The direction of this axis is used to define the type of photograph, and, in this prospectus, the axis shall be considered in the vertical position only. The ideal vertical photograph, i.e., the picture in a horizontal plane, shall be used in all the subsequent discussions.

The distance measured along the optical axis from the optical center (nodal point of emergence) of the lens to the negative is usually called the focal length of the camera. The focal length will be represented in all subsequent discussions and equations by the symbol f. In a standard aerial camera the focal length is a constant value, for the fixed-focus camera is used, and 6″, 8.25″ and 12″ are very common focal lengths used in general practice.

Geometrically, the shortest distance from the lens to the negative is also the perpendicular distance and as stated above is usually called the focal length, but occasionally it is known as the principal distance. This perpendicular intersects the negative at the geometric center and this intersection is called the principal point and will be represented by the symbol P.

Figs. 1 through 5 are reproductions of five vertical aerial photographs of our New England landscape. Careful study of these five photographs, will demonstrate general characteristics and information to be found on aerial photographs, some of which follow:

*Associate Professor of Civil Engineering, Northeastern University, Huntington Avenue, Boston, Massachusetts.

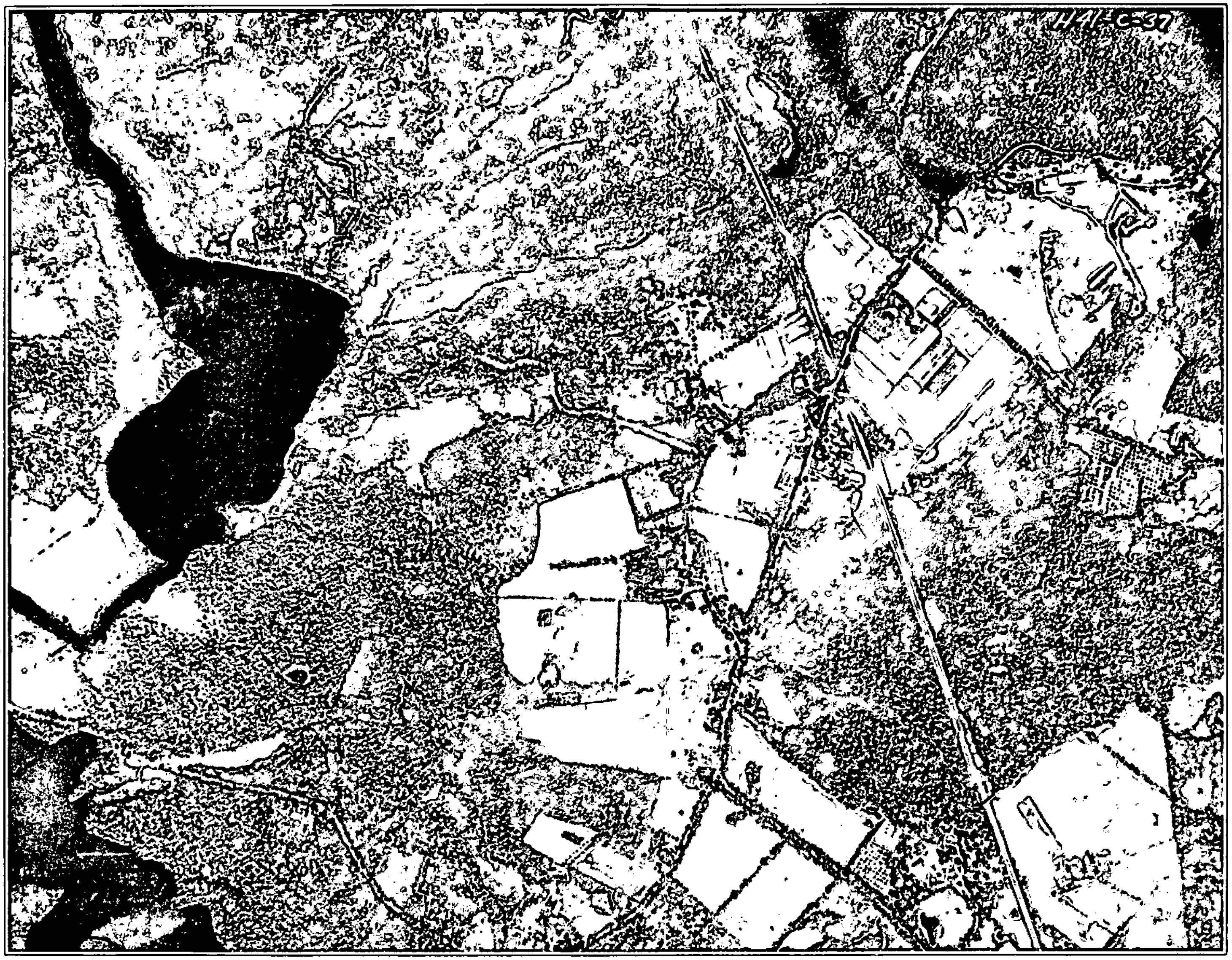

FIG. 1.

FIG. 2.

FIG. 3.

Fig. 4.

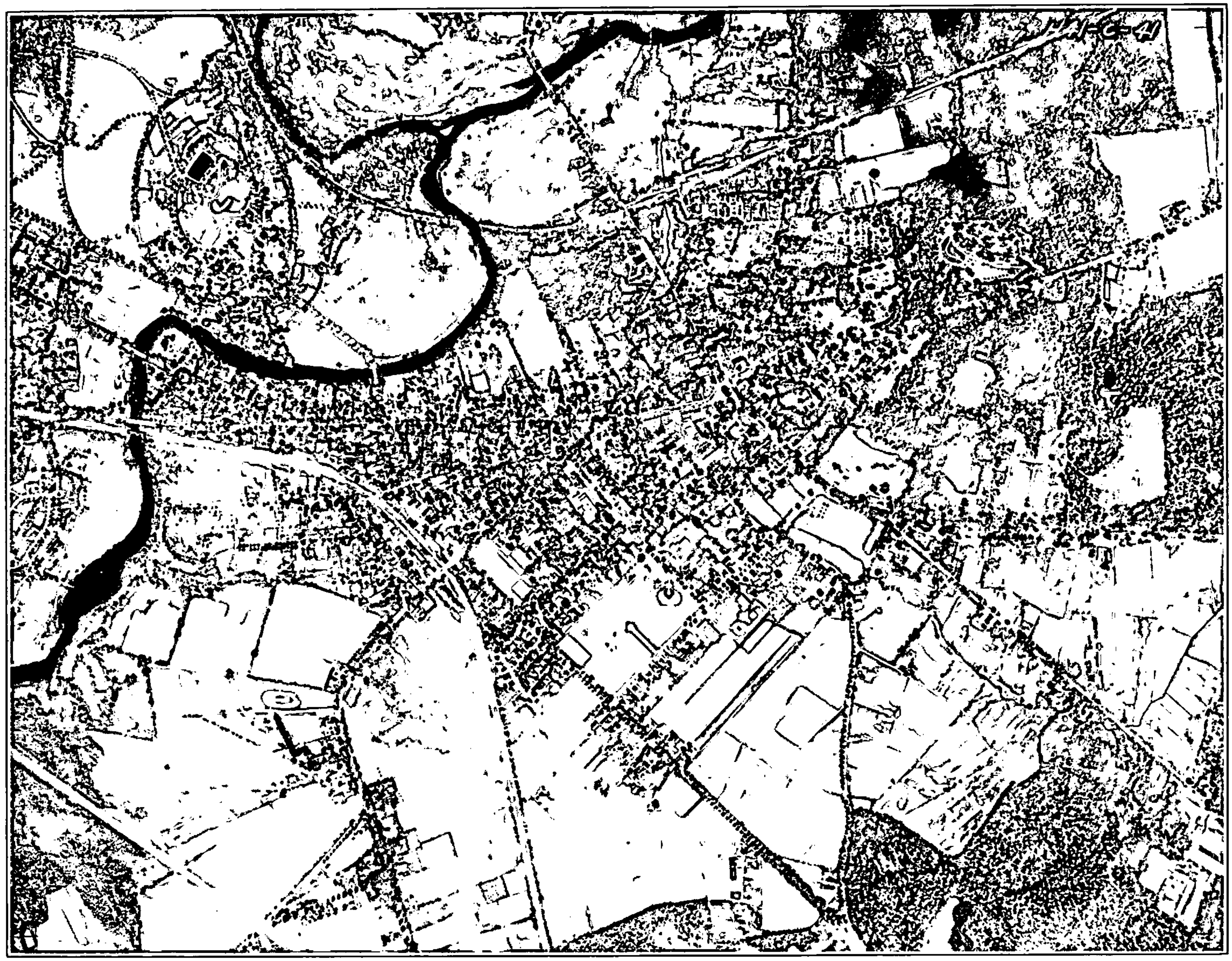

Fig. 5.

In each of the four corners of each photograph two short fine black lines at right angles to each other can be observed. These lines are known by a wide variety of names such as: centering marks, collimating marks, register marks, ticks and fiducial marks. When the photographs are oriented so that the index number is in upper right hand corner, then a small arrow can be observed crossing the horizontal fiducial mark of the lower left hand corner. This arrow is used to indicate the direction of flight, and in this group of five photographs the direction is nearly true north. An illustration of the use of fiducial marks is shown in Fig. 10. The diagonals from diametric fiducial marks intersect at the geometric center and this principal point is denoted by the symbol P_{41}

One gathers that the climate is temperate, with an abundant rainfall, ample water for domestic and agricultural needs as indicated by brooks, rivers, and ponds, heavy and luxuriant vegetation. These pictures being local in character the time of year is evident, in fact it is summer time.

This group of photographs are 7″ by 9″ in size the seven-inch length being in the direction of flight. The average, or mean, altitude above the ground varies somewhat for each individual photograph, but for practical purposes the altitude for this group of photographs is about 9,000 feet. Each photograph represents a ground area of approximately 2.6 square miles.

A sanitary engineer might very well prepare a turbidity scale by the varying degrees of blackness of the water surfaces. When the water is dirty, or turbid, light rays are reflected from the liquid surface, while the rays of light enter clean water and are absorbed before being reflected by some object suspended in the water. The ponds and lakes are dark black in appearance indicating that the water is generally fairly clean.

The topography of this group of photographs is also varied in character. Portions of each photograph indicate rough topography, as shown by steep slopes of the hills, well defined valleys with swift flowing brooks. Man made structures show deep "cuts" and high "fills." Other portions of these photographs indicate broad fertile lowlands, level or nearly level in character, for farms, orchards, and cultivated lands are near the slow meandering streams. Or in other words a geologist can learn a great deal from these photographs.

One who is familiar with topography will find that Fig. 1 supplies the following information: a double track main line railroad crosses the photograph, heading slightly west of north; that there are two highway overpasses, the first being a small secondary road, while the second is a two-lane highway bridge; just north of the first overpass is a long cut section for the railroad; there are several small orchards and one well defined orchard at the easterly edge of the print; numerous small brooks flow into the river as shown at the extreme west of the picture; that distributed along the highways are farms showing plowed lands and grass or hay fields; and the greater portion of this print shows heavy wooded areas.

Fig. 2 is perhaps more important from a historical point of view rather than illustrating new photogrammetric information. This series of aerial pictures are of historic Concord, Massachusetts, and Lake Walden is located in the northeast central portion of Fig. 2. Thoreau's cabin was located just north of Lake Walden and the remains of his cabin may be found upon the ground (not visible in this aerial photograph". At the easterly end of the lake a wharf can be easily detected.

A wide concrete highway is shown in Fig. 3 running from east to west on the photograph. This is, of course, Route 2, the Concord by-pass. Looking along the highway from east to west the first intersection is a grade crossing of Route 2 and the road to Lake Walden, while the second intersection is a grade separation with Route 2 going over the double track railroad. On the original print individual trucks and cars can be clearly seen by the aid of about a 4-power reading glass.

Sewage filter beds are located on the easterly side of Fig. 4 and the appearance of these beds can be compared with the Concord River flowing just north of the filter beds. The famous battle ground and bridge over the Concord River is located centrally between east and west sides and about 1½ inches above the lower edge of the photograph.

Fig. 5 has been selected as an excellent photograph to be used for demonstration purposes for this prospectus. The central portion shows a densely populated area and the business district of a typical New England town. On the main street of this business district, angle parking of automobiles is to be observed. Located at the center of the railroad curve is the Concord railroad station and with right angle parking in the adjacent parking areas. The athletic field just below the center of the picture is complete with a cinder track, jumping pits, baseball diamond, and both foul lines are visible. The large building across the road from the athletic field located along the extension of the left field foul line is used for airplane identification purposes; the north point and the word Concord along each side of the roof of this building can be read. (It is doubtful if this information can be reproduced on the printed page.) A single trick railroad enters the photograph at the index number, crosses a highway running northwesterly at a small oil farm. A short distance beyond this oil farm the branch railroad now stops, and the old, but abandoned, railroad is evident. Just slightly south of the mid-section of the single track railroad "Sleepy Hollow" cemetery is located an example of drainage of farm lands by ditching is shown at the extreme right edge of this plate. Small pleasure craft are at anchor in the river between the two highway bridges north of the double track railroad bridge. The distributing reservoir for the town of Concord is located in the northwest corner of Fig. 5.

All of the five photographs used in the above discussion were taken under the supervision of Col. James W. Bagley, Institute of Geographical Exploration, Harvard University.

Control is still needed in order to produce a map that is of true scale. Precise leveling can be used for vertical control, while triangulation and precise traverses or a combination of both can be used for horizontal control. Traverse stations and bench marks used in photogrammetry are located by usual surveying instruments and by old well established methods, but these ground control points must be carefully selected. These survey points must be objects that can be identified on the aerial photograph, or these survey points must be referred to (by use of ties, ranges, etc.) to objects that can be identified on the aerial photograph. The sketches and descriptions shown in Figs. 6, 7, 8 and 9 were obtained from Mr. Elmer C. Houdlette's office of the Massachusetts Geodetic Survey.

Fig. 6 is the description of traverse station 23A located in the town of Concord. The coördinate values shown are for the Lambert projection used by the state of Massachusetts and the latitude and longitude values are the geodetic location of station 23A. Fig. 7 is the reverse side of the card shown in figure number 6. This sketch gives ties to station 23A from objects that can be identified in Fig. 5 and have been identified and station 23A is shown plotted in Fig. 10.

(M)

TRAVERSE DATA

STATION 23A

CITY - TOWN Concord ABSTRACTED ACCESSION

X-COORD [illegible]	DISTANCES AND DIRECTIONS TO OBJECTS OBSERVED				
Y-COORD. [illegible]	OBJECT	DISTANCE	GRID AZIMUTH		
DATUM [illegible] 1927			°	′	″
ELEV. [illegible]	23B	2032.77	89	47	06.6
DATUM Sea Level Datum of 1929					

DETAILED DESCRIPTION

A U.S.C. & G.S. and State Survey standard disk, stamped, "23A - 135.885", set in a concrete monument flush with ground. Located 1/4 mile west of Concord R.R.Station on the B & M R R (Fitchburg Division); 819 feet from east face of abutment of bridge #20.48 over Sudbury River; 660 feet west of base; 17.8 feet north of north rail of northerly main track and 32 feet east of a telephone pole."

Recovered in good condition: October 1939.

FIG. 6.

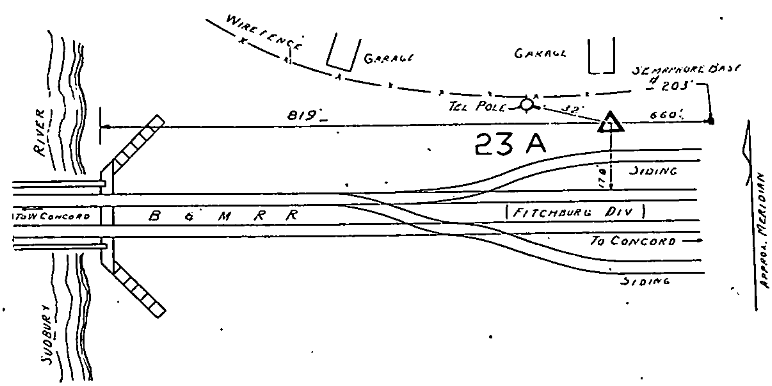

FIG. 7.

A description of bench mark 68D-32 appears as Fig. 8, while the location of this bench mark on the reverse side of the index card is shown as Fig. 9. As previously stated in regard to the traverse station, this bench mark has been located and is plotted on Fig. 10.

The principal point of photograph number 40 was located in the same manner and the principal point of photograph number 41. These two photographs are simultaneously viewed with a simple stereoscope and when properly oriented a spatial model is observed. When viewing this spatial model the principal point of photograph number 40 is located on photograph number 41, and this newly located point is called a transferred principal point. Transferred

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
Form 638
Ed. Oct. 1919

68D - 32 = 225.82
32A = 225.87
32B = 241.26

DESCRIPTION OF BENCH MARK

Designation of bench mark 68D-32 *State* Massachusetts *County* Middlesex

Nearest town Concord *County* Middlesex

Distances and direction from nearest town 0.75 mile northwest from Concord Station.

Detailed description of location In the central part of town, on the northwest side of Nashawtuck Hill, on the west corner of reservoir coping south of the gate house.
To reach the B.M. by auto from Concord Station, proceed northwest on Thoreau Street; enter and continue on Nashawtuck Road taking its left branch around the hill to the reservoir which is on the right.

Reference B.M. 68D-32A: A monel metal plug set in the east corner of reservoir coping, 250 feet from 68D-32 and 233 feet northwest from Ref. B.M. 68D-32B.

Reference B.M. 68D-32B: A granite monument marked on top "USCS," on the north corner, above the letter "U." Located in south end of grass plot on top of hill; 247 feet south from 68D-32 and 233 feet southwest from Ref. B.M. 68D-32A.

Character of the mark A monel ~~metal~~ plug

Established by what organization Massachusetts Geodetic Survey

Chief of party C.C. Brown *Date* July 14, 1936

FIG. 8.

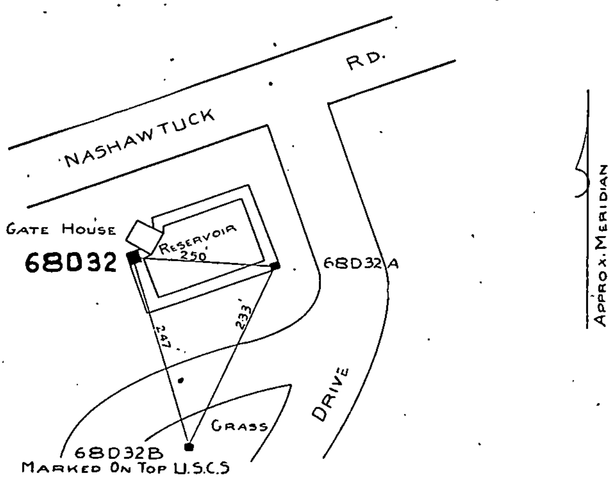

FIG. 9.

principal point (P_{40}) is shown plotted on Fig. 10. By a similar process, but using photographs number 41 and 42 the transferred principal point P_{42} is plotted.

In order to insure the transferred principal points P_{40} and P_{42} falling on photograph number 41 and that sufficient photographic detail will appear on adjacent photographs, it is customary to have an overlap of at least 60% in the direction of flight.

The linear distance on the photograph from P_{40} to P_{41} (see Fig. 10) is the photographic base as measured on photograph number 41, and this base is either measured in inches or millimeters. This same photographic base will appear on photograph number 40 as the linear distance from transferred principal point P_{41} to principal point P_{40}. For purposes of calculation the mean of the two base lines as measured above is used.

A series of precise traverse stations and vertical control points have been plotted and are shown on Fig. 10. The traverse station shown in Figs. 6 and 7 is the center of the circle marked 23A and elevation of 135.89, while the bench mark 68D-32 (shown in Figs. 8 and 9) is plotted at the distributing reservoir.

Around the periphery of this plate a number of points have been located by a circle and straight line drawn radially from the principal point and the point in question. These points are selected from physical details that can be easily identified on two or more (frequently three) adjacent photographs, and are used to secure a better and more complete graphical triangulation system than using the traverse stations only. Such points are sometimes known as wing points and an upper case letter is beside each wing point as shown in Fig. 10.

In this paper only basic principles of photogrammetry are being are being considered, therefore, the following assumptions have been made and are used in the discussions that follow: a) that the airplane is on a level line of flight; b) that the airplane is at a constant elevation; c) that the optical axis is a vertical axis, i.e., there is no tilt and d) that the principal point is the photograph of the plumb point.

The line AB, Fig. 11, is considered to be a horizontal ground line of a length of D. This line photographs on the negative as $A'B'$, or is shown on the diapositive as AB and each case its length is D' The negative and the diapositive are both a distance along the optical axis of f (focal length) from the lens. The lens, or camera station, is at an elevation of H_1 above the ground.

One method employed to record the scale of a map is the representative fraction [often called the $(R.F.)$]. This fraction is written so that the numerator is unity and the denominator a whole number and, therefore, one unit on the map equals x of the same units for the same line as measured upon the ground. The larger the value of the

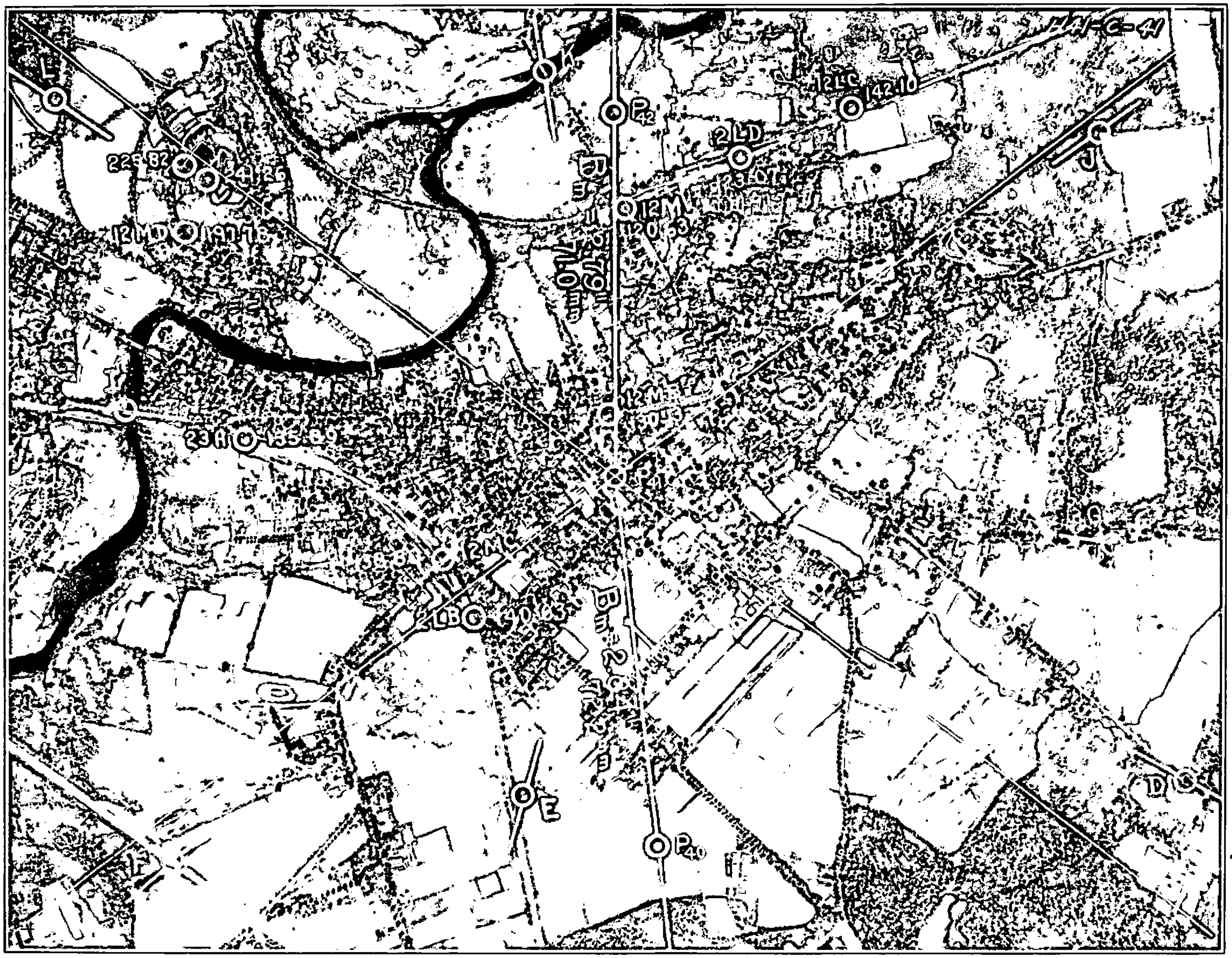

Fig. 10.

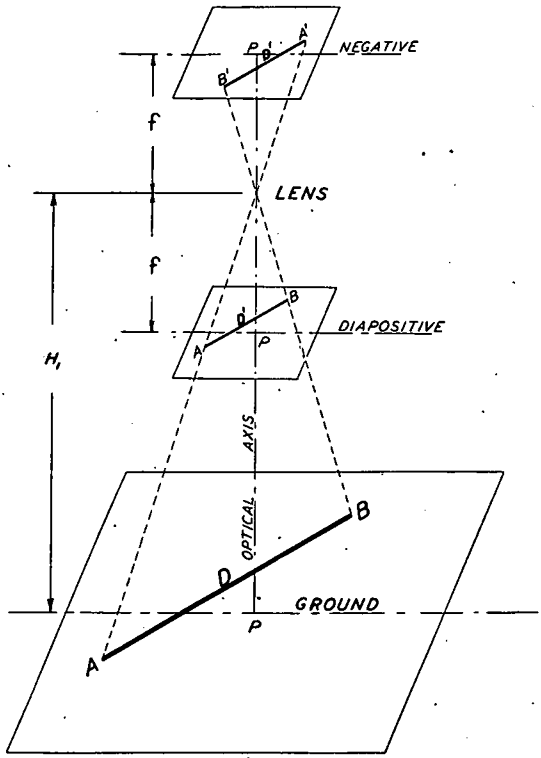

FIG. 11.—PHOTOGRAPHIC SCALE.

denominator (x) the smaller the value of the $R.F.$ and accordingly the smaller the scale of the map, while conversely the smaller the denominator the larger the scale of the map. In many problems a whole number is easier to work with than a fraction; therefore, the reciprocal of the representative fraction is often used. This new fraction or ratio is called the scale, or the scale fraction, and it is represented by the symbol S, which has the following relationship:

$$S = \frac{1}{R.F.}.$$

From Fig. 11, geometrically by similar triangles the following ratios are obtained:

$$\frac{D'}{D} = \frac{f}{H.} = R.F.$$

In the above equation, the ratios are equal to the representative fraction for the photograph, but if these fractions be inverted, we have the scale fraction of the print:

$$S = \frac{D}{D'} = \frac{H_1}{f}.$$

It is evident by inspection of the above equation, that if a photograph of some desired scale is wanted the height above the ground (H_1) can be easily computed. Frequently, the photograph is available but scale of the photograph is unknown, and here is another application of the scale fraction equation. As stated above the scale fraction may be represented by this expression:

$$S = \frac{\textit{Ground Distance}}{\textit{Photo Distance}} \text{ or } \frac{D}{D'}.$$

In practice the ground distance is measured in feet, but the photo distance is measured in inches or millimeters. In order to take care of this unit difference the scale equation may be rewritten as:

$$\textit{Photo Distance (in inches)} = \frac{12 \times \textit{Ground Distance (in feet)}}{S}.$$

Table 1 shows the photo distance in inches for scales from 100,000 to 1,000, with a range of ground distances from 100 feet to 30,000 feet. The results of the calculations listed in this table have been plotted and are shown as Fig. numbered 12 and 13. Fig. 12 is for large scale photographs with scales ranging from 20,000 to 1,000; while Fig. 13 is for small scale photographs with scales ranging from 100,000 to 10,000. Figs. 12 and 13 have been reproduced true to size and so these figures may be used graphically to determine the scale of a print. If a "positive negative" of these prints be made, then the scale of the photograph may be determined directly by moving this "positive negative over the photograph until a known distance on the photograph equals the distance represented on the ordinate of these figures 12 and 13.

The distance between traverse stations 12MC and 12MB is 1,788.13 feet and the photo distance (see Fig. 10) for the same two stations is 1.69 inches. Then the scale of this print equals:

$$S = \frac{12 \times 1{,}790}{1.69} = 12{,}700.$$

When the scale was determined by using a "positive negative" it was found to be approximately 13,000.

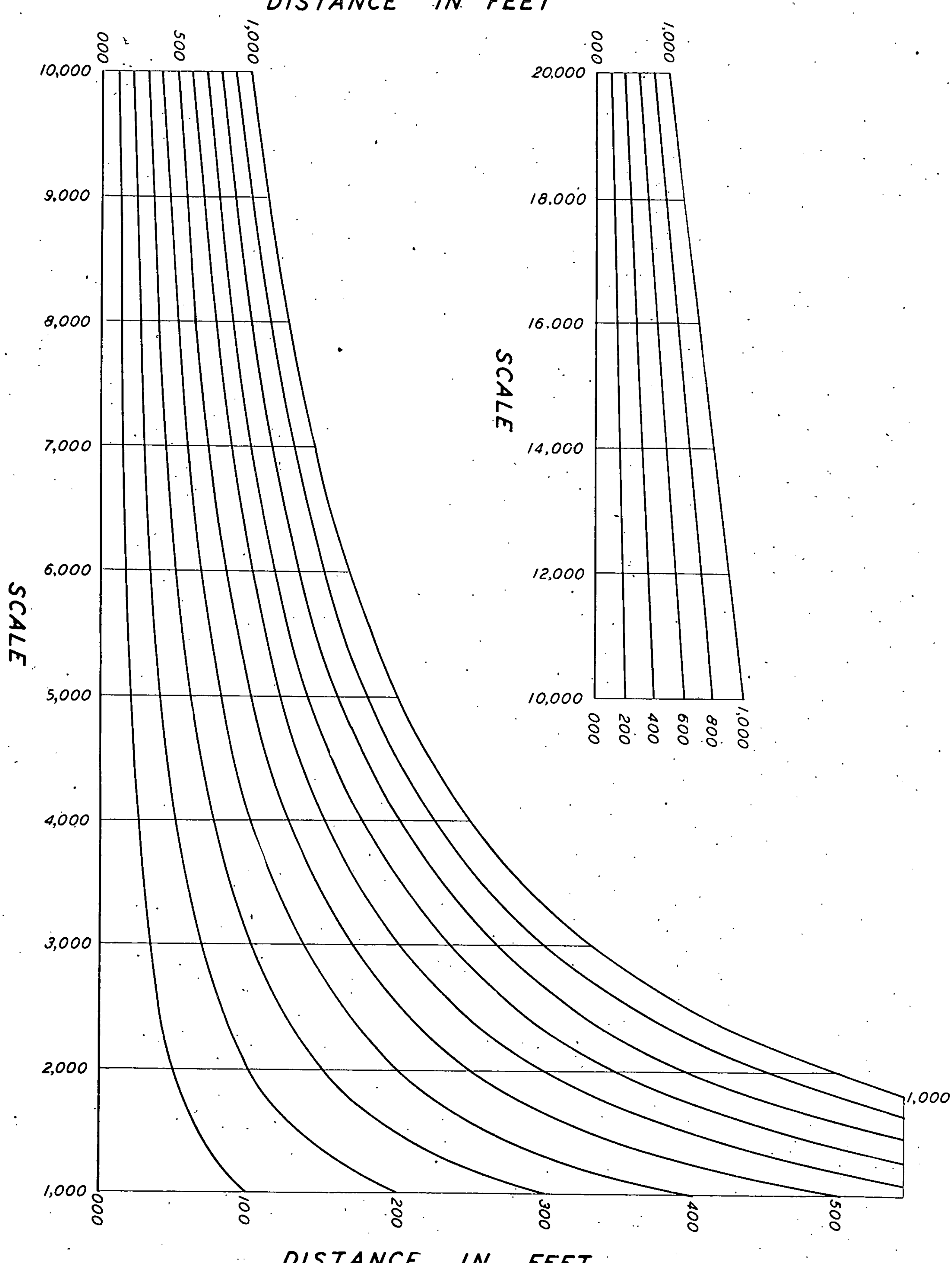
DISTANCE IN FEET
000
500
1,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
SCALE
000
100
200
300
400
500
1,000
DISTANCE IN FEET
000
1,000
20,000
18,000
16,000
14,000
12,000
10,000
SCALE
000
200
400
600
800
1,000

Fig. 12.

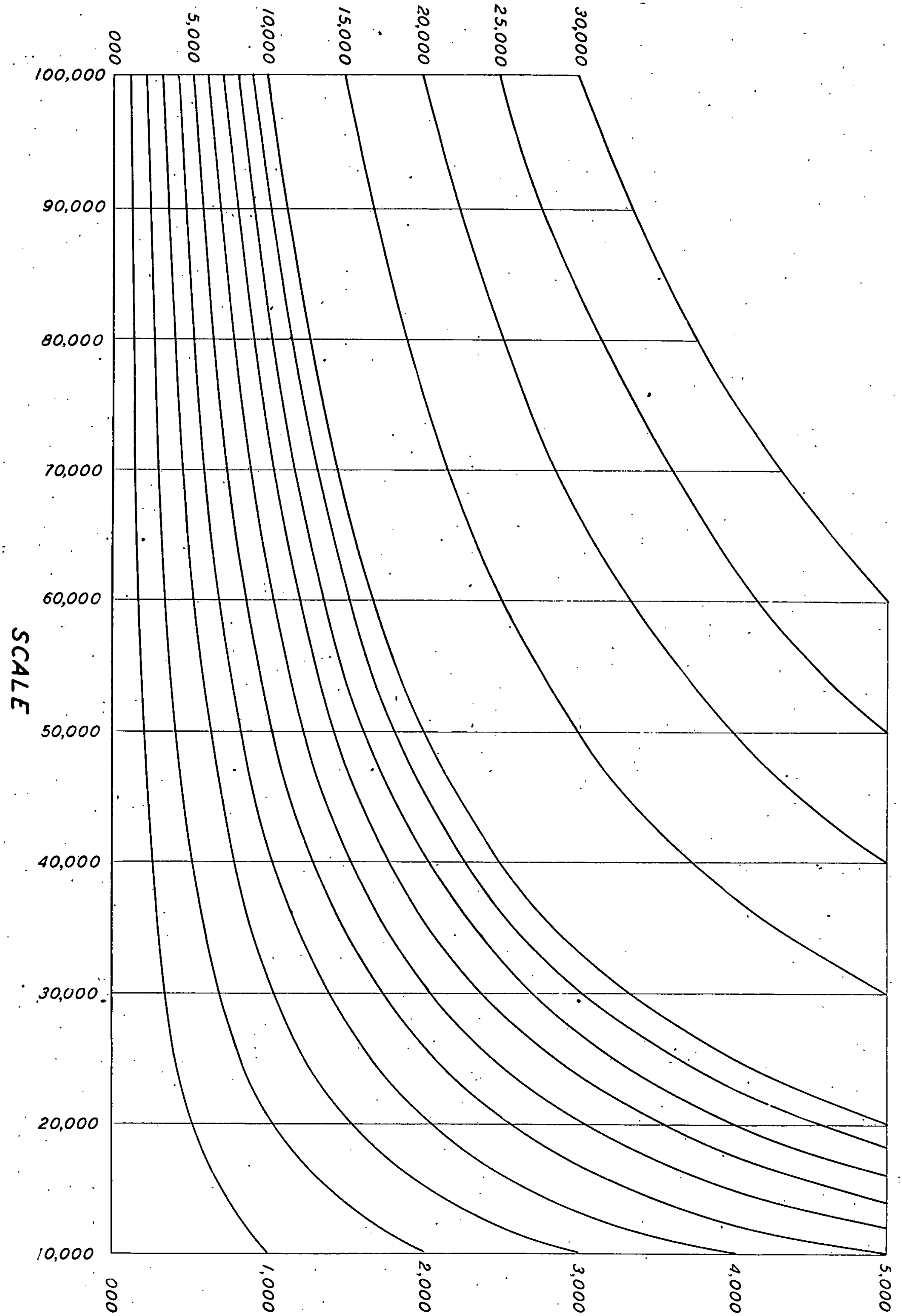
000
5,000
10,000
15,000
20,000
25,000
30,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
SCALE
000
1,000
2,000
3,000
4,000
5,000

Fig. 13.

DISTANCE IN FEET	SCALES 1.000	2,000	3.000	4.000	5.000	6.000	7.000	8.000	9.000	10.000	DISTANCE IN FEET
100	1.20	0.60	0.40	0.30	0.24	0.20	0.17	0.15	0.13	0.12	100
200	2.40	1.20	0.80	0.60	0.48	0.40	0.34	0.30	0.27	0.24	200
300	3.60	1.80	1.20	0.90	0.72	0.60	0.52	0.45	0.40	0.36	300
400	4.80	2.40	1.60	1.20	0.96	0.80	0.69	0.60	0.53	0.48	400
500	6.00	3.00	2.00	1.50	1.20	1.00	0.86	0.75	0.67	0.60	500
600	7.20	3.60	2.40	1.80	1.44	1.20	1.03	0.90	0.80	0.72	600
700	8.40	4.20	2.80	2.10	1.68	1.40	1.20	1.05	0.93	0.84	700
800	9.60	4.80	3.20	2.40	1.92	1.60	1.38	1.20	1.06	0.96	800
900	10.80	5.40	3.60	2.70	2.16	1.80	1.55	1.35	1.20	1.08	900
1000	12.00	6.00	4.00	3.00	2.40	2.00	1.72	1.50	1.33	1.20	1000
DISTANCE IN FEET	SCALES 10,000	20,000	30,000	40,000	50,000	60,000	70,000	80,000	90,000	100,000	DISTANCE IN FEET
100	0.12	0.06	0.04	0.03	0.02	0.02	0.02	0.02	0.01	0.01	100
200	0.24	0.12	0.08	0.06	0.05	0.04	0.03	0.03	0.03	0.02	200
300	0.36	0.18	0.12	0.09	0.07	0.06	0.05	0.04	0.04	0.04	300
400	0.48	0.24	0.16	0.12	0.10	0.08	0.07	0.06	0.05	0.05	400
500	0.60	0.30	0.20	0.15	0.12	0.10	0.09	0.08	0.07	0.06	500
600	0.72	0.36	0.24	0.18	0.14	0.12	0.10	0.09	0.08	0.07	600
700	0.84	0.42	0.28	0.21	0.17	0.14	0.12	0.10	0.09	0.08	700
800	0.96	0.48	0.32	0.24	0.19	0.16	0.14	0.12	0.11	0.10	800
900	1.08	0.54	0.36	0.27	0.22	0.18	0.15	0.14	0.12	0.11	900
1000	1.20	0.60	0.40	0.30	0.24	0.20	0.17	0.15	0.13	0.12	1000
2000	2.40	1.20	0.80	0.60	0.48	0.40	0.34	0.30	0.27	0.24	2000
3000	3.60	1.80	1.20	0.90	0.72	0.60	0.52	0.45	0.40	0.36	3000
4000	4.80	2.40	1.60	1.20	0.96	0.80	0.69	0.60	0.53	0.48	4000
5000	6.00	3.00	2.00	1.50	1.20	1.00	0.86	0.75	0.67	0.60	5000
6000	7.20	3.60	2.40	1.80	1.44	1.20	1.03	0.90	0.80	0.72	6000
7000	8.40	4.20	2.80	2.10	1.68	1.40	1.20	1.05	0.93	0.84	7000
8000	9.60	4.80	3.20	2.40	1.92	1.60	1.38	1.20	1.06	0.96	8000
9000	10.80	5.40	3.60	2.70	2.16	1.80	1.55	1.35	1.20	1.08	9000
10000	12.00	6.00	4.00	3.00	2.40	2.00	1.72	1.50	1.33	1.20	10000
15000	18.00	9.00	6.00	4.50	3.60	3.00	2.58	2.25	2.00	1.80	15000
20000	24.00	12.00	8.00	6.00	4.80	4.00	3.44	3.00	2.67	2.40	20000
25000	30.00	15.00	10.00	7.50	6.00	5.00	4.30	3.75	3.33	3.00	25000
30000	36.00	18.00	12.00	9.00	7.20	6.00	5.16	4.50	4.00	3.60	30000

TABLE 1.

The camera station for the photograph shown in Fig. 10 was at a height of 8,840 feet above the average ground elevation; and the aerial camera had a focal length of 8.25 inches. According to this information the scale of Fig. 10 is:
or

$$S = \frac{H.}{f} = \frac{8,840 \times 12}{8.25} = 12,800$$

$$1'' = 1,070\ ft.$$

This photograph is 7″ by 9″ in size, therefore, the area covered by this single picture is:

$$A = \frac{7 \times 9 \times (1,070)^2}{(5,280)^2} = 2.59\ sq.\ mi.$$

As previously stated it is customary to have an overlap of 60% in the direction of the flight and the 7″ length is the direction of flight on the photograph. The linear distance between adjacent exposures stations is known as the air base (B). Using the above data, the theoretical air base is:

$$B = 0.40 \times 7 \times 1{,}070 = 3{,}000 \; ft.$$

From Fig. 10, photographic base P_{40} to P_{41} is 2.84 inches and photographic base P_{41} to P_{42} is 2.79 inches. If these two photographic bases be multiplied by 1,070, then the two corresponding air bases are 3,040 feet and 2,990 feet respectively.

Assuming that the mean ground velocity of the airplane taking these pictures was 150 m.p.h., or the velocity is 220 feet per second, then the time interval between adjacent exposure stations is approximately equal to:

$$\frac{3{,}000}{220} = 13.6 \; seconds.$$

The apparent displacement of an object due to the position of the observer, parallax, can be measured on an aerial photograph. Projecting in vertical the direction, point B falls on the datum plan as point B' and these points appear as b and b' upon the negative. But, b is the photo of B and when extended to the plane of reference is at a distance of ΔD to the right of B' (see Fig. 14). ΔD, therefore, is the displacement on the datum plane of the point B, when the exposure station is as shown at a height (H) above the datum plane. Parenthetically, Δd measures the photographed parallax of point B on the negative.

The value of ΔD may be computed from a right triangle ratio, when h = elevation of point B as measured from the datum plane as:

$$\Delta D = h \tan \propto$$

The distance pb on the negative may be measured (by using a comparagraph), and the value of the focal length (f) being known, tan $\propto$ may be expressed:

$$Tan \propto = \frac{pb}{f}.$$

Because corresponding sides of similar right triangles are proportional, the following proportion is obtained:

$$\frac{\Delta d}{\Delta D} = \frac{f}{H}.$$

Solving this equation for Δd and also substituting the equivalent of ΔD, the photographic parallax becomes:

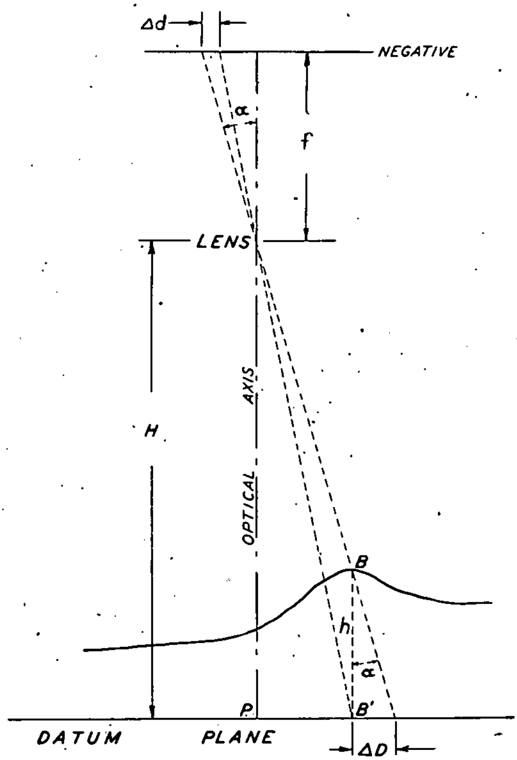

Fig. 14.—Displacement Due to Elevation.

$$\Delta d = \frac{f}{H} \cdot h \cdot tan \propto .$$

But, the fraction $\frac{f}{H}$ is the representative fraction of the negative for datum plane positions. As the reciprocal of the $R.F.$ is the scale fraction (S), the value of Δd may be rewritten as:

$$\Delta d = \frac{h}{s} \cdot tan \propto .$$

In Fig. 15 two photographs are represented as having optical centers P_1 and P_2, and both photographs are at the same elevation. A considerable portion of the detail that appears upon photograph 1 also appears upon photograph 2. The point A photographs as A_0 on both prints, while A projected upon the datum plane photographs

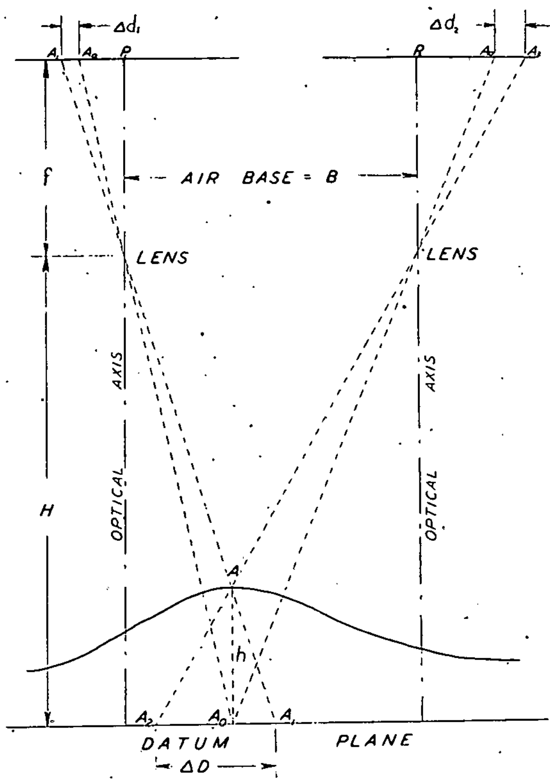

FIG. 15.—DIFFERENCE IN PARALLAX.

as A_1 upon print 1 and as A_2 upon print 2. The distances Δd_1 and Δd_2 are the displacements due to the location of the exposure stations upon their respective prints. The linear distance between the exposure stations is known as the air base and herewith this distance is represented by the symbol B, and frequently is measured in feet. As previously stated the principal points may be transferred stereoscopically to adjacent photographs, and the linear distance as measured upon a print between its principal point and the transferred adjacent principal point is called the photographic base (B_m). The ratio of air base to photographic base becomes:

$$\frac{B}{B_m} = S.$$

The total displacement of point A on the datum plane is ΔD, while the corresponding displacement on the two prints is $\Delta D_1 + \Delta d_2$ or this sum may be represented by Δd. The relationship of the datum plane displacement and the photographic displacement is equal to:

$$\Delta d \cdot S = \Delta D.$$

In Fig. 15 the following geometric proportion is seen:

$$\frac{B}{\Delta d \cdot S} = \frac{(H - h)}{h}$$

when rewritten becomes:

$$\Delta d = \frac{B \cdot h}{S(H - h)}.$$

But:

$$\frac{B}{S} = B_m.$$

So:

$$\Delta d = \frac{B_m \cdot h}{(H - h)}.$$

Assuming that the datum plane appears on the photographs then the elevation of point A can be found in terms of the photographic base (B_m) and the parallax (Δd) as:

$$h = \frac{\Delta d \cdot H}{B_m + \Delta d}$$

Or occasionally, it is more convenient to use the air base B, whence:

$$h = \frac{\Delta d \cdot S \cdot H}{B + \Delta d \cdot S}.$$

The mere fact that a portion of an ocean appears upon a series of photographs is no criterion that the United States Coast and Geodetic Survey datum plane has been photographed. The use of such a body of water as having a surface of zero elevation is ,therefore, not recommended for general practice.

Assume that point A (Fig. 16) is a point of known elevation, and that a reference plane, parallel to the datum has been passed through point A. Often in general practice, this reference plane is the mean elevation of the vertical control points that can be located upon a given photograph. A minimum of six, evenly distributed, vertical control points are used in order to obtain a plane of reference. The mean elevation, in Fig. 16, is represented by the value h_A, and

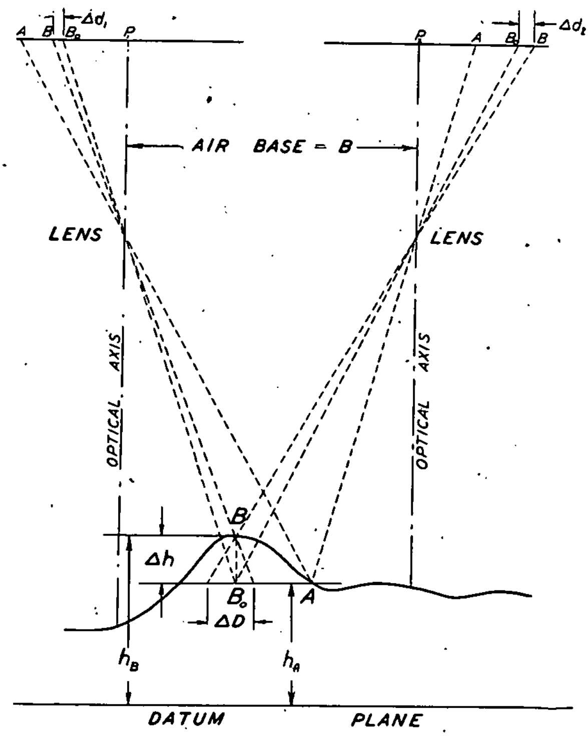

FIG. 16.—DIFFERENTIAL PARALLAX.

the nomenclature used is the same as that used in previous figures. The following algebraic equation is evident:

$$\Delta D = \Delta d \cdot s$$

and from similar triangles:

$$\frac{\Delta D}{\Delta h} = \frac{B}{(H - h_A)}.$$

By substitution, the equation becomes:

$$\frac{\Delta d}{\Delta h} = \frac{B}{S(H - h_A)} \text{ or } \frac{B_m}{(H - h_A)}$$

for which Δd equals:

$$\Delta d = \frac{B_m \cdot \Delta h}{(H - h_A)}.$$

The above equation is used in the preparation of stereoscopic parallax tables. A partial list of reference books in which parallax tables may be found are: "Manual of Photogrammetry" by the American Society of Photogrammetry; Technical Manual, TM 5-230, "Topographic Drafting", War Department; "Photogrammetry" by H. Oakley Sharp; and "Photogrammetric Engineering", Volume IX, number 2, April-May-June, 1943. In compiling these stereoscopic parallax tables, the photographic base (B_m) has been assumed to be 100 millimeters. Ordinarily, the photographic base is shorter than 100 millimeters, therefore, when using these tables it becomes necessary to correct the tabular values of parallax, by using a simple straight line relationship. It is customary to use values of Δh (difference in elevation) equal to 10 feet or 20 feet, and the elevation of the exposure station is 25,000 feet. It is then evident, that these tables are only correct when (H) the elevation of the exposure sation is 25,000 feet. For any other exposure station elevation, these parallax tables, as published, are inaccurate; but the error is insignificant for contour work when the ground elevation is a little above sea level. If in the above equation, the value of B_m equals 100 millimeters and the value of Δh equals 10 feet be inserted in place of their literal equivalents, then the value of Δd in millimeters becomes:

$$\Delta d = \frac{100 \times 10}{(H - h_A)}.$$

If 100 × 10 be replaced by k then:

$$d = \frac{k}{(H - h_A)}.$$

Solving for the elevation of the exposure station (H):

$$H = \frac{1 \cdot k}{\Delta d} + h_A.$$

This equation is now linear equation in the form of $x + y = c$, and as such may be plotted as a straight line on arithmetic coördinate paper. The value of h_A is taken as the abscissa, while the value of $\frac{1}{\Delta d}$ is taken as the ordinate. Figure number 17 is a plot of the general parallax equation, covering exposure station elevations from 3,000 feet to 25,000 feet. Many aerial photographs to be used by engineers are large scale prints, and, therefore, are taken at a low elevation. Figure number 18 was developed to take care of exposure station elevations varying from 2,000 feet to 12,000 feet. In both of the above figures the abscissa is labeled "Elevation of Plumb Point in Feet",

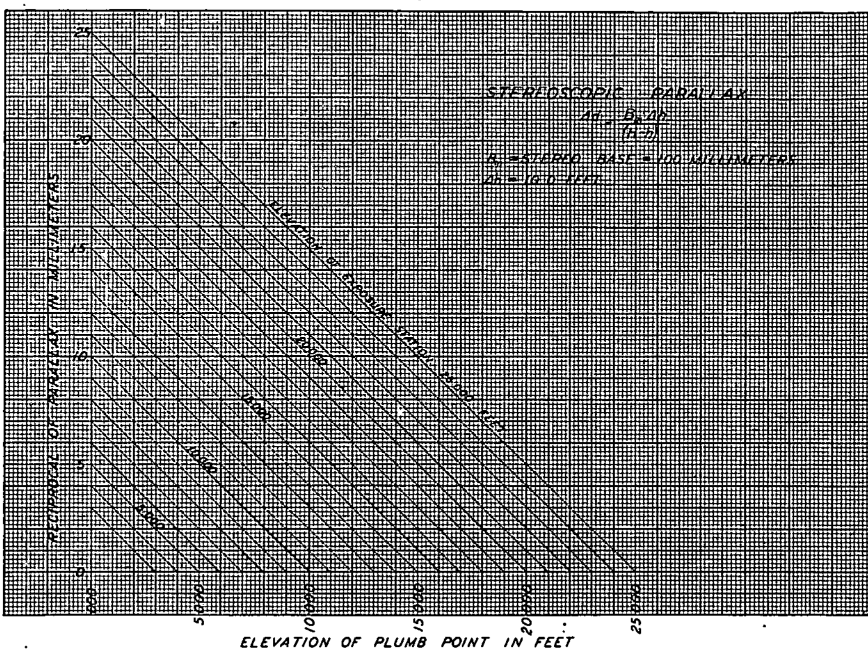

FIG. 17.

which is the value h_A and often is used as the mean elevation of the known vertical control points. In normal operation the reciprocal of parallax is read, and a most convenient method of finding the parallax is by the slide rule.

Fig. 19 was developed to meet the needs of those who are not fortunate enough to possess a slide rule. If x be chosen as the parallax in millimeters, then the reciprocal of parallax $\dfrac{1}{\Delta d}$ and x may be written as:

$$x = \frac{1}{\Delta d}$$

or:

$$1 = x \cdot \Delta d$$

and when written in logarithm form:

$$Log\ 1 = Log\ x + log\ \Delta d.$$

It is, therefore, evident that this equation is also in the form

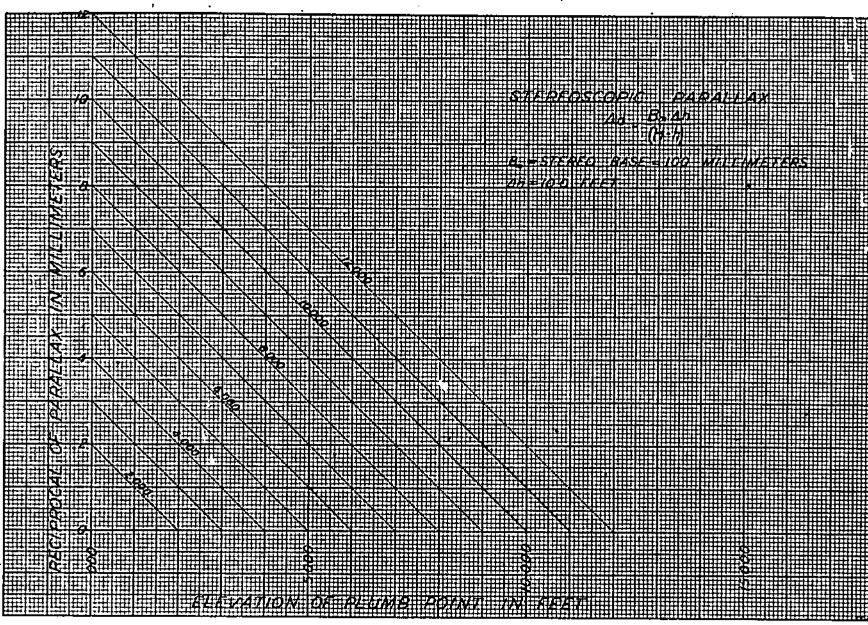

FIG. 18.

$c = x + y$; and if plotted on logarithmic paper becomes a straight line. The logarithm of the parallax is plotted as the abscissa, and the logarithm of the reciprocal of parallax is plotted as the ordinate.

The rate of change of parallax with respect to the differential change in elevation is the fraction $\frac{\Delta d}{\Delta h}$. This rate of change was previously developed from figure 16, and was equal to:

$$\frac{\Delta d}{h} = \frac{B}{S(H - h_A)}.$$

But:

$$S = \frac{(H - h_A)}{f}.$$

By substitution:

$$\frac{\Delta d}{\Delta h} = \frac{f \cdot B}{(H - h_A)^2}$$

or by inverting:

$$\frac{\Delta h'}{\Delta d} = \frac{(H - h_A)^2}{f \cdot B}.$$

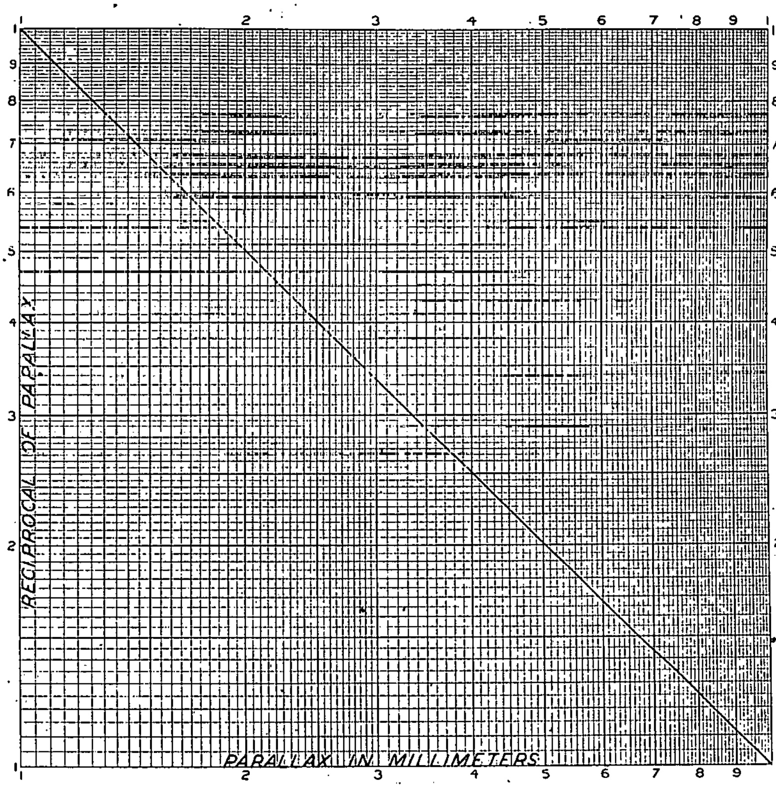

FIG. 19.

It is a matter of personal preference, whether the above general parallax equation be used or the parallax equations developed from Fig. 16 be used.

An illustrative problem using the data shown in Fig. 10 concludes this paper on "Basic Principles of Photogrammetry." The photographic base P_{40} to P_{41} (B_m) measures on the print 72.2 millimeters, while for purposes of calculations the elevation of the exposure station is 9,000 feet and mean elevation of the plotted points (see Fig. 10) is 160 feet. If the general parallax equation be solved using Δh as 1.0 foot, the parallax per foot of height becomes:

$$\Delta d = \frac{B_m \cdot h}{(H - h_A)} \; or \; \frac{72.2 \times 1.0}{(9{,}000 - 160)} = 0.00817 \; mm. \; per \; ft.$$

If one wishes to use stereoscopic parallax tables, the table is entered for a value of $(H - h_A)$ equal to 8,840; and in this portion of the table is developed for values of Δh of 10 feet. It will be remembered that B_m was used as 100 millimeters when values for the table were computed; so, 0.113 millimeters as found in the table needs to be corrected for a base of 72.2 mm. The corrected parallax value Δd when Δh equals 10 feet is:

$$\Delta d = \frac{72.2 \times 0.113}{100} = 0.0816 \; mm. \; per \; 10 \; feet.$$

A stereoscopic parallax table may not be available, therefore, figure number 18 may be used. The elevation of the exposure station is 9,000 feet, the mean elevation of the ground as shown in this print is 160 feet; and the reciprocal of the parallax $\frac{1}{\Delta d}$ is found to be 8.85 millimeters. Furthermore, if figure number 19 he used, the value of Δd is 0.113 for a photographic base of 100 millimeters and Δh of 10 feet.

The measuring device commonly used in stereocomparagraphs is graduated in millimeters, with direct readings to 1/100 of a millimeter and with further readings or subdivisions estimated by eye. Many observers arbitrarily use an index reading of 3.000 mm. for the mean ground elevation (sometimes this reading of 3.000 mm. is referred to as the datum plane reading). This above assumption has been used in preparing both tables II and III. The elevation of ground control points have been arranged in order of ascending elevations and are shown with their corresponding parallax calculations in table II.

TABLE II

Elevation	$\pm\Delta h$	Δd per foot	Difference in Parallax	Datum Plane plus Parallax Difference
120.63	—38.92	0.00816	—0.318	2.682
123.07	—36.48	"	—0.298	2.702
130.13	—29.42	"	—0.240	2.760
135.89	—23.66	"	—0.193	2.807
138.80	—20.75	"	—0.169	2.831
140.03	—19.52	"	—0.159	2.841
142.10	—17.45	"	—0.142	2.858
197.78	+38.23	"	+0.312	3.312
225.82	+66.27	"	+0.541	3.541
241.26	+81.71	"	+0.667	3.667
*159.55			0.000	3.000

*Mean elevation of plotted 10 vertical control points.

An interval chart, table III, has been prepared from table II and previous computations, for contour intervals of 20 feet. Δd for a contour interval of 20 feet equals 2×0.0816 or 0.163 millimeters.

TABLE III

Elevation	Datum Plane plus Parallax Difference
100	2.511
120	2.674
140	2.837
160	3.000
180	3.163
200	3.326
220	3.489
240	3.652
260	3.815

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AERIAL MAPPING EQUIPMENT

By Prof. Ernest L. Spencer, Member*

(Presented at a joint meeting of the Boston Society of Civil Engineers and Highway Section, B.S.C.E., held on February 28, 1945.)

It is interesting to note that the first aerial photograph ever taken was in 1860 from a balloon over Boston, Massachusetts. Aerial photos are differentiated from terrestial photos in that the camera is up in the air, whereas in the latter it is on the earth's surface at the time of exposure. Not much was done about aerial photography until World War I. Since then, enormous strides have been made both in photographic equipment and technique. Compiling maps from air photographs has now reached the stage where practically every large survey or engineering project utilizes, to a more or less degree, this type of map. Military use of such maps is obviously imperative in as much as the new battle areas of today probably have never been visited by our map makers prior to the war, and furthermore, the conditions behind the enemy's lines are constantly changing.

Approximately $^2/_3$ of our country has been photographed from the air, chiefly by the following governmental agencies:

U. S. Geological Survey
U. S. Coast and Geodetic Survey
U. S. Army—Corps of Engineers
Tennessee Valley Authority
U. S. Department of Agriculture through its sub-departments
    Soil Conservation Service
    Agricultural Adjustment Agency
    Forest Service

Photos and mosaics are available at moderate cost from the Department of Agriculture. During the war, however, a release must be obtained from the Army Defense Command Headquarters in the area concerned. Vast areas of Canada have also been photographed

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and these pictures are available at the National Air Photographic Library, Ottowa. (Naturally during the war, their release is rigidly controlled also.)

Most engineers are aware of the peace-time uses that can be found for maps made from air photos. A partial list would include the following:

1. Stream flow study—erosion problems, bridge sites, etc.—
2. Watershed areas—drainage problems with special reference to run-off conditions so that culverts and bridges can be intelligently planned.
3. Traffic counts whole pictures of traffic conditions in a given area at a given time can be viewed at once. Traffic volumes can be counted more accurately over a larger area in this manner.
4. Transmission, pipe line, and highway location—choice of some routes can be studied before the public is aware of the project and the price of land starts going up. Better estimates of cost may be made in as much as the actual construction conditions may be viewed.
5. Water supply and Hydraulic developments—stream and reservoir pollution and flood control projects studied as a whole.
6. Tax maps in cities and zoning plans—these usually require low altitude flights, but may uncover property missing from city records. The real condition of buildings, and land may be viewed and thus a more fair appraisal of property values can be made.
7. Forestry work—provides maps showing kind, character, and distribution of natural vegetation as well as existing fire hazards. The volume and varying kinds of timber may be estimated quite accurately and thus management may make wiser decisions regarding its disposition.
8. Mining and geological exploration—usually requires real experts, and decisions have to be checked in the field.
9. Camouflage detection—by using infra-red film and noting surrounding area.

TYPES OF MAPS THAT ARE MADE FROM PHOTOS

1. *Uncontrolled aerial mosiacs*—or patchwork assembly, a pictorial representation of the ground without reference to any ground control points made by matching topographical details in adjacent pictures. The central position of photograph is used generally as edges are usually distorted. The scale of such maps is not accurate. Mosaics usually show only cartography, but may be contoured if desired by use of plane table or existing maps.
2. *Controlled aerial mosaic*—pictorial representation of ground by bringing photos to a uniform scale and fitting them to ground control stations. Topographic details do not necessarily coincide at the edges of photos. No aerial survey can be complete without a ground network, horizontally and vertically—the amount depends upon the purpose of the map.
3. *Aerial line map*—made from aerial photos and shows only roads, rivers, houses, etc.;—no contours are shown, maps of this type are plotted from corrected photos and scale is quite accurate.
4. *Aerial topographic map*—an aerial line map upon which contours are sketched with the aid of a plane table. At the same time the photographic detail may be checked visually in the field.
5. *Aerial stereo-topographic map*—topographic map made from photographs in which contours have been determined by use of stereoscopic instruments in the office. The only field work necessary is that of establishing ground control and flying.

TYPES OF PHOTOS TAKEN

1. Vertical,—axis of camera is vertical giving a horizontal picture. Actually the axis is rarely truly vertical, but is practically so.
2. Oblique,—axis of camera at some angle with vertical. A common angle is 30°. These are usually combined with vertical pictures as in the case of the trimetrogen method used by the U.S.A.A.F. in its reconnaissance work. Area covered is from horizon to horizon.

Making maps from aerial photographs or Photogrammetry, "the science of measurement from photographs" as it may be called, consists essentially of four parts.

1. Flying.
2. Photography.
3. Ground control—horizontal and vertical.
4. Construction of map.

Engineers for the most part are interested in the latter two. As the ground control consists essentially of the routine survey work that is familiar to all civil engineers, this paper is concerned chiefly with number 4 of this group. More specifically, it is to discuss some of the simple and more common equipment used in compiling the maps. The equipment to be discussed is that type which might be found in the ordinary engineer's office. The highly specialized equipment, found chiefly in government offices, will not be discussed. It is elaborate, expensive, and only the government can afford it.

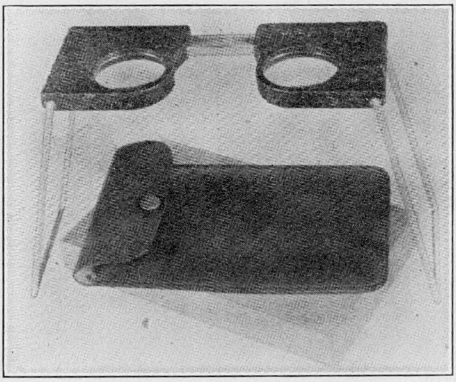
STEREOSCOPY

In order to get the greatest benefit from any set of aerial photographs, it is necessary to resort to using stereoscopes. These instruments permit us to view aerial photos in three dimensions, thus a full appreciation of the terrain characteristics may be obtained.

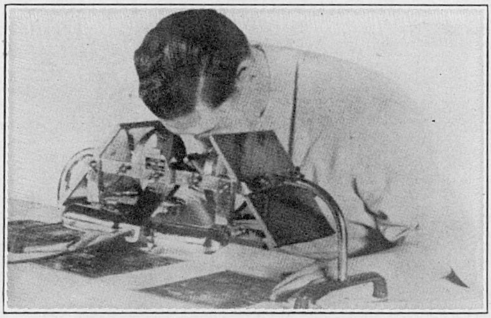
Stereoscopic instruments may be one of three types, mirror (or reflecting type), prism type, or lens (refracting type), or a combination of all. The first stereoscope is credited to Robert Wheatstone in 1838, a two-mirror type. Helmholz in 1857 constructed one of a four-mirror type similar to those in use today. Credit for the lens type goes to Sir David Brewster in 1849. The advantage of the mirror type is the fact that the overlap of larger photos may be viewed in its entirety. Fig. 1 shows two of the many types of stereoscopes in use today.

The principles and mechanics of stereoscopic perception are rather involved with geometry, combined with physiology, in as much as the human eye and its connections to the brain are involved. The workings of the eye and its brain connections are hereby left for a medical doctor to discuss, but a brief discussion of some of the elementary geometrical phases of the subject I believe are warranted.

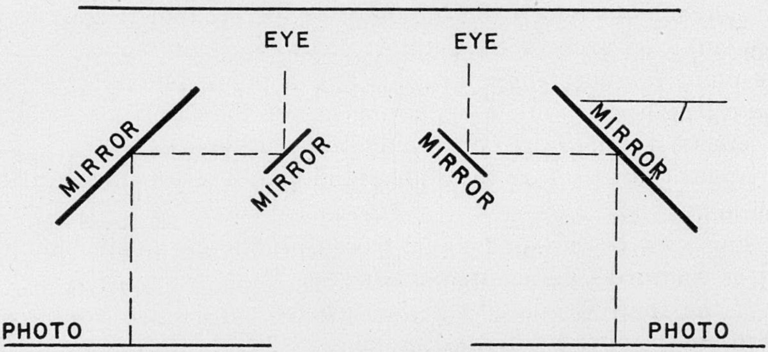
In Fig. 2, *a* and *b* represent the pupils of an observer's eye and *cd* and *ef* represent the respective retinas. Consider the object *gh* at



(Courtesy Abrams Instrument Co.)
LENS TYPE.



(Courtesy Abrams Instrument Co.)
MAGNIFYING MIRROR TYPE.



(LENS MAY BE ABOVE, BELOW, OR BETWEEN MIRRORS)
OPERATION PRINCIPLE.
MAGNIFYING MIRROR TYPE.

FIG. 1.—STEREOSCOPES.

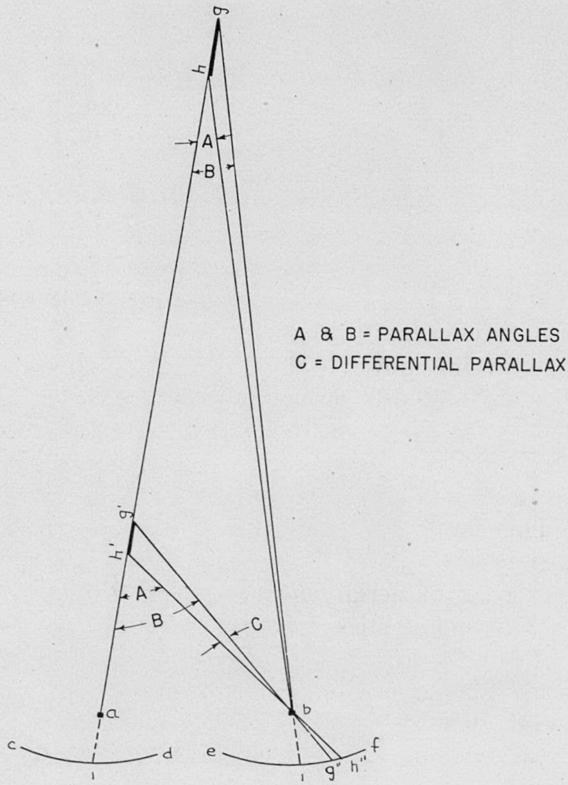


FIG. 2.—BINOCULAR VISION.

a considerable distance from the observer. Note that it appears only as a point *i* on each of the retinas. Now, if *gh* is moved nearer to some point *g'h'* the image on *cd* is still a point, but on *ef* it has a definite length *g''h''* with *h* appearing nearer than *g*.

Angles *A* and *B* are called angles of parallax.

Angle *C* or *B-A* is the differential parallax for this particular condition.

This view of the same object from two different points simultaneously is known as a stereoscopic view.

If the angle C is less than 20 seconds, normally it is impossible to distinguish differential parallax, thus a stereoscopic view cannot be obtained with the naked eye. (Some people can perceive this view with a 10-second angle.) As the eye spacing (inter-pupillary distance) is between 1.97″ to 2.85″; 2.5″ being the average, the distance from any observer that an object would still appear to have depth is from 1,700-2,500 feet, Beyond this distance, the naked eye alone cannot discriminate differences of distances or depths of objects. Depths and distances can be estimated, however, by comparison beyond the 2,500-foot distance.

The range of stereoscopic vision can be increased by increasing the stereoscopic base (inter-pupillary distance) or by magnification. The latter is most commonly used in present day instruments. The prism binocular is a good example of increasing the stereoscopic base as well as magnifying the field of view.

The magnifying power of the simple stereoscope pictured in Fig. 1 is 4. The stereoscopic vision is increased directly as the eye base distance is increased and magnification is increased. Magnifying power higher than 4 may increase the magnification of the emulsion on the photo and thus the detail topography of the picture is obscured. This factor, of course, depends upon the type of photographic paper used.

To view a set of aerial photographs it is necessary to keep in mind one or two simple steps in order to get the greatest benefit and relieve eye-strain.

First—the photos should be arranged so that the light causing any perceptible shadows appears to be coming from somewhere out beyond the upper left hand corner of the photo. Photos should be selected in order of their exposure to eliminate pseudo-stereoscopic image—i.e., elevations become depressions, etc.

Secondly—the principle points of each photo should be marked off, utilizing, of course, the fiducial marks on the picture. Each photo of a properly taken pair of consecutive photographs contains about 60% of the details of the other, thus the principle point of each adjacent photo is visible on any one photo, except those photos taken at the beginning and end of a flight strip. These are called Transferred Principle Points (see Fig. 3). They are readily transferred by noting its location with respect to the surrounding detail and, with the aid of a large magnifying glass, this same spot can easily be found on the adjacent photo. Use of a stereoscope aids in checking this location. Care should be taken in transforming these points, as the distances between them are important in the advanced phases of photogrammetry. Only the overlapped position is avail-

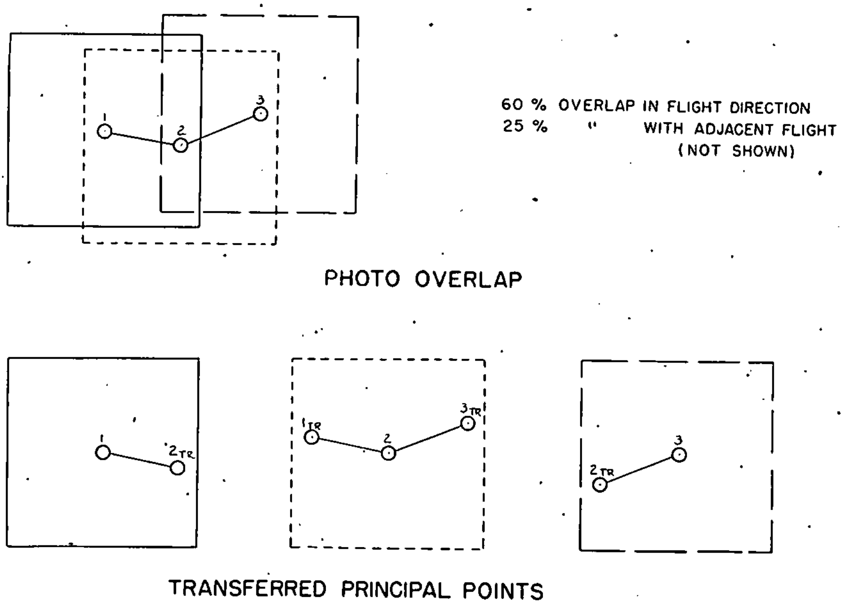


FIG. 3.

able for stereoscopic vision—i.e., same portions of the ground viewed from two different points.

For the lens type, the setup is as illustrated in Fig. 4. The manufacturers will supply the distance necessary between the Principal Point and the Transferred Principle Point. In the lens type, it is necessary to observe sectionally, that is, to have one photo on top of the other, then flip them over; the outside corners being the only ones held down by tape. It is absolutely necessary that a straight line be maintained between the principal points and the stereoscope base must be held parallel to this line. The spacing of the lenses in the stereoscopes should conform to the inter-pupillary distance of the observer's eye.

In the mirror type, depending, of course, on the arrangement of the mirrors, the photos are separated and photo overlapped area may be studied as a whole. The same "straight line and stereoscopic base parallel idea" still holds.

Usually, if the observer's eyes are corrected by glasses it will be found easier to wear the glasses while viewing the stereoscopic model. The three-dimensional model may not be apparent at first

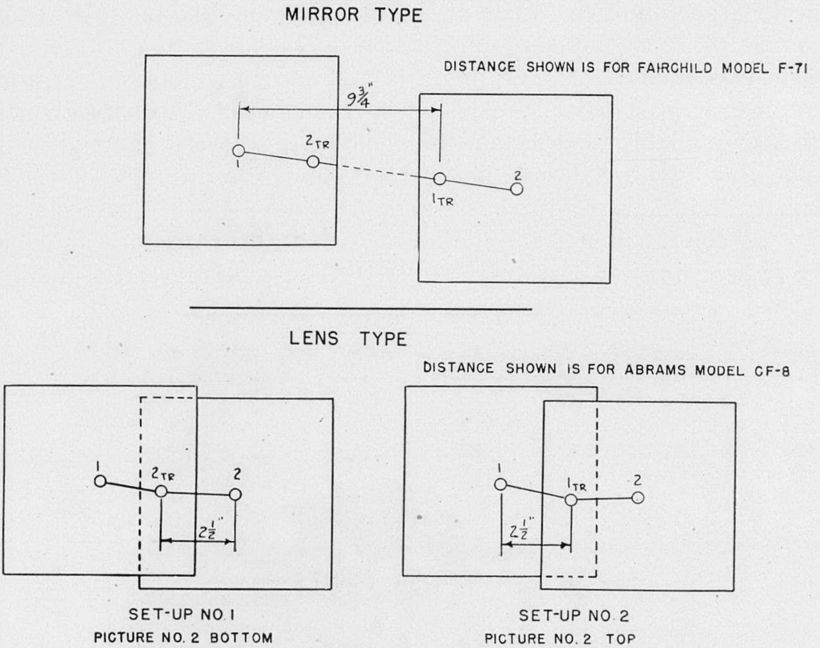


Fig. 4.—Photo Set-up for Stereoscopes.

glance, but by continued sighting, it will soon "jump up" at the observer. Sighting the eyes out the window at some distance object before viewing the photos through the stereoscope is helpful. This aids in making the lines of sight of the eyes parallel, thus enabling one to get the spatial model view more rapidly.

Ratioed Photos

There are times when a series of aerial photos must be used as a unit i.e., a mosaic is to be constructed. It is then desirable to have as near a common scale as possible for all photos. It should be clear that flying a plane at a constant height above the ground and without some slight tilting of the plane is practically impossible. A scale variation of 2% in any series of photos is not considered excessive. Various devices to maintain the camera axis vertical to the plane of the ground have been tried out but they are not too successful. "Crabbing" or swing of the plane off course to compensate for wind and air currents is another factor to be reckoned with. Most specifications limit the angle of tilt to 5° for any one photo and to an average of 2° in any ten-mile section. The angle of crab shall not be in excess of 10°. The angle of tilt can be computed if ground stations, at least three, are visible in the photo. Mechanical means are also available to ascertain the angle of tilt. With reasonably skilfull flying, about 85% of the photos taken have an angle of tilt less than 1° and the rest between 1° and 2°. Few (3% ±) are over 3°.

To correct photos for these errors and also to reduce or enlarge the scale, a projecting camera is used. The type illustrated in Fig. 5

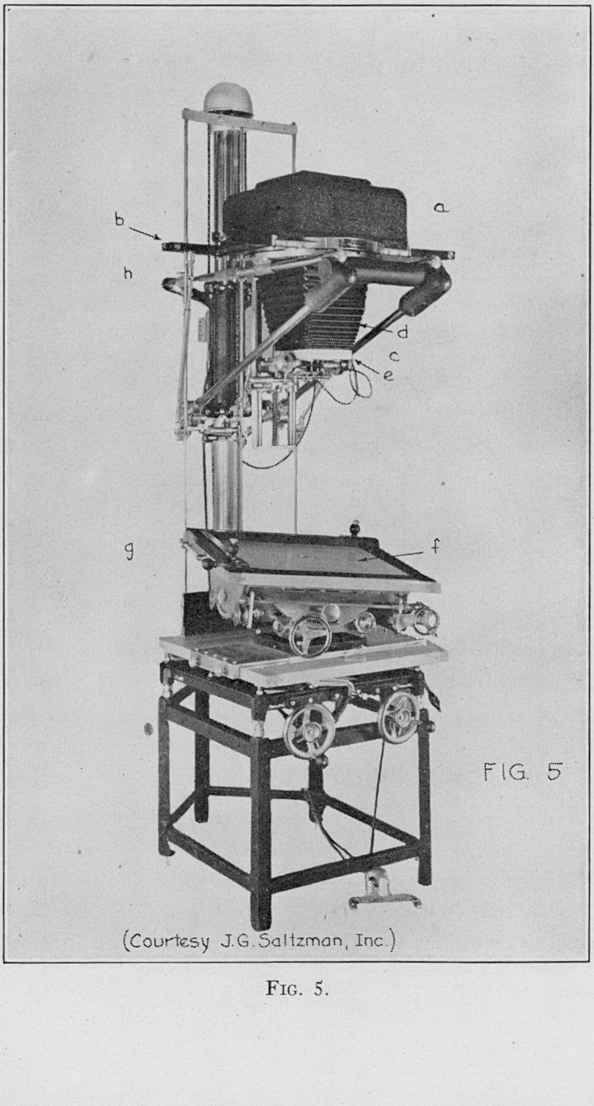


FIG. 5.

is a Vertical Saltzman projector. Horizontal projectors are also available.

The lamp for furnishing light is in housing *a* while negative roll of film is on roller *b*. Lens is at *c* and is suspended at the end of bellows *d* by means of bracket *e*. The photographic paper *f*, on which the print is to be made is fastened to easel *g*. This easel can be tilted in two directions as much as 20° from the horizontal. The distance between lens and easel is adjusted by turning wheel *h*. The lens may also be adjusted by moving bracket *e*.

The ratio of the scale of feet per inch in the original negative to the number of feet per inch of the desired scale is called the scale ratio. Scale of photo or negative is found by comparing the length of some known distance on the ground to the scaled distance in the photo. From a clear negative, the enlargement may be two or three times.

In order to correct for tilt, ground stations are necessary. These locations are located by the usual triangulation methods and leveling procedures. The procedure for making adjustments of the projector is generally to approximately adjust the distance from lens to easel to get the desired ratio. The ground control points are plotted on the easel to the desired scale and are located and marked on the negative. By tilting the easel the projection of the control points from the negative is made to coincide with the plotted points on the easel. When this is done, photographic paper is placed on the easel and exposed to the projection from the negative. A print free from tilt is the result. More accurate mosaics, or aerial panoramic views as they may be called, can be constructed with these rectified photos.

Distortion at the edges of the photo due to the image rays being at an angle with the ground cannot be corrected by this means however. Scaled distances on mosaics are therefore only approximate, those near the principle points being most nearly correct.

Control Points

The first step in map compilation is to construct a control plot on the map sheet, either drawing paper, tracing paper, or cloth. This control plot is prepared by plotting enough ground survey points to coördinate the aerial survey data and ground survey data. Ground control points are supplemented with enough photographic control points to permit proper matching of the photos. These photographic control points should be visible on two or more photos, but are not required to be mathematically tied into the ground control system. Another name for them is Radial Line Points, Pass Points, or Wing Points.

Actually, use of these Radial Line Points is a graphic method of obtaining photogrammetric triangulation. Slotted templates made from transparent celluloid or metal templates are used in this graphical solution. This radial plot is based upon the principle that *true* horizontal angles can be measured around the nadir point of the photo regardless of the scale change, tilt of camera, or relief displacement as such errors radiate from this nadir point. Usually the nadir point, which is the intersection, on the plane of the photo, of a plumb line

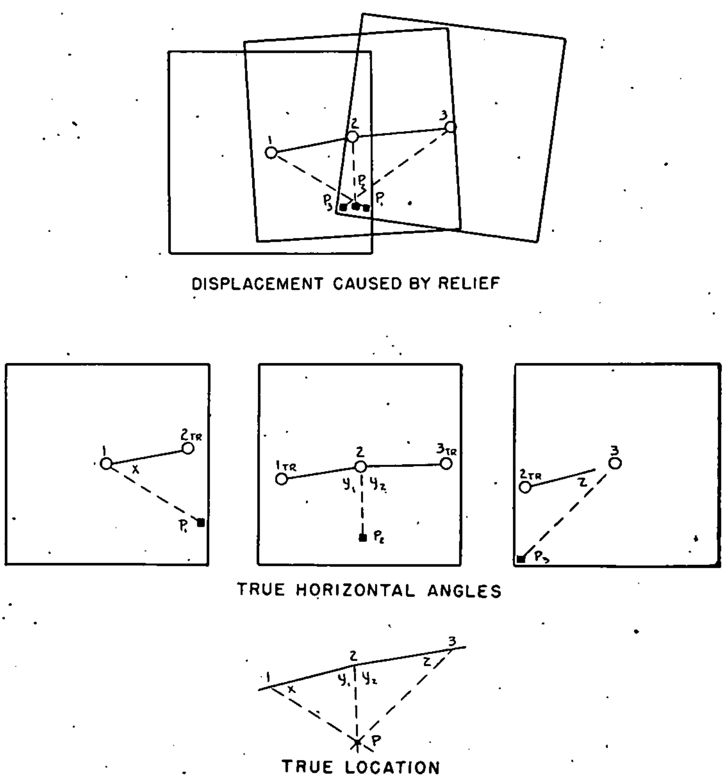


FIG. 6.—RADIAL LINE METHOD OF LOCATING OBJECTS ON MAP.

extending through the exposure station, and the principle point coincide. If there is a large tilt, this is not quite true, but up to 3° the error may be considered as negligible.

This principle dates back to 1873 when C. B. Adams was awarded a patent for use with photos from balloons. Col. J. W. Bagley, in 1923, probably gave it its greatest impetus.

In Fig. 6, point p on the three photos is shown in its displaced position due to relief, or difference in elevation. The figures in the preceding paper by Prof. Baird have already illustrated the geometry of this displacement.

The top part shows an attempt to have point p coincide. The true horizontal angles are shown in the middle portion as radial lines from the Principle Points (or Nadir points). These true angles, x, y_1 and y_2, and z are then plotted on the bottom of the figure to give the true location of the point p by three-point intersection. Only two lines are actually necessary, the third line being used as a check.

The steps in preparing a set of prints for a radial plot are illustrated in Fig. 7. Those steps enumerated are:—

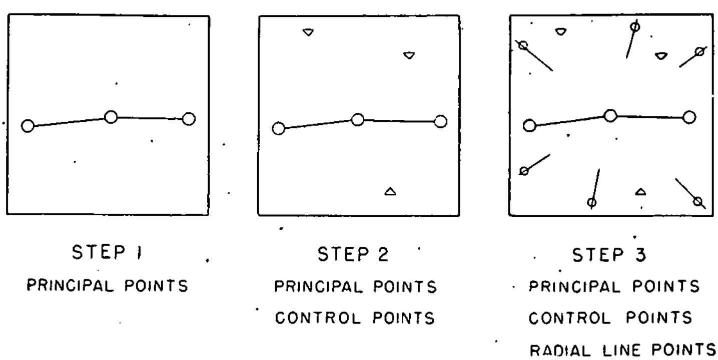


FIG. 7.—PREPARING PHOTO FOR RADIAL PLOT.

1. Locate Principle Points and Transferred Principle Points.
2. Locate and identify control points on photos and plot their location by x and y coördinates on the plotting sheet to the desired scale.
3. Select pass points, radial line point, or wing points. These points are usually selected near the edges of the photos and consist of prominent points of topography such as road

intersections, corners of buildings, isolated trees, property corners, bridge abutments, etc., and should appear in at least two photos, and if possible three photos.

4. Construct the template using transparent celluloid or preferably the slotted metal templates as indicated in Fig. 8. Celluloid templates are not reusable whereas metal ones are. All radial line points are marked with small steel pins over which is slipped a stud which in turn fits snugly into the slot of the metal strip.

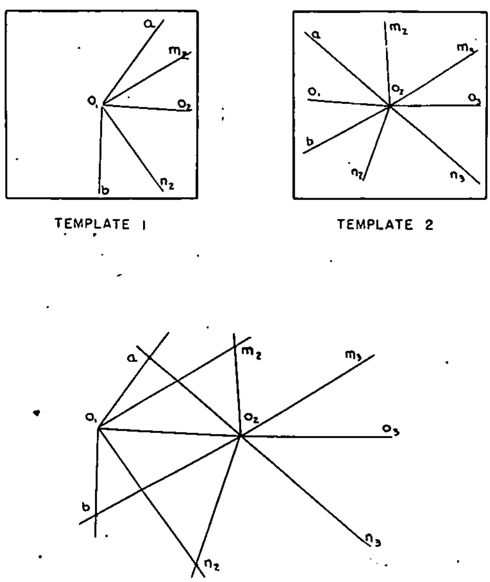
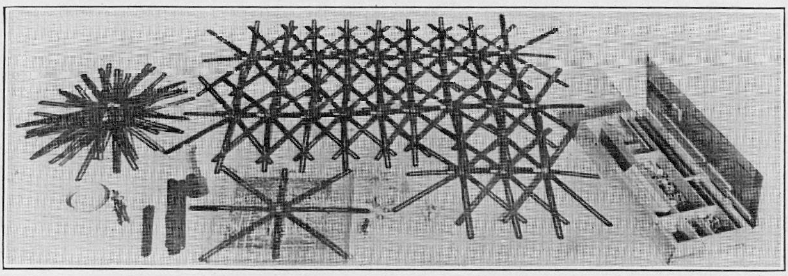


FIG. 8.—CONSTRUCTING RADIAL TRIANGULATOR.

5. When the templates for each photo have been constructed by assembling and tightening up on the lock nuts at the center, they are assembled by superimposing one on top of the other over the plotting sheet and sliding along until all the properly marked arms overlap. Studs are then slipped into the grooves in the overlapping arms and the true location of the point marked by pin pricks. (See Fig. 9.) As further ground control points are encountered along a flight



(Courtesy Abrams Instrument Co.)

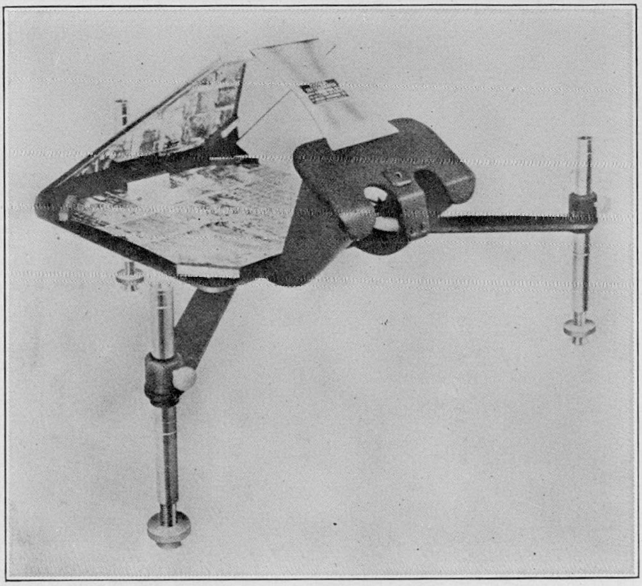
FIG. 9.—THE ABRAMS MECHANICAL TRIANGULATOR.

line layout, the entire assembly is flexed like an accordion to adjust the location. It may be possible that a triangle of error will occur on some of the radial line points. Using the centroid of the triangle will give an accurate enough location providing the triangle is small.

6. The data from the photos can now be transferred to the plotting sheet by use of the Vertical Sketchmaster or by proportioning the photo distances to the plotted distances. In the latter case, many more radial control points are usually plotted than those shown on the figure in order to break up the error distribution into smaller distances.

The Vertical Sketchmaster (see Figs. 10 and 11) is an instrument for adjusting photo errors and plotting their true location. It enables one to see both the plotting sheet and the photo at the same time by use of a half silvered mirror. Scale ranges from .38 to 1.14, by use of varying diopter lenses directly under the half silvered mirror, can be effected. A diopter is merely the reciprocal of the focal length of the lens in meters. The purpose of this lens is to focus the map plane upon the eye. By raising and lowering the entire instrument further adjustments in scale may be made as well as corrections for tilt and tip.

The photo is held on the picture plane by six Alnico magnets. The instrument is centered over the control points on the map plane and adjusted by raising and lowering its legs until the picture points coincide with the plotted points. In this way adjustments for tilt, tip, and relief and scale are cared for. The proper lens depends, of



(Courtesy Abrams Instrument Co.)
FIG. 10.—VERTICAL SKETCHMASTER.

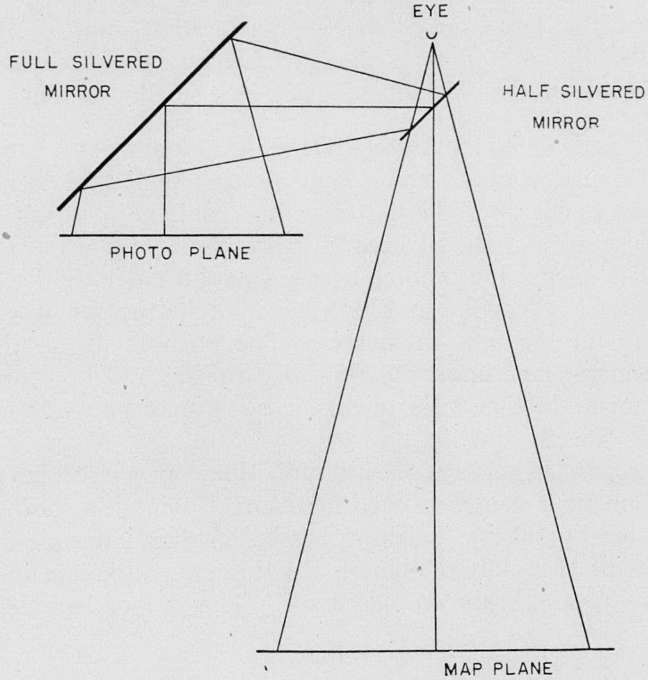


FIG. 11.—DIAGRAMATIC SKETCH OF VERTICAL SKETCHMASTER.

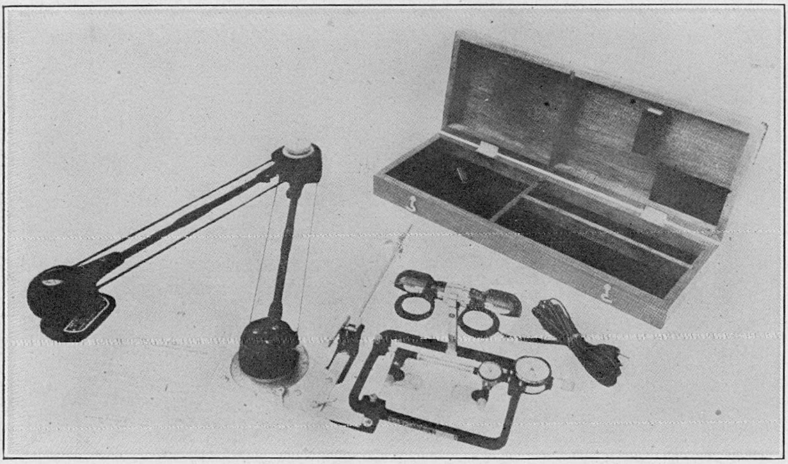
course, upon the picture scale and the map scale. No lens at all is used if picture is close to proposed map scale. The scale ranges are usually indicated with each lens.

This instrument is also useful in transferring detail from drawings or existing maps to a new map base in revising old maps.

Contour Finder

As indicated in the previous article by Prof. Baird, relief displacements cause parallactic displacements on the photo. An instrument for measuring this displacement and thus obtaining the actual difference in elevation of the points on the ground is available. The accuracy of these elevation differences depends upon the photo measuring equipment, altitude of the plane, the amount of tip and tilt present in the photo as well as the amount of shrinkage in the paper. This instrument is known as a Stereocomparagraph or Contour Finder, depending on the manufacturer.

The Contour Finder (Abrams Instrument Company) consists of a four-power simple stereoscope and two index marks (dots, crosses, or circles) indented upon two lucite plates that rest upon the surface of the photo (see Fig. 12). These two items are mounted upon a frame which is in turn attached to a Universal drafting arm



(Courtesy Abrams Instrument Co.)

Fig. 12.—The Abrams Contour Finder.

so that the base of the stereoscope is always parallel to the flight line as it is moved over the photos.

The index marks, called "floating dots", are attached to the base of the stereoscope by means of a measuring unit which is capable of measuring parallax differences both in the x and y directions to .01 mm. using an Ames dial. The prints are illuminated by two seven-watt bulbs.

The Fairchild Model is similar to this except it uses a mirror type stereoscope.

A tracing arm is attached to the drafting arm so that as the spatial model is viewed and the floating dot is moved over the photo, the contours can be drawn.

From the above discussion, it should be evident that this instrument is capable of "running levels" as it were, or "chasing out contours". All this work, mind you, is being done in an office, regardless of the weather. If ground control points are not available, a base may be assumed and the "form lines" drawn out. "Chasing the contour" is accomplished by setting the dial to a given reading and by keeping the floating dot in contact with the ground as it appears spatially, the particular contour desired may be traced out.

It would probably be out of order to go into detailed discussion on how the apparatus is definitely set-up. Manufacturers' handbooks give this precise information.

Errors in photographs due to tip, tilt, and distortion of photographic paper will cause errors in the contour location. Corrections may be made in the parallax measurements (or dial readings) if enough control points are available and spaced appropriately by plotting correction curves (similar to contour lines) on one of the prints and the dial readings changed accordingly as the index marks encounter the curve in its wanderings. This correction graph is extremely tedious to work out and plot. Other errors in this method of plotting are due to scale differences in scale of adjacent photos and also the contours shown are a perspective view of the area rather than an orthographic view.

Tilted photos may be contoured and then placed in the sketchmaster and rectified—the same control points are used as in the topo details.

The accuracy obtainable is about 1/300th of the height of the plane above the ground.

Contours may also be drawn in the field with the aid of a plane table using the photo as a map if it is desired. Additional planimetry obscured from the aerial camera may be added or cleared up.

The basic principle of the Contour Finder or Stereocomparagraph underlies the manufacture of most of the large plotting machines in use in the military and government offices. These larger machines are designed to care for practically all the errors that might creep into aerial photographic work.

A new instrument called the KEK plotter is now being used in some offices. It differs from the stereocomparagraph in that:

1. Photos are mounted on tilting tables in order to eliminate some of the false parallax values caused by tilt of the camera.

2. The floating dots are situated well above the photos instead of resting on them.

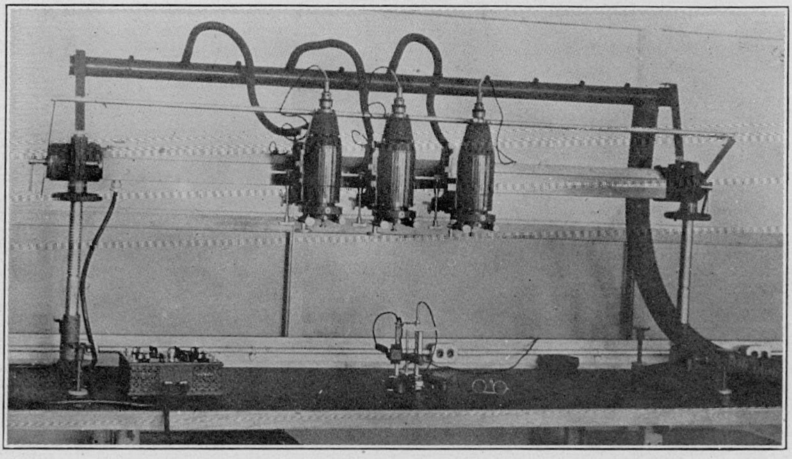
3. Photos may be raised or lowered permitting a scale change for each contour line, thus bringing all contours to their true map position.

The Brock Process has been used extensively especially by Aero Service Corporation. Its chief highlights are:

1. Glass plates are used instead of film—in this way errors due to distortion of the film is eliminated.
2. Tilt eliminated by rectifying camera.
3. All plates brought to same scale by ratio projector.
4. Pair of corrected plates aligned in stereocomparator and contours drawn on transparent overlay.
5. Contour sheet then brought to map scale by tracing projector.
6. Planimetry is compiled by means of radial plot.

Perhaps the most interesting and rapid means of compiling a map from aerial photos is that using the Multiplex Aero Projector. (Fig. 13.) It is also claimed that this method is more accurate than the stereocomparagraph; the accuracy being about 1/500th of the plane's height. It is simple in construction, has few moving parts and costs considerably less than any of the large plotting instruments such as are used by Army Map Service and Geological Survey.

The Multiplex operation may be summed up as follows: Two overlapping photos are projected upon a map sheet by projectors, each photo having its own projector. The photos are placed in the projectors in the form of small glass slides (diapositives). The size is usually 1/5 to 1/4 the original. This is necessary in order



(Courtesy Bausch and Lomb Co.)

FIG. 13.—THE MULTIPLEX-PROJECTOR.

that the principal distance of the diapositive is equal to the principal distance of the projector. The principal distance is the distance from the principle point of a photo to its perspective center. In this way, when the diapositive is centered in the projector its emergent cone of light rays will have the same angular relationship as when the original negative was exposed in the aerial camera.

The projectors are attached to the horizontal bar in such a manner that they can be moved horizontally (x direction), vertically, (z direction), and perpendicular to the bar in a horizontal plane (y direction). In this way the projectors may be made to duplicate, in map scale, the exact positions of the camera lens at the instant the photo was made. A colored filter is placed in each projector above the diapositive, the left one being blue-green and the right one being red. The operator wears glasses with the same arrangement of colored lenses.

When the overlapping photos are projected and are in the proper relative position, the operator will be able to view a seemingly gelatin spatial model of a relief map of the ground surface. As the colors used are complimentary, the color of the model will be in the ordinary photographic black and white tones. As the impression is entirely optical, it is sometimes called the phantom model.

Elevations may be determined by raising and lowering the tracing table, in the center of which is a tiny spot of light. The settings of this table are determined in much the same manner as for the Contour Finder. Contours may easily be traced out by setting the table at a given height and moving it around on the spatial model with the spot of light in contact with the seemingly ground surface. A pencil point is attached to the table directly under the light. Planimetry may be traced off by raising or lowering the table as the profile of the object is traced out.

By arranging the projectors properly, several men may work at one table.

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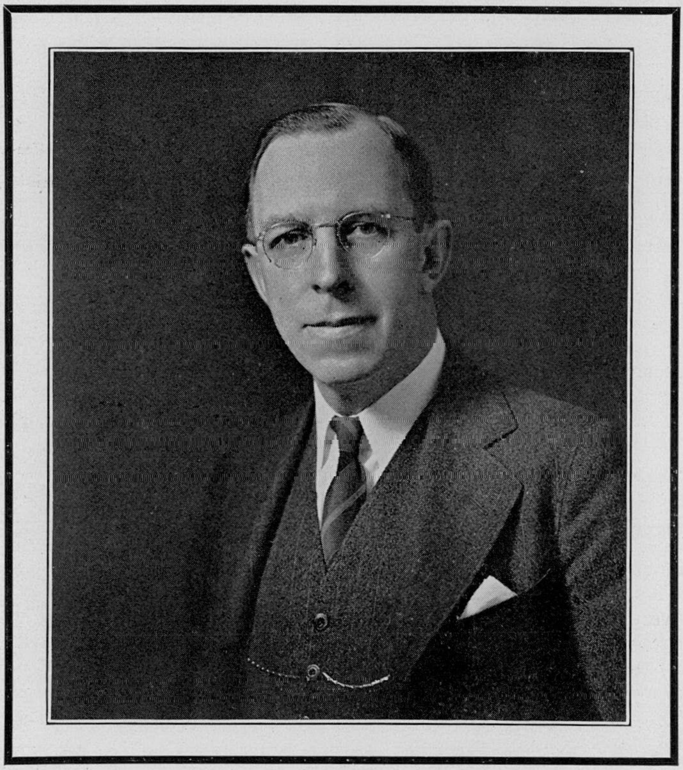

SAMUEL MORRISON ELLSWORTH

1895-1944

Samuel Morrison Ellsworth was my friend. I learnt to know him when we were students together at the Massachusetts Institute of Technology, and our paths crossed again and again in later life, while we pursued our separate careers in sanitary engineering, he as a practicing engineer and I as a teacher. Our professional interests were, to a degree, complementary. His were my contacts with the art of engineering; mine kept him abreast of its scientific progress. Together we tried to espouse the culture of our profession. I sought his advice freely and he mine, in professional as well as social matters. Our thinking on social problems followed much the same groove, and we enjoyed good music together, both as amateur violinists and as lovers of good music. Among the most satisfying recollections of our student days were long Sunday evenings devoted to chamber music in the home of Henry Greenleaf Pearson, Professor of English at the Massachusetts Institute of Technology.

As I look back upon Ellsworth's career in the practice of civil and sanitary engineering, I am struck first of all by the purposeful planning of his apprenticeship. He chose his masters wisely and with care. His years of apprenticeship include service with the Massachusetts Department of Public Health, the municipal sewerage authority of Rye, N. Y., the North Jersey District Water Supply Commission, and three firms of consulting engineers: Messrs. Weston and Sampson, Morris Knowles, Inc., and Messrs. Metcalf and Eddy. Included in his experience were surveying and field studies, supervision of construction, preparation of preliminary as well as final designs for sanitary works, and responsibility for engineering investigations and reports of varied character. This portion of his career occupied twelve fruitful years during which he became familiar with the thinking and methods of some of the leaders of the profession, including the late X. H. Goodnough, Robert Spurr Weston, Morris Knowles, and Harrison P. Eddy. They were good masters under whom to learn, and splendid exemplars of the service to society which Ellsworth wanted eventually to perform in his own right, as a consulting engineer.

I am impressed further with Ellsworth's willingness to forsake economic security when it could be obtained only in exchange for the abandonment of his ambitions. In this he has set an example for younger engineers who are too prone to let the obstacles that seem to beset the path of beginners deter them from the career of their choice to which they have devoted long years of preparation.

Characteristic of Ellsworth''s steadfastness of purpose was his seizing upon the depression years of the early nineteen thirties to announce his independence as a practicing engineer. Some months after an extended trip to Europe to study the latest developments in sanitary works abroad, while on leave from the firm of Metcalf and Eddy, he started his consulting practice in Boston, Massachusetts. This practice grew slowly but steadily and was devoted to investigations, reports, design, and supervision of construction of water supply and sewerage works for New England municipalities and industries. His solution of the engineering problems involved was characterized by a ready grasp of the essentials, willingness to give adequate analysis, and directness of execution.

When America was drawn into world conflict in 1917, Ellsworth sought usefulness first with the American Red Cross and U. S. Public Health Service in extra-cantonment sanitation, and later in the American Expeditionary Force. There he rose from infantry private to second lieutenant in water sanitation with the First Army and ultimately to Area Water Inspector at the American Embarkation Center at Le Mans, France.

As the clouds of world-wide war gathered for a second time during his life, Ellsworth directed all of his energies towards the design and construction of essential military installations. Either in his own name or in collaboration with others he became associated with engineering work on Camp Edwards, Mass., Weymouth, Mass. Lighter-than-Air Base, Naval Advance Base Depot at Davisville, R. I., Camp McCain at Granada, Miss., the Holston Ordnance Works at Kingsport, Tenn., and the Pratt & Whitney Works at East Hartford, Conn. Without giving concern to his own welfare, he devoted long hours to the completion of these tasks that were to become so important in the winning of the war. His untimely death may reasonably be traced to his failure properly to husband his strength during three years of continuous application to these problems.

Samuel Morrison Ellsworth was a native of Braintree, Mass., the son of George Gower and Helen (Morrison) Ellsworth. From his Pilgrim ancestors, he inherited a rugged idealism which was linked to reality by a gentle sense of humor. This gave comfort to him as well as to those who sought his judgment on some of the perplexing social questions of the times. His interest in public affairs made him conscious, in particular, of the public responsibilities of the engineer. His own responsibilities he met with sincerity and integrity. He served the Town of Braintree as Chairman of the Sewer Commission, the City of Boston as a member of the Works Projects Board, Harvard University as Lecturer on Sanitary Engineering Design, and the national government as Water Consultant. In addition, Ellsworth held office in many of the engineering societies of which he was a member, including the presidencies of the Northeastern Section of the American Society of Civil Engineers and the New England Sewage Works Association, and the secretaryship of the New England Section of the American Water Works Association. At the time of his death he was President of the Boston Society of Civil Engineers and Director-elect of the New England Water Works Association.

Ellsworth wrote a number of papers descriptive of the engineering works that he constructed. Among his most thought-provoking writings, however, were those relating to the welfare of the engineering profession and a paper in which, well in advance of others, he raised the question whether infantile paralysis could be spread by bathing in sewage-polluted waters.

Samuel Ellsworth was a true son of New England. As such he possessed rectitude of thought in full measure. However, he did not permit his thinking to be hampered by traditionalism. Instead he was willing to accept changing social practices as evolutionary to the American way of life. His friends will remember him for the stimulating arguments which he presented for keeping an open mind on all questions and for advancing the welfare of the profession of engineers as well as that of all other manner of men. Often his arguments were started to clarify his own thinking on timely subjects. This fact he would wistfully acknowledge if forced to do so—a trait that endeared him to his listeners.

In his professional and social contacts, Ellsworth possessed the rare ability to find something in the character of or behavior of most persons that he could admire and through which he could reach a common meeting ground. In consequence he was respected by simple folk as well as by more broadly educated people. Quarrels he had, like all men who feel deeply and are honestly outspoken. But his quarrels were directed to the exposure of shallow and dishonest thinking or thoughtless acts. In this he manifested an urge for reforming people and circumstances—a vestige probable of his descent from a long line of teachers and preachers.

His death at the threshold of the years in which he might have made his enginering ability and personal force felt more widely has deprived the profession of a man who represented its finest type and his friends of a wise counsellor and congenial companion.

On November 6, 1926, Samuel Ellsworth contracted a happy marriage with Marjorie Ann Thomas of Summit, New Jersey, who survives him together with two sons, Samuel Morrison Jr., and Thomas Allen.

Born January 4, 1895
Died August 13, 1944.

Member Boston Society of Civil Engineers, Elected May 21, 1930
Chairman, Sanitary Section, B.S.C.E., 1938-1939
Director—1940-1942
Vice President—1943-1944
President—March-August, 1944

Memoir by Prof. Gordon M. Fair

SECURITY AND ITS PURSUIT*

By Samuel M. Ellsworth
Late President, Boston Society of Civil Engineers

Out of the paralizing fear which swept this nation in the early '30's, a somewhat uninspiring word arose to take a place among the brightest stars in the heavens of American democratic philosophy. Near the fixed stars of "freedom," "liberty," "democracy," there appeared one called "security," of such magnitude that, during the years of economic depression, it sometimes seemed to outshine the older members of this American constellation. Was this object, now dimmed by the clouds of war, really a star or only a satelite shining in reflected glory?

There is reason to believe that the blind and overwhelming desire for security which enveloped most of the world following the economic collapse contributed much to bringing on the present world conflict. Germany was allowed to re-arm while the rest of the world talked of security. In our persistent desire for security at home we delayed our preparations for war until it was all but lost. Our young men in schools and universities had become so completely saturated with the philosophy of security that during the anxious months before Pearl Harbor there were grave doubts as to their ability to assume the hardships and responsibilities of war. Fortunately, enough of the essence of courageous leadership was saved from the depression to revive in these young men something of the spirit of the founding fathers. Now for them, there is no security. They have left their homes and families to engage in another world war wherein courage and unselfish devotion to duty are the primary requisites to success and the desire for personal security the surest road to failure.

In peace and war since the turn of the century the influence of the American engineer on the social and economic structure of this country has been growing at an accelerated rate. In peace his efforts have been toward increasing the comfort, ease and security of living; in war, to the design, mass-production and transportation of the materials of destruction. Thus far the engineer has generally been too busy with engineering to spend much time or thought on the overall social and political implications of the products of his profession. Moreover, to be thoroughly competent in his own field he has

*Last article written in 1944 by Mr. Ellsworth.

felt he cannot in good faith spread his activities much beyond the limits of that field. Yet by his failure to do so, his works, without the understanding to control them, become a threat to civilization. Like Frankenstein, the engineer conceives and builds, but has little or no control over the final results of his labors.

This war, in which engineers have played so large a part, will end. The problems of reconstruction and conversion of commerce and industry to a peacetime basis may be even more complex than the problems of war. They must be met with all the intelligence, understanding and skill possessed by government, business and the professions. In the technical planning and execution of reconstruction and conversion, the engineer will do his job well. But if, in this engineering age, the nation is to go forward to a full realization of the benefits which engineering science can give, we engineers must courageously grasp the responsibilities which rightfully belong to our profession, and become something more than a subsidized group of technological prostitutes.

The past three years have demonstrated forcefully that the productive capacity of this country is far beyond anything we might have expected prior to the war. With the construction of training facilities for millions of soldiers, munitions works and munitions, shipyards and ships, a complete new rubber industry, and the thousands of items needed to carry on a global war, we are still not yet seriously inconvenienced by shortages in our day-to-day needs. Is it possible after such a demonstration of productive capacity that we shall be satisfied to sink back into a state so dominated by a desire for security as that which existed before the war?

The desire for security is instinctive, being basically an expression of fear. Its force being greatest in the presence of danger, anticipation of danger and preparation for it tends to keep this force under control. Engineers play a large part in such preparations. Consider flood control, fire prevention, sanitation, the design of buildings to withstand extreme wind loads and earthquakes; all contribute to a sense of security on the part of the lay public. Considering the time and thought given by the engineer to matters affecting public safety, it is not surprising that he should become solicitous of his own security in matters outside the field of engineering. But if the engineer is to assume a place of leadership, he must not be over-apprehensive regarding his own fortunes.

Before the stimulation of war has passed we engineers must consider the part we are to play in the restoration of peacetime activities. If our chief interest is in our own personal security we must expect to take an inferior and subservient place in the construction of a new world. But if our interest is as it should be, then the desire for personal security must be submerged in an overwhelming urge to give to the world the benefits of all that is possible from the full utilization of modern engineering knowledge. Following this objective with courage and conviction we should greatly enhance our opportunities for leadership.

The hope of the engineering profession lies chiefly with the younger engineers. Too often the older and sometimes prominent members of the profession have unwittingly sacrificed professional principles and ideals for the sake of personal security. They have permitted the commercial side of engineering to dominate the professional, and through fear, many high-grade engineers have been moved to accept positions solely on the basis of security. Unfortunately some of the leaders in our profession can be included in this category. But the younger engineers, and particularly those who have served with the armed forces, will have learned something of the true meaning of service and devotion to duty, and will have found that personal security in itself is of secondary importance. Given encouragement and opportunity these men may have a profound influence on the design and construction of the post-war world.

When the framers of the American Declaration of Independence, proclaimed certain inalienable rights of man, they mentioned only three;—"Life, Liberty, and the pursuit of Happiness." The first were unconditional,—but in using the phrase "pursuit of Happiness" they denied any inalienable right to happiness itself. So it is with security. It may be something to be desired, but no free government can guarantee more than the right of its citizens to pursue it, and like happiness, its full attainment is possible only through service to others.

OF GENERAL INTEREST

PRIZES AWARDED AT ANNUAL MEETING ON MARCH 21, 1945

The Desmond Fitzgerald Award

TO SCOTT KEITH, MEMBER

Presentation made by President Harry P. Burden

Prof. Harold K. Barrows, Chairman of the Committee on Award of the Desmond Fitzgerald Award, consisting of Prof. Harold K. Barrows, James E. Lawrence and Arthur L. Shaw, outlined the purpose of this prize, which was instituted and endowed in 1910 by the late Desmond FitzGerald, a Past President and Honorary Member of this Society. This award is given annually for a paper presented by a member and published during the year, which is adjudged worthy of special commendation for its merit. The paper selected by this committee and recommended to the Board of Government for the Award was that by Scott Keith, Member, entitled "Hydraulics of the Park River Conduit, Hartford, Conn.," presented at a meeting of the Hydraulics Section, held on May 3, 1944, and published in the July 1944, issue of the JOURNAL.

President Burden on behalf of the Board of Government presented the Desmond FitzGerald Award to Mr. Scott Keith, who accepted this award with appropriate remarks.

The Hydraulics Section Prize

TO EDWIN B. COBB, MEMBER

Announcement made by President Harry P. Burden

The President announced that in accordance with the recommendation of the Committee on Award of the Hydraulics Section Prize, the Board of Government *VOTED* to award the Hydraulics Section Prize to Edwin B. Cobb, member, for his paper on "Flow of Water In Network Piping System," presented at a meeting of the Hydraulics Section held on February 2, 1944, and published in the October, 1944, issue of the JOURNAL. In view of the fact that Mr. Cobb is in the U. S. Navy, Civil Engineer Corps, he could not be present at this meeting to receive this award.

Clemens Herschel Award

To Howard M. Turner, Member

and

Mr. A. C. W. Seicke

Presentation made by President Harry P. Burden

Mr. Arthur L. Shaw, member of the Committee on Award of Prizes, outlined the purpose of the Clemens Herschel Award which was established by a gift from the late Clemens Herschel, a Past President and Honorary Member of this Society, and is awarded for a paper which has been particularly useful and commendable and worthy of recognition. This year two prizes were awarded, one to Mr. Howard M. Turner, Member, for his paper on "Domestic Rates and Consumption," presented at a meeting of the Society held on March 22, 1944, and published in the April, 1944, issue of the Journal; the second prize was awarded to Mr. A. C. W. Siecke, for his paper, "Engineering Highlights of the Normandie Salvage," presented at a meeting of the Society held on October 27, 1943, and published in the January, 1944, issue of the Journal.

The prizes consisted of books: To Mr. Turner,—"Engineering for Dams," Vols. 1. 2, 3., by William P. Creager, Joel D. Justin, Julian Hinds; to Mr. Siecke "Mechanical Engineers' Handbook," by Lionel S. Marks; "Civil Engineering Handbook," by Leonard C. Urquhart; "Structural Engineers' Handbook" by Milo S. Ketchum. Mr. Turner and Mr. Siecke accepted the prizes with fitting remarks and expressed their appreciation of them.

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETING

Boston Society of Civil Engineers

January 24, 1945.—A regular meeting of the Boston Society of Civil Engineers was held this evening at the 20th Century Association, 3 Joy Street, Boston, Mass., and was called to order by Vice-President, Carroll A. Farwell, due to the absence of the President on account of illness. Eighty-eight members and guests attended the meeting. Ffty-four members and guests attended the dinner.

Vice-President Farwell requested members to rise, and he announced the death of the following member:—

Charles G. Craib, who was elected Associate Member, March 16, 1898, and who died April 29, 1944.

The Vice-President announced that the February meeting will be held at the 20 Century Association. Speaker to be announced.

The Vice-President announced that the following had been elected to membership:—

Grade of Member: *Albert E. Abruzzese, George S. Brush, Albert L. Coyne, Ernest L. Spencer, William E. Stanley.

Grade of Junior: †Richard F. Dutting, †Carlo R. Paladino.

*Transfer from Grade of Junior.
†Transfer from Grade of Student.

VOTED that the Secretary be directed to extend to President Burden the greetings of the members of the Society and best wishes for a speedy recovery.

Upon recommendation of the Board of Government to the Society, *VOTED* that the Board of Government be authorized to appropriate the sum of $100 as a contribution toward the cost of an exhibit known as "Greater Boston Looks Ahead," to be held at the Boston Art Museum, January 15 to February 15, 1945. Final action on this matter will be taken at the next meeting of the Society.

Vice-President Farwell then introduced the speaker of the evening, Commander J. E. Larsen, U.S.N.R., who gave an extremely interesting talk on "Construction with the Seabees in Iceland." The paper was illustrated with slides. A question period followed the paper.

The speaker was given a rising vote of thanks.

Adjourned at 9:00 P. M.

EVERETT N. HUTCHINS, *Secretary*

FEBRUARY 28, 1945.—A regular meeting of the Boston Society of Civil Engineers was held this evening in Room 228, New Building, Northeastern University, and was called to order by President, Harry P. Burden. This was a Joint Meeting with the Highway Section BSCE. Sixty members and guests attended the meeting and dinner.

President Burden asked members to rise and announced the death of the following members:

Mayo T. Cook, who was elected a member June 18, 1885, and who died April 11, 1944.

William F. Donovan, who was elected a member February 19, 1930, and who died February 13, 1945.

Henry V. Macksey, who was elected a member January 26, 1898, and who died February 14, 1945.

The President stated that at the last meeting of the Society held on January 24, 1945, a vote was passed to authorize the Board of Government to appropriate the sum of $100 as a contribution toward the cost of an exhibit known as "Greater Boston Looks Ahead," to be held at the Boston Art Museum, January and February, 1945. The announcement of this meeting stated that final action on this matter would be taken at this time.

On motion duly made and seconded, it was *VOTED* that the Board of Government appropriate the sum of $100 toward the cost of the exhibit known as "Greater Boston Looks Ahead," held at the Boston Art Museum, January and February of this current year.

President Burden called upon Prof. Charles O. Baird, Chairman of the Highway Section, to carry on any necessary business for that Section.

President Burden introduced the speakers for the evening:

Prof. Charles O. Baird, Associate Professor of Civil Engineering, Northeastern University, "Basic Principles of Photogrammetry."

Prof. Ernest L. Spencer, Assistant Prof. of Civil Engineering, Northeastern University, "Demonstration, Horizontal and Vertical Surveying Equipment, Mechanical Triangulation, Vertical Sketchmaster, Sterocomparagraph (Contour Finder) other Photogrammetric Equipment."

The talks were illustrated by lantern slides.

Subsequent to the Society meeting, those attending had an opportunity to inspect stereoscope and other instruments designed for studying aerial photographs and for making maps from such photographs.

Adjourned at 9:30 p.m.

EVERETT N. HUTCHINS, *Secretary*

MARCH 21, 1945.—The ninety-seventh annual meeting of the Boston Society of Civil Engineers was held today at the 20th Century Association, 3 Joy Street, Boston, Mass., and was called to order at 4:30 p.m., by President Harry P. Burden.

The minutes of all previous meetings of the current fiscal year which have been printed in the various issues of the JOURNAL were approved.

The Secretary reported the election of the following members:

Grade of Member: Albert E. Cummings, Frank A. Cundari, James E. Cunniff, Byron O. McCoy, Charles F. Peoples, Harold S. Schiano, Harrison E. Shock, Edward N. Tashian.

Grade of Junior: *Francis Sattin.

Grade of Student: Charles Axelrod, Bernard A. Barnes, Donald B. Carter, Jr., David I. Lowell, Francis J. Mastropiere, Alfred J. Pacelli, Jr.

The Annual Reports of the Board of Government, Treasurer, Secretary and Auditors were presented. Reports were also made by the following committees: Hospitality, Welfare, Library, John R. Freeman Fund, Subsoils of Boston.

VOTED that the reports be accepted with thanks and placed on file and that they be printed in the April, 1945, JOURNAL.

VOTED that the incoming Board of Government be authorized to appoint such committees as it deems desirable.

The Report of the Tellers of Election, Charles C. McDonald and Herbert D. Hurley, was presented and in accordance therewith the President declared the following had been elected officers for the ensuing year:

President—Carroll A. Farwell
Vice-President (for one year)—Raymond W. Coburn
Vice-President (for two years)—Harvey B. Kinnison
Secretary (for one year)—Everett N. Hutchins
Treasurer (for one year)—Chester J. Ginder
Directors (for two years)—Miles N. Clair, Francis H. Kingsbury
Nominating Committee (for two years) — Alexander J. Bone, James F. Brittain, Lawrence G. Ropes

*Transfer from Grade of Student.

The retiring President, Harry P. Burden, then gave his address on "Education for Civil Engineering."

Fifty members and guests attended this part of the meeting.

The meeting adjourned to assemble at 7:30 p.m., the Annual Dinner being held during the interim.

The President then called the meeting to order for the presentation of Prizes.

The President requested Prof. Harold K. Barrows, Chairman of the Desmond FitzGerald Award Committee, to outline the purpose of this prize and to present the candidate for the Prize. The President, on behalf of the Society, then made the presentation of the Desmond FitzGerald Award to Scott Keith, member, for his paper on "Hydraulics of the Park River Conduit, Hartford, Conn"., presented at a meeting of the Hydraulics Section held on May 3, 1944, and published in the July 1944, issue of the JOURNAL.

The President requested Mr. Arthur L. Shaw, member of the Committee on Prize Awards, to outline the purpose of the Clemens Herschel Prize and to present the candidates. The President on behalf of the Society then made the presentation of the Clemens Herschel Award to Mr. A. C. W. Siecke, for his paper on "Engineering Highlights of the *Normandie* Salvage," presented at a meeting of the Society held on October 27, 1943, and published in the January, 1944, issue of the Journal; and to Mr. Howard M. Turner, member, for his paper on "Domestic Rates and Consumption," presented at a meeting of the Society held on March 22, 1944, and published in the April, 1944, issue of the JOURNAL.

The prize consisted of the following books:

Mr. Siecke — "Mechanical Engineer's Handbook," by Lionel S. Marks.
"Civil Engineering Handbook," by Leonard C. Urquhart.
"Structural Engineers Handbook," by Milo S. Ketchum.
Mr. Turner — "Engineering for Dams," by William Creager, Joel D. Justin, Julian Hinds. Vols. 1, 2, 3.

President Burden then introduced the guest speaker, Dr. Karl Terzaghi, Lecturer on Soil Mechanics and Engineering Geology, at Harvard University, who gave a very interesting talk on "Unusual Landslides." The talk was illustrated with lantern slides.

At the conclusion of this address, President Burden introduced the newly elected President, Carroll A. Farwell. The meeting adjourned at 9:15 p.m.

One hundred seventy-five members and guests attended the dinner.

EVERETT N. HUTCHINS, *Secretary*

SANITARY SECTION

DECEMBER 6, 1944.—A meeting of the Sanitary Section was held this evening in the Society Rooms, 715 Tremont Temple, at 7:30 p.m., following an informal dinner gathering at Patten's Restaurant. Thirty persons attended the meeting with nineteen at the dinner.

Vice-Chairman Mellish presided, in the absence of Chairman Gibbs. Upon motion duly made and seconded, it was voted that the Chairman should appoint a Nominating Committee to recommend candidates for officers of the section and members of the Executive Committee for the year beginning March 7, 1945.

The speaker of the evening was Mr. Ralph W. Horne, member of the firm of Fay, Spofford & Thorndike, who gave an interesting illustrated talk on "Control of Infiltration and Storm Flow into Sanitary Sewers."

After considerable general discussion, the speaker was given a rising vote of thanks and the meeting adjourned about 8:30 p.m.

Respectfully submitted,
GEORGE C. HOUSER, *Clerk.*

DESIGNERS' SECTION

JANUARY 10, 1945.—A meeting of the Designers Section of the Boston Society of Civil Engineers was held at the Society Rooms following an informal luncheon at the Ambassador Restaurant. The meeting was opened by Chairman Lawrence M. Gentleman at 6:45 p.m.

The report of the previous meeting was approved as read. Past Chairmen, Wilbur, Gramstorff and Protze were elected members of a committee to present nominations for officers of the Section for the coming year with the request that the nominations be submitted at the February meeting.

Dean Frank W. Garran of the Thayer School of Civil Engineering, Dartmouth College, presented a paper entitled, "The Future of Civil Engineering Education." Dean Garran outlined briefly the history of engineering schools and the founding of engineering societies, the changes in engineering curricula to date and offered suggestions for a post-war curriculum. In the discussion following the paper, many members and guests expressed thoughts regarding the engineering ability of the men released from college and made suggestions for the improvement of civil engineering courses.

There was an attendance of 45 members and guests.

The meeting adjourned at 8:45 p.m.

FRANK L. LINCOLN, *Clerk.*

FEBRUARY 14, 1945.—A meeting of the Designers Section of the Boston Society of Civil Engineers was held at the Society Rooms, 715 Tremont Temple, Boston, at 6:45 p.m. following an informal luncheon at the Ambassador Restaurant. Chairman, Lawrence M. Gentleman presided.

The clerk's report of the previous meeting was read and accepted.

The nominating committee consisting of Herman G. Protze, Emil A. Gramstorff and John B. Wilbur submitted the following slate of officers for the coming year to be elected at the annual meeting on March 7, 1945.

For *Chairman*—Eugene Mirabelli
Vice-Chairman—Frank L. Lincoln
Clerk—Dean Peabody, Jr.
Executive Committee—
Burtis S. Brown
J. Stuart Crandall
Henry I. Wyner

The speakers for the evening were Professors Howard R. Staley and Dean Peabody, Jr., of Massachusetts Institute of Technology, both of whom spoke on the subject "Creep Measurement of Pre-Stressed Gunite and Concrete Bars." Professor Staley described the tests made and Professor Peabody presented the theoretical discussion.

There was an attendance of 22 members and guests. The meeting adjourned at 8:20 p.m.

FRANK L. LINCOLN, *Clerk*.

MARCH 14, 1945.—A meeting of the Designers Section of the Boston Society of Civil Engineers was held at the Society Rooms, 715 Tremont Temple, Boston, at 6:45 p.m. following an informal dinner at the Ambassador Restaurant. Chairman Lawrence M. Gentleman presided.

The clerk's report of the previous meeting was read and accepted.

Mr. Gentleman announced that the next meeting would be held on April 11, that it would be a joint meeting with 1945 at Northeastern University and the Highway Section of the Northeastern University Section of the Boston Society of Civil Engineers. Full details of the meeting were to be announced in the next issue of the ESNE JOURNAL.

Due to unavoidable circumstances the Nominating Committee consisting of Herman G. Protze, Emil A. Gramstorff and John B. Wilbur, found it necessary to submit the following revised report:

"It is with sincere regret we learn that the ill health of Professor Mirabelli has forced him to decline the nomination for Chairmanship of the Designers' Section for the coming year. The Nominating Committee appointed at the January meeting of the Section therefore submits the following revised slate of officers for your consideration for the coming year.

For *Chairman*—Frank L. Lincoln
Vice-Chairman—Dean Peabody, Jr.
Clerk—Henry I. Wyner
Executive Committee—
J. Stuart Crandell
Burtis S. Brown
Eugene Mirabelli."

The meeting was thrown open for nominations from the floor and hearing none it was moved and passed that the nominations be closed. By vote of the membership present the clerk was instructed to cast one ballot electing the above slate of officers for the coming year.

The speaker for the evening was James F. Brittain, formerly with the Pacific Bridge Co., who presented a very interesting paper entitled, "Experiences in the Construction of Steel Floating Drydocks." The talk was followed by an open discussion period and the meeting adjourned at 8:15 p.m.

There was an attendance of 43 members and guests.

HENRY I. WYNER, *Clerk*.

HIGHWAY SECTION

FEBRUARY 28, 1945.—The Annual Meeting of the Highway Section of the Boston Society of Civil Engineers was held this evening at the New Building, Northeastern University, at 7:00 p.m. This was a Joint Meeting with the main Society. Dean Harry P. Burden, President, called the meeting to order.

Seventy-six members and guests attended the meeting and sixty members and guests attended the dinner preceding the meeting.

President Burden called upon Professor Charles O. Baird, Chairman of the Highway Section to conduct any matters of business required by that Section. Professor Baird read the report of the nominating committee. In the ensuing vote the following were elected to serve as officers for the coming year:

Chairman—William C. Paxton
Vice-Chairman—Francis T. McAvoy
Clerk—George W. Hankinson ......
Executive Committee—
Alexander J. Bone
Thomas C. Coleman
Charles O. Baird

President Burden introduced the speakers for the evening:

Prof. Charles O. Baird, Associate Professor of Civil Engineering, Northeastern University, "Basic Principles of Photogrammetry."

Prof. Ernest L. Spencer, Assistant Professor of Civil Engineering, Northeastern University, "Demonstration, Horizontal and Vertical Surveying Equipment, Mechanical Triangulation, Vertical Sketchmaster, Sterocomparagraph (Contour Finder) other Photogrammetric Equipment." The talks were illustrated by lantern slides.

Subsequently to the Society meeting, those attending had an opportunity to inspect stereoscope and other instruments designed for studying aerial photographs and for making maps for such photographs.

The meeting adjourned at 9:00 p.m.

George W. Hankinson, *Clerk.*

HYDRAULICS SECTION

February 7, 1945.—A meeting of the Hydraulics Section was held in the Society Rooms, 715 Tremont Temple, following a dinner at the Ambassador Restaurant. During a business meeting conducted by the Chairman, Allen J. Burdoin, the report of the Nominating Committee was read. In the ensuing vote the following were elected to serve as officers for the coming year:

Chairman—Charles C. McDonald
Vice-Chairman—Harold A. Thomas
Clerk—John G. W. Thomas
Executive Committee—
James F. Brittaan
Clarence E. Carter
Leslie J. Hooper

The speaker of the evening was Mr. M. Spillman, consulting engineer, Worthington Pump Machinery Company. The topic was "Centrifugal Pumps—Types and Applications." With the aid of slides, Mr. Spillman described the essential properties of centrifugal pumps and discussed certain features of the characteristics of the various types of equipment. Of particular interest was the speaker's account of the evolution of the axial flow of pump with its special capabilities and merits, including in particular higher specific speed, which he helped to pioneer and bring to the present stage of development. Some time was devoted to cavitation, its effects, and the mathematical formulation involved.

The unusually large attendance and the lively discussion were evidence of the interest in the subject material so ably covered by Mr. Spillman. The meeting was adjourned with a rising vote of thanks to the speaker.

Seventy-five members and guests attended the meeting.

Respectfully submitted,
Harold A. Thomas, *Clerk*

NORTHEASTERN UNIVERSITY SECTION

Field Trip of the Northeastern University Section

January 11, 1945.—Four members and Faculty Advisor C. O. Baird went on an inspection trip to Cushing General Hospital in Framingham, Massachusetts. Under the direction of Captain W. A. Shaw, Post Engineer, the party was escorted through various sections of the hospital such as the power plant, water and sewage pumping stations, Chapel, gymnasium, and hospital facilities. In the hospital itself, the wards, surgery and X-ray departments, kitchen, and receiving station were visited. Of particular interest was the lay-out and construction of the plant itself. Particular emphasis was placed on the precautions required for the care of patients and exceptional features required for their protection.

The trip to and from the hospital was very interesting because it afforded a passing inspection of various types of highway, bridge and acqueduct construction.

GORDON H. SEARLES, *Secretary.*

APPLICATIONS FOR MEMBERSHIP

[APRIL 20, 1945]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of fifteen (15) days from the date given.

For Admission

C. Lawrence Bond, Topsfield, Mass. (b. March 24, 1898, Boston, Mass.) Harvard College, 1916-19, A.B. 1920; Harvard Engineering School 1919-1922, S.B. in Civil Engineering. Experience, 1922-1926, with Warren Bros., Co., on asphalt paving; 1926-1927, associated with Wm. Noyes as surveyors on Cape Cod; since 1928 have been primarily in the property management profession, but have done small engineering practice on my own in Essex and Middlesex Counties. In 1930 worked for Metcalf & Eddy, Engineers, Boston; 1943-1944 worked with Howard M. Turner for varying periods on specific jobs. Refers to *T. R. Camp, F. Dittami, G. C. Houser, H. G. Dresser, H. M. Turner.*

For Admission

Sanford S. Mitchell, Boston, Mass. (b. August 6, 1885, Cherryfield, Maine.) September, 1904-January, 1907, special student in Civil Engineering, University of Maine. Experience, January, 1907-April, 1908, draftsman and computer for H. G. Robinson, Civil Engineer, Patten, Maine; September, 1908-December, 1908, transitman, land surveys, O. H. Tripp, Rockland, Maine; May, 1909-January, 1911, rodman to assistant engineer on Railroad Construction, Bangor & Aroostook Railroad; May, 1911- November, 1911, assistant engineer-office of City Engineer, Bangor, Maine, acting Resident on foundations, reconstruction of Bangor & Brewer Bridge; November, 1911-January, 1912, camp draftsman, railroad location, Eastern Maine Railroad; January, 1912-February, 1913, Resident Engineer, Railroad Construction, Canadian Northern Railroad; September, 1913-November, 1913, land damage surveys, office of P. H. Coombs Company, Bangor, Maine; May, 1914-January, 1916, assistant engineer Forest Engineering Department, Great Northern Paper Company; January, 1916-May, 1916, Field Engineer, Coal Pocket Construction, Darrow Mann Coal Company, Charlestown, Mass.; May, 1916-January, 1917, draftsman, Boston & Maine Railroad; January, 1917-April, 1917, appraiser, National Appraisal Company, Boston; May, 1917-October, 1917, inspector (Paving) Town Engineer Office, Brookline, Mass; October, 1917-April, 1918, job engineer, Aberthaw Company, on Victory Plant, Squantam; April, 1918-April, 1919, assistant engineer in charge of layout R. R. Streets, Water, Sewers and Drains, U. S. Army Base, South Boston, Fay, Spofford & Thorndike; April, 1919-October, 1919, examiner wood ship construction E. F. G., USSB, New England District; October, 1919-August, 1920, job engineer and acting superintendent, Aberthaw Company, building slip construction, Fore River Yard; August, 1920-November, 1920, job engineer reconstruction of Boston Arena, William Bailey; November, 1920-January, 1921, supt. of construction for M. Serretto, Boston, on work at U. S. Naval Hospital Chelsea, Mass.; October, 1926-January, 1927, job engineer, construction storage warehouse, H. K. Noyes & Son, Boston; January, 1927-April, 1930, assistant engineer Street Railway valuation for New York, New Haven and Hartford Railroad; July, 1930-March, 1941, resident engineer, bridge construction Maine State Highway Commission; March 1941-January, 1944, assistant engineer, computing and design of streets curbs, etc, for U. S. Army Bases in Newfoundland, design of runways, etc., for northern airports and field surveys for record plans, airport in Labrador, Shreve, Lamb & Harmon-Fay, Spofford & Thorndike, Boston. February, 1944-March 1945, draftsman, Hull Department, Bethlehem-Hingham Shipyard Inc. At present Field engineer for J. R. Worcester & Company, Boston on East Boston Ordnance Plant. Refers to *R. C. Chase, C. A. Farwell, C. N. Cann, W. L. Hyland, C. M. Spofford.*

John J. Stanton, Framingham, Mass. (b. January 18, 1901, Worcester, Mass.) Graduated from Masachusetts Institute of Technology in 1924, S.B. degree. Professional Engr., Mass. certificate 466. Experience, rodman, Tacna-Arica, boundary commission, work consisted of survey of the boundary line between Chile and Peru, South America, done under the jurisdiction of the U. S. Coast & Geodetic Survey Department, 1926; Sanitary Engineer, 1927-1929, J. A. Cotter Company, Boston; 1929-1935, J. A. Cotter Company, Cambridge, Mass.; Mechanical Designer, Stone & Webster Engineering Corp. 1938-1940; Senior Sanitary Engineer for constructing Quartermaster, War Department, U. S. Army, 1940-1943; Water Supply Engineer, U. S. Army Engineers, Boston, 1943-1944; Boston Loan Agency, Reconstruction Finance Corporation, examiner surplus war property. Refers to *W. L. Hyland K. Jetter, J. D. Mitsch, A. D. Weston.*

Transfer from Grade of Student

Henry J. Bishop, New Bedford, Mass. (b. October 31, 1918, New Bedford, High School in June, 1939; received B.S. degree in Civil Engineering from Northeastern University December, 1944. Co-operative work—1941, rodman and transitman for Whitman and Howard, Engineers, Boston, Mass., making land surveys and topographical drawings for defense housing projects in Maine, and laying out base lines for the Naval Ammunition Depot at Hingham, Mass.; 1941-1944, with the New York, New Haven and Hartford Railroad Company, as rodman, transitman and draftsman also survey party chief on line and grade work and making accident survey. Laid out freight sidings for the Navy at Melville, R. I. June, 1944—December, 1944, with the National Advisory Committee on Aeronautics as structural engineer in conjunction with their building program at Langley Field, Virginia, duties consisted of keeping pile records, progress reports, checking reinforcing steel, sampling and testing concrete, directing the building of plywood forms for walls, columns and footings, and the erection of structural steel columns, beams and trusses. At present employed by the Turner Construction Company of Boston, as a civil engineer, doing field work. Refers to *C. O. Baird, A. E. Everett, E. A. Gramstorff, E. L. Spencer.*

Joseph J. Bulba, Hartford, Conn. (b. April 16, 1924, Hartford, Conn.) Graduated from Northeastern University, December, 1944. Experience, worked all co-operative work periods for the New York, New Haven and Hartford Railroad Company at Hartford, Conn., in the Maintenance of Way Department. Worked from June, 1942 to September, 1943, for a total of nine months, as rodman, transitman, chief of party and general draftsman. During this period was transitman on re-ballasting program and detailed drawing of large office and storehouse building. Refers to *C. O. Baird, A. E. Everett, E. A. Gramstorff, E. L. Spencer.*

Robert N. Kuehn, Manchester, N. H. (b. October 31, 1922, Manchester, New Hampshire.) Graduated from Manchester Central High School in June 1940, and received the B.S. degree in Civil Engineering from Northeastern University, December, 1944. Co-operative work was as follows: August, 1941 to November, 1941 and January 26, 1942, to April, 1942, with the Metropolitan District Water Bureau, Hartford, Conn., as a rodman and computer; June, 1942 to September, 1942 with Ritchie—Ellsworth, Camp Edwards, Massachusetts as a rodman, transitman and inspector on Otis Field; November 1942, to January, 1942, with W. S. Crocker, Boston, as rodman, transitman and computer; April, 1943 to June, 1943, with the Boston and Albany Railroad as rodman; September, 1943 to March 1944, with the Bethlehem-Hingham Shipyard Inc., Hingham, Mass., as transitman in a ship surveying party. At present with Jackson and Moreland, Boston. Refers to *C. O. Baird, A. E. Everett, E. A. Gramstorff, E. L. Spencer.*

George W. Laakso, Jr., Peabody, Mass. (b. September 19, 1924, Peabody, Mass.) Graduated from Peabody High School in June, 1941. Received B.S. degree in Civil Engineering from Northeastern University, December, 1944. Co-operative work experience, September, 1942 to November, 1942, with General Electric Company as rodman; February 1943 to April, 1943, and June, 1943 to September, 1943, with New York, New Haven and Hartford Railroad Company as rodman, transitman and draftsman. At present employed as draftsman by Jackson and Moreland. Refers to *C. O. Baird, A. E. Everett, E. A. Gramstorff, E. L. Spencer.*

Robert J. Markell, Roxbury, Mass. (b. April 12, 1924, Boston, Mass.) Graduated from Northeastern University, December, 1944, B.S. degree in Civil Engineering. Co-operative work—with U. S. Coast and Geodetic Survey September, 1942 to November, 1942, as rodman on a levelling party; November, 1942 to May, 1943, with the New York, New Haven and Hartford Railroad Company, rodman, blueprinter, tapeman, draftsman (official titles—Rail Inspector and Maintenance Helper). At present employed with the Grumman Aircraft Engineering Corporation, Bethpage, Long Island, New York, as an apprentice engineer in training for the stress analysis department. Refers to *C. O. Baird, C. S. Ell, A. E. Everett, E. A. Gramstorff, E. L. Spencer.*

Edward W. Murphy, South Boston, Mass. (b. February 9, 1923, Cambridge, Mass.) Graduated from Northeastern University, December, 1944. Co-operative work—July, 1941 to November, 1941, with Fore River Shipyard, as a chaser, March, 1942, to June, 1942, as a material clerk, from September 1942, to January, 1943, as a checker of sub assembled material in the steel mill and two ten-week periods and one 6-month period in the Test Department as a technical aide in testing shipboard installations, the last period of this work was from November, 1943, to March, 1944. At present test engineer at the Quincy Shipyard. Refers to *C. O. Baird, A. E. Everett, E. A. Gramstorff, E. L. Spencer.*

Samuel J. Pattison, Jr., Newton, Mass. (b. January 9, 1923, Boston, Mass.) Graduated from Northeastern University, December, 1944, B.S. degree in Civil Engineering. Co-operative work, September, 1941 to April, 1943, rodman and transitman on line and grade work on street, sidewalk, drain and sewer construction, for the City of Newton, Mass., Engineering Department; January, 1942 to February, 1942, draftsman and expeditor at the General Electric Company, West Lynn, drawing production curves for the shipping department and expediting small stock for the research engineers. April, 1943 to March, 1944, with the Bethlehem Steel Company, ship surveyor, laying out square lines, center lines, water lines, etc. Also worked on a spare time basis for the Raytheon Mfg. Company, Waltham, Mass., as a mechanical inspector on radar units. Refers to *C. O. Baird, A. E. Everett, E. A. Gramstorff, E. L. Spencer.*

ADDITIONS

Members

Frank A. Cundari, 1730 Columbia Road, South Boston 27, Mass.
Harrison E. Schock, 31 West Cedar Street, Boston 8, Mass.
Albert E. Cummings, 90 West Street, New York 6, N. Y.
Byron O. McCoy, 46 Summit Road, Wellesley, 81, Mass.

Students

Charles Axelrod, 14 School Street, Beverly, Mass.
Bernard A. Barnes, 16 Greenough Street, Brookline, Mass.
Donald B. Carter, Jr., Y.M.C.A., Huntington Avenue, Boston, Mass.
David I. Lowell, 93 Madison Avenue, Newtonville, Mass.
Francis J. Mastropieri, 924 Central Avenue, Needham, Mass.
Alfred J. Pacelli, Jr., 96 Atlantic Street, No. Quincy, Mass.
Carl W. Eschelbach, 864 Watertown Street, West Newton, Mass.

DEATHS

William F. Donovan, February 13, 1945
Henry V. Macksey, February 14, 1945
William F. Covil, March 23, 1945

ANNUAL REPORTS

REPORT OF THE BOARD OF GOVERNMENT FOR THE YEAR 1944-1945

Boston, Mass., March 21, 1945.

To the Boston Society of Civil Engineers:

Pursuant to the requirements of the By-Laws, the Board of Government presents its report for the year ending March 21, 1945.

Membership

Sixteen new members, and 21 students have been added during the year, and 6 members, 1 junior and 3 students have been reinstated, making a total addition of 47 members.

During the year 20 members have died, 7 have resigned, and 19 students not now in college have been dropped, making a total deduction of 46.

The present net membership of the Society consists of 6 honorary members, 616 members, 56 Juniors, 13 students, 4 associates, making a total membership of 695, a net gain for the year of 1.

The honorary membership list is as follows:

Dr. Karl T. Compton, elected, February 17, 1932
Prof. C. Frank Allen, elected, March 16, 1932
Charles M. Allen, elected, January 14, 1942
Arthur W. Dean, elected, January 14, 1942
Charles F. Gow, elected, January 14, 1942
Arthur T. Safford, elected, January 26, 1943

Deaths

Members:

Arthur J. Maynard, January 3, 1944
Franklin H. Robbins, March 12, 1944
Mayo T. Cook, April 11, 1944
Albert E. Kimberly, April 21, 1944
Theodore B. Parker, April 27, 1944
Charles G. Craib, April 29, 1944
C. Leonard Brown, April 30, 1944
Herbert C. Keith, May 2, 1944
Robert J. Greer, May 12, 1944
James R. Gibson, May 13, 1944
Nathan C. Burrill, May 26, 1944
Frederic N. Fay, June 5, 1944
Ernest F. Gallagher, June 22, 1944
Samuel M. Ellsworth, August 13, 1944
Alexander L. Kidd, August 21, 1944
James L. Crandall, September 18, 1944
Herbert B. Allen, November 30, 1944
Herbert L. Ripley, December 1, 1944
William F. Donovan, February 13, 1945
Henry V. Macksey, February 14, 1945

Remission of Dues

During this year the Board of Government granted a number of members an extension of time for payment of dues. Dues for the year ending March 21, 1945, have been remitted for those members in the Armed Services, numbering seventy, and for one member who is a prisoner in the Philippines, and for one other member.

Exemption of Dues

Eighty-three members are now exempt from dues in accordance with By-Laws 8, which provides that "a member of any grade who has paid dues for forty years, or who has reached the age of seventy years and has paid dues for thirty years, shall be exempt from further dues."

Meetings of the Society

Eight regular meetings and an excursion since the Annual, have been held during the year.

The September meeting was the Annual Student Night attended by Student Chapters, American Society of Civil Engineers, at Massachusetts Institute of Technology, Tufts, University of Maine, Worcester Polytechnic, Yale University, Rhode Island State College and the Northeastern Section of the Boston Society of Civil Engineers.

The total attendance at all meetings was 1039 persons; the largest attendance was 295 and the smallest 38. Suppers have been a feature at all the meetings and they were well attended, a total of 993 at all dinners.

The papers and addresses given were as follows:

March 22, 1944. Annual Meeting. Address of retiring President, Howard M. Turner, "Domestic Electric Rates," followed by dinner.

April 20, 1944. Joint Meeting. American Society of Civil Engineers, Northeastern Section and Boston Society of Civil Engineers, "Municipal and Metropolitan Improvements," by Robert Moses, Commissioner of Parks, New York City, N. Y. Illustrated.

May 17, 1944. Symposium. "Public Works Construction in the Bridge from War to Peace," by Hall Nichols, Secretary and Chief Engineer, Massachusetts Emergency Public Works Commission; "The Post-War Highway Construction," by Hon. Edward W. Staves, State Representative and Vice-Chairman of the Massachusetts Post-War Highway Commission, and Phillip H. Kitfield, Assistant Project Engineer, Massachusetts Department of Public Works; "Aims and Activities of the Metropolitan Transit Commission," by Commissioner Carroll L. Meins, Chairman of the Massachusetts Department of Public Utilities.

June 10, 1944. Inspection trip to General Edward Lawrence Logan Airport, at East Boston. One hundred forty-five members and guests attended this trip.

September 27, 1944. Student Night. Joint Meeting, Boston Society of Civil Engineers, and American Society of Civil Engineers, Northeastern Section and Highway Section BSCE. "Land and Air Transport After the War," by Prof. Charles B. Breed, Professor of Civil Engineering, Massachusetts Institute of Technology. Illustrated.

October 16, 1944. "The Construction of the Walsh-Kaiser Shipyard At Providence and the Building of Ships," by Mr. J. S. MacDonald, General Manager of the Walsh-Kaiser Shipyard, Providence, R. I.

November 15, 1944. Joint Meeting. Boston Society of Civil Engineers and Designers Section BSCE. "Recent Timber Floating Dry Docks," by J. Stuart Crandall. Illustrated.

December 20, 1944. Joint Meeting. Boston Society of Civil Engineers and Highway Section BSCE. "Highway Construction in Persia," by Capt. J. D. Boylan, U. S. War Department, Corps of Engineers. Illustrated.

January 24, 1945. "Construction with the Seabees in Iceland," by Commander J. E. Larsen, U.S.N.R. Illustrated.

February 28, 1945. Joint Meeting. Boston Society of Civil Engineers and Highway Section BSCE. Symposium—"Photogrammetry." "Basic Principles of Photogrammetry," by Prof. Charles O. Baird, Associate Professor of Civil Engineering, Northeastern University; "Equipment Used for Making Maps from Service Photographs" by Prof. Ernest L. Spencer, Assistant Professor of Civil Engineeing, Northeastern University. Illustrated.

Sections

Thirty-four meetings were held by the Sections of the Society during the year. These meetings of the Sections offering opportunity for less formal discussion, have continued to demonstrate their value to their members and to the Society. The variety of subjects presented has made an appeal to the members, as indicated by the general attendance at these meetings.

Sanitary Section Meetings. The Sanitary Section held 5 meetings during the year, with an average attendance of 30. The papers and meetings are listed in the report of the Executive Committee.

Designers Section Meetings. The Designers Section held 8 meetings during the year, with an average attendance of 46. The papers and meetings during the year are listed in the report of the Executive Committee.

Highway Section Meetings. The Highway Section held 4 meetings during the year, with an average attendance of 80. The papers and meetings are listed in the reports of the Executive Committee.

Hydraulics Section Meetings. The Hydraulics Section held 3 meetings during the year, with an average attendance of 49. The papers and meetings are listed in the report of the Executive Committee.

Northeastern University Section Meetings. The Northeastern University Section held 14 meetings and 2 excursions during the year, with an average attendance of 27. The meetings held are listed in the report of the Executive Committee.

Journal

The complete report of the Editor of the JOURNAL for the calendar year 1944 will be printed in the April, 1945, JOURNAL.

*Funds of the Society**

Permanent Fund. The Permanent Fund of the Society has a present value of about $63,600. The Board of Government authorized the use of as much as necessary of the current income of this fund in payment of current expenses.

John R. Freeman Fund. In 1925 the late John R. Freeman, a Past President and Honorary member of the Society, made a gift to the Society of securities which was established as the John R. Freeman Fund, the income from which was about $1030. The income from this fund is to be particularly devoted to the encouragement of young engineers. Mr. Freeman suggested several uses, such as the payment of expenses for experiments and compilations to be reported before the Society; for underwriting meritorious books or publications pertaining to

*Details regarding the values and income of these funds are given in the Treasurer's report.

hydraulic science or art; or a portion to be devoted to a yearly prize for the most useful paper relating to hydraulics contributed to this Society; or establishing a traveling scholarship every third year open to members of the Society for visiting engineering works, reports of which would be presented to the Society. No additional scholarship was authorized during the year.

Edmund K. Turner Fund. In 1916 the Society received, 1,105 books from the library of the late Edmund K. Turner, and a bequest of $1000, "the income of which is to be used for library purposes." The Board voted to use $35 of the income for the purchase of books for the library.

Alexis H. French Fund. The Alexis H. French Fund, a bequest amounting to $1000, was received in 1931, from the late Alexis H. French of Brookline, a former Past President of the Society. The income of this fund is "to be devoted to the Library of the Society." The Board voted to use $35 of the available income for the purchase of books for the library.

Tinkham Memorial Fund. The "Samuel E. Tinkham Fund," established in 1921, at the Massachusetts Institute of Technology by the Society "to assist some worthy student of high standing to continue his studies in Civil Engineering," had a value of $2437.11 on June 30, 1944. Henry Martyn Paynter, Jr. of Kensington, Maryland, a senior student in Civil Engineering has been awarded this scholarship for the year 1944-1945.

Desmond FitzGerald Fund. The Desmond FitzGerald Fund, established as a bequest from the late Desmond FitzGerald, a Past President and Honorary member of the Society, provided that the income from this fund shall "be used for charitable and educational purposes." No expenditures from this fund were made during the year.

Clemens Herschel Fund. This fund was established in 1931, by a bequest from the late Clemens Herschel, a former Past President and Honorary member of the Society. The income from this fund is to be used for the presentation of prizes for particularly useful and commendable papers presented at a meeting of the Society. The present value of this fund is about $1250. The expenditure made during the year from this fund was for prizes.

Edward A. Howe Fund. This fund, a bequest of $1000, was received December 2, 1933, from the late Edward A. Howe, a former Past President of the Society. No restrictions were placed upon the use of this money, but the recommendation of the Board of Government is that the fund be kept intact, and that the income be used for the benefit of the Society or its members. No expenditure from this fund was made during the year.

Prize Awards

Desmond FitzGerald Medal. The Desmond FitzGerald Medal (bronze) was provided for in 1910 as an endowed prize by the late Desmond FitzGerald, a former Past President and Honorary member of the Society. The prize is awarded annually to a member who presents an original paper to the Society which is published in the JOURNAL for the current year. This year the Board voted to award a suitable certificate until the medals were again available.

In accordance with the recommendation of the Committee on Awards, the Board of Government voted to award a Desmond FitzGerald Award* to Scott Keith, member, for his paper on "Hydraulics of the Park River Conduit, Hartford, Conn." presented at a meeting of the Hydraulics Section held on May 2, 1944, and published in the July, 1944, issue of the JOURNAL.

*The award consists of a certificate suitably inscribed in leather case, in place of a medal, which is unobtainable for the duration.

Section Prizes

The Board of Government voted on April 12, 1924, to present a prize for a worthy paper given in each section by a member of that section. "This award to consist of books suitably inscribed."

Hydraulics Section Prize. The Board adopted the recommendation of the Hydraulics Section Prize Award Committee and voted that the Hydraulics Section Prize be awarded to Edwin B. Cobb, member, for his paper on "Flow of Water in Network Piping System," presented at a meeting of the Hydraulics Section held on February 2, 1944, and published in the October, 1944, issue of the JOURNAL.

Clemens Herschel Award

The late Clemens Herschel, a former past President and Honorary Member made a bequest to the Society which would provide for the presentation of prizes for papers presented at meetings of the Society which have been particularly useful and worthy of grateful acknowledgment. On recommendation of the Committee on Awards, the Board voted to award a Clemens Herschel prize to Howard M. Turner, member, for his paper on "Domestic Rates and Consumption," presented at a meeting of the Society held on March 22, 1944, and published in the April, 1944, issue of the Journal; and to Mr. A. C. E. Seicke, for his paper on "Engineering Highlights of the *Normandie* Salvage," presented at a meeting of the Society held on October, 27, 1943, and published in the January, 1944, issue of the JOURNAL. The prize consisted of the following books:

Mr. Turner: "Engineering for Dams," by William P. Creager, Joel D. Justin, Julian Hinds. Vol. 1, 2, 3.

Mr. Siecke: "Mechanical Engineers' Handbook" by Lionel S. Marks
"Civil Engineering Handbook." L. C. Urquhart
"Structural Engineers' Handbook" by Milo S. Ketchim

Meetings

Four of the regular meetings were held at the Twentieth Century Association, one at the Boston City Club and three were held at Northeastern University. An Inspection Trip to General Edward Lawrence Logan Airport, at East Boston was made on June 10, 1944.

Library

The report of the Committee on Library contains a complete account of the library activities during the past year.

Society Activities

The usual special committees dealing with the activities and conduct of the Society have included the following: Program, Publication, Library, Hospitality, Relations of Sections to Main Society, Welfare, Investment, Subsoils of Boston, John R. Freeman Fund, Committee on Ethics and the committees on the various Society Awards.

The Society participated in the exhibit known as "Greater Boston Looks Ahead," held at the Boston Museum of Fine Arts during January and February, 1945, and authorized a contribution of $100 toward the cost of the exhibit.

The Society has cooperated with the Engineering Societies of New England, and members of the Society have served on Engineering Societies Council and Committees.

Your Board, in conclusion, wishes to express its appreciation of the excellent work done by the officers of the Sections and by the Committees of the Society.

HARRY P. BURDEN, *President*

REPORT OF THE TREASURER

Boston, Mass., March 8, 1945.

To the Boston Society of Civil Engineers:

The financial standing of the Society on March 8, 1945, at the end of the accounting period, is shown in the following:

Table 1.—Distribution of Funds—Receipts and Expenditures.

Table 2.—Record of Investments.

The receipts from dues during this year amounted to $4,317.00 compared with $4,676.00 paid in as dues during the previous year. These receipts were $486.00 less than the average amount received from this source during the past five years. However, this deficit is almost entirely due to the fact that dues, of members in the Armed Forces, to the extent of $444.00 were remitted during the year. The payment of dues by the active members has been very satisfactory.

The income to the Current Fund has again been insufficient to meet current expenses and a transfer of $1,403.76 from the income of the Permanent Fund to the Current Fund has been necessary to meet this deficit. This transfer amounts to 60% of the income to the Permanent Fund compared to a similar transfer amounting to 62% for the previous year.

The expenses of the Society have conformed very closely to the budget throughout the year and very close to the expenses during the preceding year. The general rise of prices has increased the cost of running the Society and this situation together with the loss of dues remitted to members in the Armed Forces has been met by the transfer of money to the Current Fund rather than the curtailment of activities of the Society.

Following the ruling which was made by the Department of Internal Revenue on February 23, 1944, that the Society is not subject to the requirements of Section 101 (6) of the Internal Revenue Code, we received a tax refund amounting to $263.96 which represented our payment during the previous year of Social Security taxes, interest and fines. Legal fees in connection with obtaining this ruling and refund, amounted to $170.27.

The amounts transferred from the Permanent Fund to the Current Fund during the last five years are shown in the following:

	1940-41	1941-42	1942-43	1943-44	1944-45
Receipts to Current Fund					
Dues	$4961	$4876	$4653	$4676	$4317
Other than dues	3632	2860	2180	3161	3518
Total Receipts to Current Fund	$8593	$7736	$6833	$7837	$7835
Current Fund Expenditure	8977	9738	8243	9246	9239
Deficit: Transferred from Permanent Fund	$384	$1002	$1410	$1409	$1404

The records of the Current Income and Current expenditures are kept separate from those applicable to other accounts. The total of income and profits from all sources during the past year amounted to $13,065.68 against total expenditures and losses of $10,758.53, making a net increase in assets of $2,307.15.

TABLE 1—DISTRIBUTION OF FUNDS—RECEIPTS AND EXPENDITURES

	Book Value March 6, 1944	Interest and Dividends Cash	Interest and Dividends Credit	Net Profit or Loss at Sale or Maturity +	Net Profit or Loss at Sale or Maturity −	Transfer of Funds Purchased +	Transfer of Funds Sold −	Book Value March 8, 1945
Bonds	$38,763.93	$1,084.00	$ 60.00	$105.92	$13.75	$1,000.00	$4,007.83	$35,816.10
Cooperative Banks	10,942.02	85.00	203.17			390.00		11,535.19
Stocks	45,186.63	2,078.02				5,521.81		50,708.44
Cash available for Investment	1,481.57						860.00	621.57
Total (except Current Fund)	$96,374.15	$3,247.02	$263.17	$105.92	$13.75	$6,911.81	$4,867.83	$98,681.30

	Book Value March 6, 1944	Allocation of the above Income & Profit 3.75%	Allocation of the above Loss	Misc. Receipts	Misc. Expenditures	Book Value March 8 1945
Permanent Fund	$62,546.26	$2,346.83	$ 8.91	$210.00	$1,403.76	$63,690.42
John R. Freeman Fund	27,470.59	1,030.74	3.92			28,497.41
Edmund K. Turner Fund	971.89	36.47	.14		35.00	973.22
Desmond FitzGerald Fund	1,874.81	70.35	.27		1.50	1,943.39
Alexis H. French Fund	1,031.46	38.70	.15		35.00	1,035.01
Clemens Herschel Fund	1,235.77	46.37	.18		29.95	1,252.01
Edward A. Howe Fund	1,243.37	46.65	.18			1,289.84
	$96,374.15	$3,616.11	$13.75	$210.00	$1,505.21*	$98,681.30
Current Fund	1,500.00			9,239.57	9,239.57	1,500.00
Totals	$97,874.15	$3,616.11	$13.75	$9,449.57	$10,744.78	$100,181.30

Secretary's change fund of $30.00 should be added to show total assets.
*Includes transfer of $1,403.76 from income of the Permanent Fund to the Current Fund.

TABLE 2—RECORD OF INVESTMENTS

	Date of Maturity or Classification	Fixed or Current Interest Rate	During the Year March 6, 1944 to March 8, 1945				March 8, 1945		
			Interest Received	Additional Amount Invested	*Sold or Matured* Amount Received	*Sold or Matured* Profit + (or loss —)	Par Value	Book Value	Market Value
BONDS									
American Tel. & Tel. Co.	Sept. 1, 1956	3 %	$ 9.00*	....	....	....	$ 600.00	$ 603.00	$ 729.75
Baltimore & Ohio R.R.	Aug. 1, 1944	4 %	40.00	....	2,000.00	13.75—	....	....	....
Canadian Pacific R.R.	July 2, 1949	4 %	152.50	....	....	....	5,000.00	5,342.50	4,812.50
Eastern Mass. Street Ry. Co.	Jan. 1, 1948	4½%	22.50	....	1,052.50	30.00+	....	....	....
Penn. Central Light & Power Co.	Nov. 1, 1977	4½%	45.00	....	....	....	1,000.00	1,052.89	1,080.00
The Pennsylvania R.R. Co.	June 1, 1965	4½%	45.00	....	....	....	1,000.00	1,017.74	1,230.00
The Pennsylvania R.R. Co.	Apr. 1, 1970	4½%	45.00	....	1,047.50	75.92+	....	....	....
Puget Sound Power & Light Co.	Dec. 1, 1972	4¼%	42.50	....	....	....	1,000.00	1,058.44	1,090.00
Standard Oil Co. of N. J.	July 1, 1953	2¾%	27.50	....	....	....	1,000.00	1,021.25	1,048.75
Texas Electric Service Co.	July 1, 1960	5 %	100.00	....	....	....	2,000.00	2,000.00	2,070.00
The Toledo Edison Co.	July 1, 1968	3½%	70.00	....	....	....	2,000.00	2,092.50	2,130.00
Union Pacific R.R. Co.	June 1, 1980	3½%	70.00	....	....	....	2,000.00	2,125.00	2,150.00
Western Maryland R.R. Co.	Oct. 1, 1952	4 %	40.00	....	....	....	1,000.00	982.78	1,063.75
United States Savings Bonds, Series D	Jan. 1, 1950	....	60.00	....	....	....	3,000.00	2,520.00	2,520.00
United States Savings Bonds, Series G	June 1, 1953	2½%	200.00	....	....	....	8,000.00	8,000.00	8,000.00
United States Bonds, Series G	July 1, 1954	2½%	175.00	....	....	....	7,000.00	7,000.00	7,000.00
United States Savings Bonds, Series G	Nov. 1, 1956	2½%	....	1,000.00	....	....	1,000.00	1,000.00	1,000.00
TOTALS			$1,144.00	$1,000.00	$4,100.00	92.17+	$35,600.00	$35,816.10	$35,924.75

*Coupon due March 1, 1945 was collected after the close of this accounting period.

TABLE 2—RECORD OF INVESTMENTS—*Continued*

	Date of Maturity or Classification	Fixed or Current Dividend Rate	During the Year March 6, 1944 to March 8, 1945: Dividends Received	Additional Amount Invested	*Sold or Matured*: Amount Received	Profit + (or loss −)	March 8, 1945: Number of Shares	Book Value	Market Value
CO-OPERATIVE BANKS									
Codman Co-operative Bank	Matured Shares	3 %	$ 60.00	....	....	....	10	$2,000.00	$2,000.00
Suffolk Co-operative Federal Savings & Loan Assoc.	Matured Shares	2½%	25.00	....	....	....	5	1,000.00	1,000.00
Suffolk Co-operative Federal Savings & Loan Assoc.	Series 134	....	203.17	$ 390.00	....	....	30	8,535.19	8,535.19
TOTALS			$ 288.17	$ 390.00				$11,535.19	$11,535.19

TABLE 2—RECORD OF INVESTMENTS—*Continued*

	Date of Maturity or Classification	Fixed or Current Dividend Rate	During the Year March 6, 1944 to March 8, 1945: Dividends Received	Additional Amount Invested	*Sold or Matured* Amount Received	Profit + (or loss −)	March 8, 1945: Number of Shares	Book Value	Market Value
STOCKS									
American Tel. & Tel. Co.	Common	$ 9.00	$414.00	....	....	....	46	$5,346.04	$7,526.75
Bankers Trust Co., N. Y.	Common	1.40	42.00	....	....	....	36	1,590.00	1,723.50
Central Hanover Bank & Trust Co. of N. Y.	Common	4.00	120.00	....	....	....	30	3,210.00	3,345.00
Commonwealth & Southern Corp.	Cum. Pfd.	5.00	40.00	....	....	....	8	....	779.00
Commonwealth & Southern Corp.	Common	....	....	....	....	....	25	1,019.89	21.88
Commonwealth & Southern Corp.	Opt. Warrants	....	....	....	....	....	12	....	....
Consolidated Natural Gas Company	Capital	2.00	4.00	....	....	....	2	49.87	72.00
Consolidated Edison (Gas) Co. of N. Y.	Common	1.60	32.00	....	....	....	20	1,906.50	535.00
Continental Insurance Co.	Capital	2.00	50.00	....	....	....	25	1,206.44	1,318.75
Erie Railway 5%	Pref.	....	....	1,133.05	....	....	15	1,133.05	1,113.75
General Electric Co. of N. Y.	Common	1.40	70.00	....	....	....	50	2,341.47	2,112.50
Great Northern Railway	Pref.	....	....	778.67	....	....	15	778.67	761.25
Hartford Fire Insurance Co.	Common	2.50	25.00	....	....	....	10	761.25	1,100.00
Minnesota Power & Light Co., Min.,	Pref.	7.00	70.00	....	....	....	10	980.00	1,105.00
National Dairy Products Corp.	Common	1.10	55.00	....	....	....	50	1,154.74	1,425.00
National Fire Insurance Co. of Hartford	Common	2.00	40.00	....	....	....	20	1,240.00	1,235.00
New England Power Assoc.	Pref.	4.00	80.00	....	....	....	20	1,815.00	1,397.50
North American Trust Shares	July 15, 1955	12.8c	192.00	....	....	....	1500	5,342.00	4,500.00

Table 2—Record of Investments—*Continued*

	Date of Maturity or Classification	Fixed or Current Dividend Rate	During the Year March 6, 1944 to March 8, 1945: Dividends Received	Additional Amount Invested	Sold or Matured: Amount Received	Profit + (or loss —)	March 8, 1945: Number of Shares	Book Value	Market Value.
Stocks									
Pacific Gas & Elec. Co.	Cum. 1st Pfd.	$1.50	$ 90.00	....	....	....	60	$1,922.02	$2,400.00
Pacific Gas & Elec. Co.	Cum. 1st Pfd.	1.37	27.52	....	....	....	20		722.50
Pacific Gas & Elec. Co.	Common	2.00	128.00	....	....	....	64	1,808.79	2,368.00
Southern California Edison Co. Ltd.	Cum. Orig. Pfd.	1.50	60.00	....	....	....	40	1,161.22	1,180.00
Southern California Edison	Common	1.50	30.00	....	....	....	20	539.75	590.00
Southern Railway	Pref.	....	....	1,136.80	....	....	15	1,136.80	1,138.12
Standard Oil Co. of N. J.	Capital	2.50	50.00	....	....	....	20	1,011.10	1,225.00
Tampa Electric Co.	Common	1.60	48.00	....	....	....	30	1,151.25	866.25
Timken Roller Bearing Co.	Common	2.00	37.50*	....	....	....	15	1,018.97	810.00
Trimount Dredging Co.	Pref.	....	....	....	....	....	2	....	....
Union Carbide & Carbon	Capital	3.00	90.00	....	....	....	30	2,407.79	2,651.25
Union Pacific Railroad	Common	3.00	33.00	2,473.29	....	....	22	2,473.29	2,677.50
U. S. Smelting Refining & Mining Co.	Pref.	3.50	70.00	....	....	....	20	1,365.04	1,230.00
United States Trust Co. of Boston	Conv. Pref.	.80	180.00	....	....	....	225	4,837.50	4,162.50
Totals			$2,078.02	$5,521.81				$50,708.44	$52,093.00

*Five quarterly dividend payments are included in this accounting period.

The holdings of the Society in Cooperative Bank Shares were continued throughout the year. The running shares were maintained and payments were made monthly, thereby increasing the value of all of our holdings from $10,942.02 on March 6, 1944, to $11,535.19 on March 8, 1945.

There was considerable refunding of bond issues by railroad companies during the year and the following bonds held by the Society were called:

2,000—Baltimore and Ohio Railroad 4%—August 1944
1,000—Eastern Mass. Street Railway 4½%—1948
1,000—Pennsylvania Railroad 4½%—1970

The proceeds of these bonds, together with other money available for investment during the year, have been reinvested partly in United States Savings Bonds, Series G, and partly in railroad stock as follows:

1,000—United States Savings Bonds Series G, November 1956
15—Great Northern Railway Preferred
15—Erie Railroad, Series A, 5% Preferred
15—Southern Railway Preferred
22—Union Pacific Railroad Common

The Society received a stock dividend of 6 shares of Bankers Trust Company of New York which has been added to the port-folio without making any increase in the book value.

The Boston Safe Deposit and Trust Company has continued to act as Investment Counsel for the Society throughout the year and they were consulted in connection with all purchases and sales of securities.

The total book value of all securities, plus cash on hand now stands at $100,181.30, an increase of $2,307.15, in assets during the year.

The following table shows the comparative book values of the two principal funds at the close of last five years and the ratio of market value to book value.

	Mar. 10, 1941	Mar. 6, 1942	Mar. 6, 1943	Mar. 6, 1944	Mar. 6, 1945
Permanent Fund	$60,527	$61,080	$62,283	$62,546	$63,690
John R. Freeman Fund	27,666	26,528	26,862	27,470	28,497
Market Value in per cent of Book Value	87.92%	83.44%	88.57%	96.47%	101.7%

The growth of the Permanent Fund is affected not only by the percentage of return on investments but also by the amount it has been necessary to transfer from the income of this fund, in order to meet current expenses. The value of the Freeman Fund depends largely upon the expenditures made from the fund during the year and as no expenditures were made during the past year the only charge to the fund has been the allocation of the book loss incurred through the sale of depreciated securities, amounting to $3.92, as shown in Table 1.

The following table will show for the past five years the book value of securities and bank deposits and the total value of all holdings, not including the value of the library and physical property.

The Treasurer's cash balance $2,121.57 included $35.00, withheld taxes of the office secretary for the months of January and February, 1945, which is pay-

	Mar. 10, 1941	Mar. 6, 1942	Mar. 6, 1943	Mar. 6, 1944	Mar. 6, 1945
Bonds	$30,782.49	$31,610.49	$38,670.49	$38,763.93	$35,816.10
Cooperative Banks	17,971.92	19,490.68	12,392.68	10,942.02	11,535.19
Stocks	44,957.17	43,967.17	43,967.17	45,186.63	50,708.44
Cash	2,428.01	365.94	2,031.39	2,981.57	2,121.57
	$96,139.59	$95,434.28	$97,061.73	$97,874.15	$100,181.30

able to the Collector of Internal Revenue in April, 1945. The Secretary's "change fund," $30, however is not included in the cash balance shown above.

Respectfully submitted,

CHESTER J. GINDER, *Treasurer*

REPORT OF THE SECRETARY

Boston, Mass., March 8, 1945

To the Boston Society of Civil Engineers:

The following is a statement of cash received by the Secretary and of the expenditures approved by the President, in accordance with the Budget adopted by the Board of Government.

FOR THE YEAR ENDING MARCH 21, 1945
CURRENT FUND ACCOUNT

	Account Number	Expenditures	Receipts
Office			
Secretary, salary and expense	(1)	$240.00	
Stationery, printing and postage	(2)	255.95	
Incidentals and Petty Cash	(3)	105.00	
Insurance and Treasurer's Bond	(4)	65.25	
Safety Deposit Box	(5)	12.00	
Quarters, rent, light, telephone	(7)	1,760.54	$600.00
Office—clerical	(8)	1,542.20	
Auditors for 1944 accounts and Investment Service	(9)	250.00	
Reserve for Taxes and Legal Services	(10)	170.27	263.96*
Meetings			
Rent of Halls	(11)	200.00	
Stationery, printing	(12)	17.23	
Social Activities	(13)	1,054.23	944.52
Steropticon and reporting	(14, 15)	11.00	
Annual Meeting (March 1944)	(16)	114.90	
Sections			
Sanitary Section	(21)	12.00	
Designers Section	(22)	16.00	
Highway Section	(23)	8.00	
Northeastern Univ. Section	(24)	12.00	
Hydraulics Section	(25)	12.00	

	Account Number	Expenditures	Receipts
Journal			
Editor's salary and expense	(31)	308.00	
Printing and postage	(32)	1,980.88	
Reprints	(33)	76.40	
Advertising	(34)		876.00
Sale of Journals & reprints	(35, 36)		685.56
Library			
Books and expense	(41)	69.75	
Periodicals	(43)	90.91	
Binding	(44)	38.00	
Miscellaneous			
Fines on overdue books	(45)		1.78
Furniture repairs	(54)	126.00	126.00
Exhibit, "Greater Boston Looks Ahead"	(54)	100.00	
Badges for members	(51)	5.22	5.22
Binding Journals for members	(52)	21.00	15.77
Dues to E.S.N.E.	(59)	564.84	
Dues from B.S.C.E. members	(70)		4,317.00
Transfer part of income from Permanent Fund to Current Fund			1,403.76
		$9,239.57	$9,239.57
Entrance Fees to Permanent Fund		$210.00	

16 new members; 21 students; 3 juniors transferred to members; 12 students transferred to juniors; 1 student transferred to member.

The above receipts have been paid to the Treasurer, whose receipt the Secretary holds. The Secretary holds cash amounting to $30 included as payment under Item 3 (Petty Cash) to be used as a fixed fund or cash on hand for making change at buffet suppers.

Respectfully submitted,

EVERETT N. HUTCHINS, *Secretary*

REPORT OF THE AUDITING COMMITTEE

Boston, Mass., March 21, 1945.

To the Boston Society of Civil Engineers:

We have reviewed the records and accounts of the Secretary and Treasurer of the Boston Society of Civil Engineers and the report of William H. Hyde, Certified Public Accountant, who has examined said records and accounts and we have examined the securities enumerated by the Treasurer.

We have accepted and present herewith with our approval the signed report of the Accountant.

EMIL A. GRAMSTORFF
ALBERT E. KLEINERT
Auditing Committee of the Directors of the Boston Society of Civil Engineers

Boston, Mass., March 19, 1945

PROF. EMIL A. GRAMSTORFF
Chairman of the Auditing Committee
Boston Society of Civil Engineers:

DEAR SIR:

In accordance with instructions, I have completed the annual audit of the financial records of the Society for the fiscal year ending March 8, 1945, and report as follows.

Securities held by the Society as of March 8, 1945 were examined and found in order. All coupons for interest due were collected. Dividends earned were correctly accounted for.

All changes in securities owned were found recorded in the accounts. All receipts of income, as recorded in the Secretary's records, including entrance fees, and interest and dividends were found correctly recorded in the Treasurer's accounts and to have been deposited in the bank.

Cooperative Bank earnings were verified and found correct.

All disbursements were in settlement of vouchers duly approved by the President and Secretary and were substantiated by examination of checks paid by the bank.

There is a liability for withheld taxes for January and February amounting to $35.00, which will be turned over to the Collector of Internal Revenue, in April. The Secretary's "Change Fund" $30.00, in accordance with past custom, is not included in the summary of assets reported by the Treasurer. The net result is a liability of $5.00.

A verified copy of your Treasurer's Report is attached hereto and summaries of his ledger accounts are shown in detail.

My audit found the records of the Treasurer for the fiscal year ended March 8, 1945, correct and in excellent condition.

Respectfully submitted,
WILLIAM J. HYDE, *Certified Public Accountant*

REPORT OF THE EDITOR

Boston, Mass., January 18, 1945

To the Board of Government
Boston Society of Civil Engineers.

The JOURNAL for the calendar year 1944 (Volume XXXI) was issued quarterly, in the months of January, April, July and October, as authorized by the Board of Government on December 20, 1935.

During the year 1944 there have been published eight papers presented at meetings of the Society and Sections, and six other technical articles. The table of Contents and Index for the year are included in the October, 1944, issue.

The four issues of the JOURNAL contained 270 pages of papers and discussions, 6 pages of Index, and 26 pages of advertising, a total of 312 pages. An average of 1031 copies per issue were printed. The net cost was $528.87 as compared with $871.30 for the preceding year.

The cost of printing the JOURNAL was as follows:

Expenditures

Composition and printing	$1,307.61	
Cuts	518.85	
Wrapping, mailing & postage	73.73	
Editing	300.00	
Copyright	8.00	
		$2,208.19

Receipts

Receipts from sale of JOURNALS and Reprints	$ 621.32	
Receipts from Advertising	1,058.00	
		1,679.32
Net cost of JOURNAL to be paid from Current Fund		$ 528.87

Respectfully submitted,

EVERETT N. HUTCHINS, *Editor*

REPORT OF THE COMMITTEE ON WELFARE

Boston, Mass., March 21, 1945

To the Boston Society of Civil Engineers:

During the past year the activity of the Welfare Committee has been limited to stand-by service. The engineering employment situation has been a healthy one and in consequence no matters relating to welfare assistance for our members have come to the Committee's attention.

The Chairman has kept in touch with the employment situation by serving as a member of the Advisory Committee to the Boston office of Engineering Societies Personnel Service, Inc.

Respectfully submitted,

R. W. HORNE, *Chairman*

REPORT OF THE HOSPITALITY COMMITTEE

Boston, March 21, 1945

To the Boston Society of Civil Engineers:

The Hospitality Committee submits the following report for the year 1944-45.

Eight regular meetings in addition to the Annual Meeting were held during the year. Two of the meetings were held at the Boston City Club, four at the 20th Century Association and three at Northeastern University. The total number of members and guests served with suppers at these meetings was 993 an average attendance of 118 per meeting. The total attendance at Society meetings was 1039.

Two hundred and thirty-two members and guests were present at the Annual Dinner at the Boston City Club. One hundred and sixty persons were served at the Student Night meeting in September at Northeastern University. This was 109 less than for the 1943 Student Night meeting.

The summary of attendance at the various meetings follows:

Date	Speaker	Place	Attendance at Dinner	Attendance at Meetings
3-22-44	Howard M. Turner	Boston City Club	232	232
4-20-44	Robert Moses	Boston City Club	295	295
5-17-44	Hall Nichols Edward W. Staves Philip H. Kitfield Carroll L. Meins	20th Century Assoc.	58	66
9-27-44	Prof. C. B. Breed	N. E. University	160	160
10-18-44	Mr. J. S. MacDonald	N. E. University	50	50
11-15 44	J. Stuart Crandall	20th Century Assoc.	50	50
12-20-44	Capt. J. D. Boylan	20th Century Assoc.	34	38
1-24-45	Comdr. J. E. Larsen	20th Century Assoc.	54	88
2-28-45	Prof. C. O. Baird Prof. E. L. Spencer	N. E. University	60	60
			993	1039

Respectfully submitted,

JOHN H. HARDING, *Chairman*

REPORT OF THE LIBRARY COMMITTEE

Boston, Mass., March 21, 1945.

To the Boston Society of Civil Engineers:

The Library Committee functioned under a handicap this year, as we were without the services of a librarian during the entire year. The clerical duties formerly taken care of by the librarian have been turned over to Mrs. Boudia, and the $50 salary formerly paid the librarian has been used for the purchase of new books and for the binding of technical journals.

During the year the estate of the late Frederic H. Fay, gave the library a valuable set of "City of Boston Contracts and Specifications," bound in leather, covering various work performed about the turn of the century.

The following books were purchased during the year:

Handbook of Hydraulics, 3rd Edn., by Horace W. King.
Estimating Building Costs, 3rd Edn., by Charles F. Dingman.
Handbook of Brick Masonry Construction, 1st Edn., by John A. Mulligan.
Pile Driving Handbook, by Robert D. Chellis.
Basic Structures, by F. R. Shanley.
Kent's Mechanical Engineers Handbook, 11th Edn., Design. Ship Practics, by Robert T. Kent.
Kent's Mechanical Engineers Handbook, 11th Edn., Power, by Robert T. Kent.
Applied Hydro-and Aeromechanics, 1st, Edn., by L. Prandtl.
Hydraulics. A text on Practical Fluid Mechanics., 4th Edn., by R. L. Daugherty.
Stream Sanitation, by Earl B. Phelps.
Photogrammetry, 3rd Edn., by H. Oakley Sharp.
Engineering Contracts and Specifications, by Robert W. Abbott.

Vibration Problems in Engineering, 2nd Edn., by A. Timoshenko.
Mathematics for Engineers, 2nd Edn., by Raymond W. Dull.
Centrifugal Pumps and Blowers, by Austin H. Church.
Fundamentals of Hydro-and Aeromechanics, 1st Edn., by L. Prandtl.
Engineering for Dams. Vol. I, General Design, by Creager, Justin and Hinds.
Engineering for Dams. Vol. II, Concrete Dams by Creager, Justin, and Hinds.
Engineering for Dams, Vol. III, Earth, Rock-Fill, Steel and Timber Dams, by Creager, Justin and Hinds.
Airport Engineering, by H. Oakley Sharp.
Mechanics of Turbulent Flow, by Bakhmeteff.
Corrosion of Metals & Alloys, by McKay & Worthington.

The following book was donated by one of the authors.

"Soil Mechanics & Foundations," by Plummer & Dore. A gift from Stanley M. Dore.

The number of books loaned during the year was 114.

The money collected in fines was $1.78.

Respectfully submitted,

ALLEN J. BURDOIN, *Chairman*

REPORT OF THE COMMITTEE ON SUBSOILS OF BOSTON

Boston, Mass., March 21, 1945

To the Boston Society of Civil Engineers:

One formal meeting and a number of discussions were held. Quite definite plans for the collection of boring data and other data have been outlined, but because of present conditions relatively little progress has been made during the year in the actual collection of data.

Respectfully submitted,

DONALD W. TAYLOR, *Chairman*

REPORT OF COMMITTEE ON JOHN R. FREEMAN FUND

Boston, Mass., March 21, 1945

To the Boston Society of Civil Engineers:

There has been no change in the Committee's policy since the report made at the last Annual Meeting. The decision, reported at that time, was to allow the income from the Freeman Fund to accumulate in anticipation of the great opportunities that will exist after the war for encouraging young engineers.

The standing of the fund is printed in the treasurer's report.

Respectfully submitted,

THE FREEMAN FUND COMMITTEE,
CHARLES M. ALLEN
WILLIAM F. UHL
HOWARD M. TURNER, *Chairman*

REPORT OF THE EXECUTIVE COMMITTEE OF THE SANITARY SECTION

Boston, Mass., March 7, 1945

To the Sanitary Section, Boston Society of Civil Engineers:

During the past year five meetings have been held as follows:

March 1, 1944.—Annual Meeting and election of officers. Mr. Philip B. Streander, Streander, Stone and Webster Corpn., Consulting Sanitary Engineer, presented a paper entitled "Some Interesting Features of Sewage Plant Design." Attendance 31.

April 5, 1944.—Joint meeting of the Northeastern University Section and the Sanitary Section. Mr. Joseph A. McCarthy, Chief of Laboratory, Lawrence Experiment Station, Massachusetts Department of Public Health, spoke on "Sewage Treatment Experiments—Sometimes They Work." Attendance 42.

June 7, 1944.—Mr. E. Sherman Chase, Partner, Metcalf & Eddy, spoke on "The Proposed Method of Sewage Treatment for Los Angeles, Cal." Attendance 42.

October 4, 1944.—Mr. Ralph M. Soule, Assistant Sanitary Engineer, Massachusetts Department of Public Health, spoke on "Effects of 1944 Hurricane on Water Supplies in Southeastern Massachusetts." Attendance 26.

December 6, 1944.—Mr. Ralph W. Horne, of Fay, Spofford & Thorndike, spoke on "Control of Infiltration and Storm Flow into Sanitary Sewers." Attendance 30.

The average attendance was 30.

Five meetings of the Executive Committee have been held during the year.

Respectfully submitted,

GEORGE C. HOUSER, *Clerk*

REPORT OF THE EXECUTIVE COMMITTEE OF THE DESIGNERS SECTION

Boston, Mass., March 5, 1945

To the Designers Section, Boston Society of Civil Engineers:

The following meetings were held during the past year:

March 8, 1944.—Annual Meeting and election of officers. Mr. F. L. Lawton, Assistant Chief Engineer, Aluminum Company of Canada LTD, spoke on the "Design and Construction of the Shipshaw Hydroelectric Development." Attendance 60.

April 12, 1944.—Mr. O. H. Ammann, Consulting Engineer, New York City, spoke on "Bridges of New York." Attendance 57.

May 10, 1944.—Mr. A. H. Hadfield, Assistant Chief, Airways Engineering Division, Civil Aeronautics Administration, Washington, D. C., spoke on "Airport Pavement Design." Attendance 56.

October 11, 1944.—Professors Walter C. Voss and Dean Peabody, Jr., of Massachusetts Institute of Technology, spoke on "Concentrated Loads on Thin Shelled Spherical Domes." Attendance 37.

November 15, 1944.—Mr. J. Stuart Crandall, President and Chief Engineer, Crandall Dry Dock Engineers, spoke on "Recent Timber Floating Drydocks." This was a joint meeting with the parent society. Attendance 65.

December 13, 1944.—Professor George C. Marvin of Massachusetts Institute of Technology, spoke on "Methods for the Prevention of Corrosion." Attendance 28.

January 10, 1945.—Dean Frank W. Garràn, Dean of the Thayer School of Civil Engineering, Dartmouth College, spoke on "The Future of Civil Engineering Education." Attendance 45.

February 14, 1945.—Professors Howard R. Staley and Dean Peabody, Jr., of Massachusetts Institute of Technology, spoke on "Creep Measurement of Pre-Stressed Gunite and Concrete Bars." Attendance 22.

The total attendance for the year was 370.

The average attendance was 46.

Respectfully submitted,

FRANK L. LINCOLN, *Clerk*

REPORT OF THE EXECUTIVE COMMITTEE OF THE HYDRAULICS SECTION 1944-1945

Boston, Mass., March 5, 1945

To the Hydraulics Section, Boston Society of Civil Engineers:

The following meetings were held during the past year:

May 3, 1944.—Mr. Scott Keith of Metcalf & Eddy, presented a paper entitled "Hydraulics of the Park River Conduit, Hartford, Connecticut." Attendance 37.

November 1, 1944.—Mr. William F. Covil, Senior Hydraulic Engineer, Metropolitan District Water Supply Commission, presented a paper entitled "A Practical Formula for the Flow of Water in Pipes." Attendance 35.

February 7, 1945.—Mr. M. Spillman, Consulting Engineer, Worthington Pump Mfg. Corporation, presented a paper entitled "Centrifugal Pumps—Types and Applications." Attendance 75.

The total attendance at the meetings was 147. The average attendance was 49.

Respectfully submitted,

HAROLD A. THOMAS, *Clerk*

REPORT OF THE EXECUTIVE COMMITTEE OF THE NORTHEASTERN UNIVERSITY SECTION

Boston, Mass., March 5, 1945

To the Boston Society of Civil Engineers:

The Executive Committee of the Northeastern University Section submits herewith the annual report of the Section's activities for the year 1944. The meetings were as follows:

March 16, 1944.—Mr. Hans Bernt, General Manager of the David Nassif Construction Company gave an illustrated lecture on "The Alaskan Military Highway." Attendance 70.

March 28, 1944.—Mr. James E. Jagger, Acting Assistant Secretary for the American Society of Civil Engineers, spoke on "Maintenance." Attendance 31.

April 5, 1944.—Joint Meeting with Sanitary Section of Boston Society of Civil Engineers, Mr. Joseph A. McCarthy, Chief of Laboratory, Lawrence Experiment Station, Massachusetts Department of Public Health, presented a talk on "Sewage Treatment Experiments—Sometimes They Work." Attendance 43.

April 12, 1944.—Mr. Diebert of the W. & L. E. Gurley Company gave an illustrated talk on "The Anatomy of a Transit." Attendance 34.

May 10, 1944.—Mr. Herman G. Dresser addressed the group on "Sanitary Engineering Problems." Attendance 17.

June 20, 1944.—A business meeting to elect officers. Attendance 12.

August 2, 1944.—Major Zavin Malkasian of the Boston Office of the United States Engineering Department gave an illustrated talk on "Sonic Sounding Devices." Attendance 34.

August 9, 1944.—A movie on "The Inside of Arc Welding," by General Electric Company was presented to the group. Attendance 16.

September 27, 1944.—For the third consecutive year the annual Student Night sponsored by the Boston Society of Civil Engineers and the Northeastern Section of the American Society of Civil Engineers was held at Northeastern University. Professor Charles B. Breed of M.I.T. spoke on "Land and Air Transportation in the Post-war Period." Attendance 105.

October 25, 1944.—A movie on "Pile Driving and Equipment" was presented to the group. Attendance 11.

November 2, 1944.—Mr. Oliver G. Julian of the Design Department, Jackson and Moreland, Inc., gave a talk on "What I Expect of a Graduate." Attendance 17.

November 9, 1944.—Mr. E. C. Houdlette of the Massachusetts Geodetic Survey presented a lecture on "Geodetic Control and Its Use in the State." Attendance 20.

November 17, 1944.—The A.S.C.E. movie on the failure of the Tacoma Narrows Bridge was presented to the group. Attendance 21.

February 21, 1945.—A Joint Meeting of all the Engineering Societies Student Chapters at Northeastern University was held in the form of a smoker. Mr. Holcomb Brown, former President of the Engineering Societies of New England, and former General Manager of the U. S. Gypsum Company, gave a short informal talk on engineering in practice. Attendance 50.

The average attendance for these meetings is 27, not including the annual Student Night on September 27, 1944, or the joint meeting on February 21, 1945.

The section also sponsored the following trips:

October 9, 1944.— The group was taken on a tour of inspection of Logan Airport, East Boston, by Mr. Everett N. Hutchins District Waterways Engineer of the Mass. Department of Public Works, in charge of the project, and Major McGrath, State Director of the Port. Attendance 17.

January 11, 1945.—The group took a trip to Cushing General Hospital in Framingham, Massachusetts. They were guided by Captain J. F. Shea, Post Engineer. Attendance 4.

Respectfully submitted,

ROY WOOLDRIDGE, *Vice Chairman*

ADVERTISEMENTS

The advertising pages of the JOURNAL aim to acquaint readers with Professional and Contracting Services and Sources of Various Supplies and Materials. You would find it of advantage to be represented here.

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BOSTON SOCIETY OF CIVIL ENGINEERS

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