NEWARK ENGINEERING NOTES

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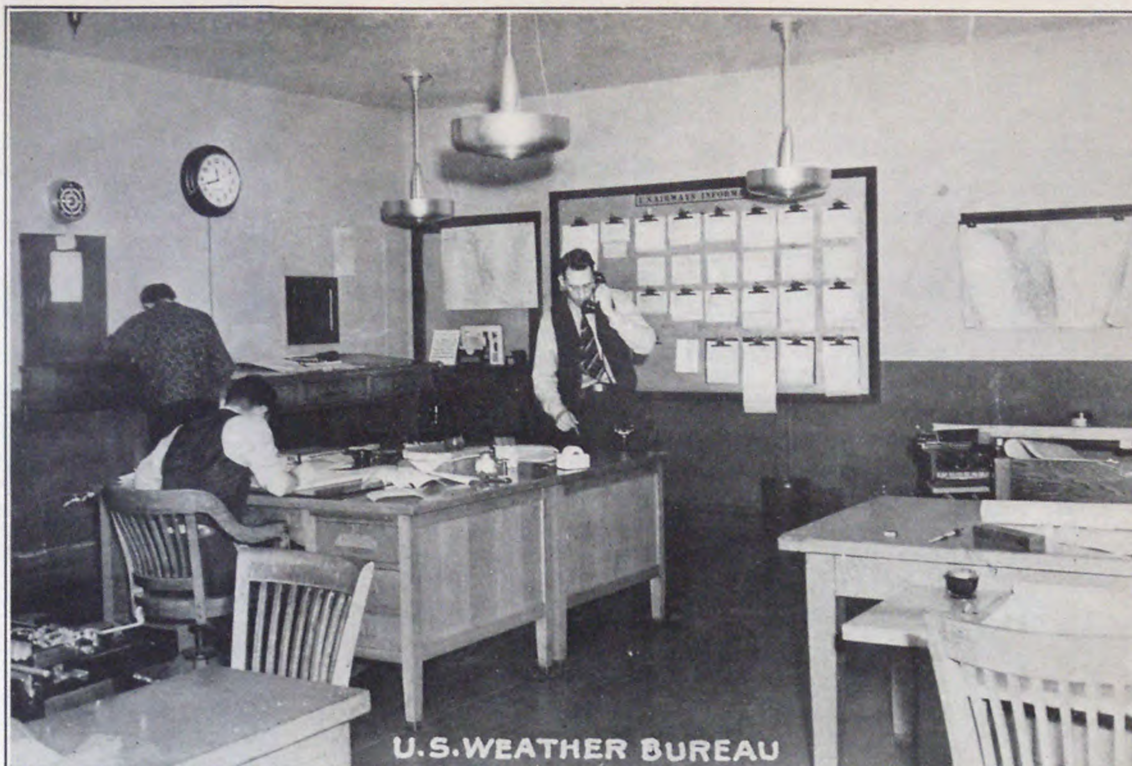

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FEBRUARY, 1939

NEWARK ENGINEERING NOTES

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DO YOU WANT TO BE ON OUR MAILING LIST?

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

THE PRESIDENT'S DIARY

December 20th—Engineers and Democracy

One thing that seems to be significant at the moment is that the attention of all of us is being turned toward our own form of government, our democracy. There seems to be a little more interest, a little more desire for thought and consideration and analysis than there ever has been in my memory. We are beginning to appreciate perhaps a few of the things we have in the face of the situation in other countries which seems to us so serious.

It would see mthat out of this general perplexed situation some good might come to us, some good if it resulted in making us a little more sensitive, a little more careful, and a little more willing to help with respect to those principles which stand for individual liberty and which are typical of our form of government.

This is perhaps something that touches engineers even a little more closely than it does some business people, for gradually we engineers are coming more and more into the public service in connection with national, state, county and civic work, and we are coming to have a professional place in the whole political scheme of things. So that it is perhaps wise for us to be particularly careful to understand and to help in this matter of protecting and conserving our democratic form of government.

January 2nd—For Better Citizenship

It is significant that the American Society of Mechanical Engineers has for some years been rather sensitive to this necessity for active participation in the work of the government, and the writer has been for several years the Chairman of their Committee on Citizenship. Indications point to the fact that other groups and societies of engineers are becoming more and more interested in the whole question of citizenship, and it is perhaps significant that for six years in the College we have had a required course in citizenship which in my opinion has been one of the very considerable contributions which we have made to some of the broader aspects of the profession.

The lessons that we have learned in the past six years have been quite definite, and while the course was, throughout the first years of its existence, somewhat of an experiment, it has long since passed that phase. The results as we see them indicate that such a course not only has some general value but it does serve to direct the thoughts and some of the energies of the graduates to matters of their responsibility toward their government.

One of the interesting side lights on the course is that we believe the same general ideas, the same general methods and technique that we have found interest the student body would serve to interest the public at large in their duties of citizenship.

It might be wise to indicate what some of these things are. In order to interest a voter directly in the problems of his country, that is, interest him to such an extent that he will actually spend some of his time and some of his energy in government, is in itself no easy task. It goes without saying that the method is one which should vary with the group of individuals, their background, their needs, and their interests, but it should be quite definitely planned that it should be aimed, as ours is here, to show clearly and unmistakably the great desirability and even necessity for a man's profession and his professional life to be correlated with the development of his government.

If young people or any other people are to be influenced in this particular way, it must be by means of their most intimate interest. When our government touches us closely professionally or financially and when there can be clearly shown an advantage which comes not only to the general good but specifically to the profession and the individual, interest is greatly stimulated. We have found that discussions must be carefully planned, just as any engineering structure is carefully planned, to take advantage of any factors which will insure success.

January 12th—Men with Experience

The second thing we have found is that with a carefully planned course touching the profession and the individual at as many points as possible, we must have in the conduct of the course or perhaps in the presentation of the material, men who not only are interested and do some wishful thing with respect to democracy but who know and have had some experience in the practical give and take of politics in our democracy. We must, moreover, have men of ability and men of character, men of unquestioned capacity and high ethical standards.

Perhaps some of you will think that such men are hard to secure. May I make the very simple announcement that they are not. In our politics and in our state, contrary to the prevalent opinion, there are able, honest, and interested men who can present to young men, specifically to young men in the profession of engineering, some of the ideals and some of the difficulties in our political set-up. The work has been done with us by a group of men, including one of our former Freeholders, Dr. Roy V. Wright, and such men as our own County Engineer, William A. Stickel, the late John S. DeHart, and others.

We must, then, have a carefully planned and carefully designed method of approach. We must have the design in the hands of not only able but experienced men, and if we are to talk to engineers, these men should preferably be engineers.

There are other matters with respect to the technique of questioning, methods of handling discussion, questions of bibliography, etc., about which our six years' experience has taught us something. As is indicated, a pamphlet or lecture is not sufficient. There must be a very close correlation between a man's life work and his government if the government is to in any way share in his life work.

Practically, of course, the question that must be asked is this . . . Have any of the graduates of our institution taken any constructive or active part in this matter? We must remember that we are not trying to train politicians but to train men who will be helpful directly and indirectly to the function of their government. It is impossible that some of these should not be elected to public office, but the election to public office is in no sense an objective, and we find that these young men individually and in groups have been extremely helpful in our own locality.

THEY USED THEIR HEADS

By MALCOLM EAGLES RUNYON

Junior Partner, Runyon & Carey, Consulting Engineers

The fellow who had the contract to lay the cast iron mains for the water supply was one of those individuals having the vices of both the old and the new countries and the virtues of neither. In short, he *needed* watching. Which was why I was Field Engineer, or Inspector, on the job.

At one place in the town, where the brook curved Passaic River fashion, it flowed around a horseshoe-shaped peninsula, and so low was the ground to landward that it was a question whether, at flood time, it were not really an island. The plans called for the pipe line to cross the stream through the very center of this strip, and at that time the water was scarcely over a man's shoe tops and no wider than the average driveway. Yet here the progress of the work was delayed for nearly a week.

While the best of modern equipment, clam shell diggers, back hoes, and trenching machines lay idle, the contractor tried various expedients . He sheeted and shored, pumped and bailed; laid the pipe to the middle of the stream and then repeated the process from the opposite side. Often when a joint was about to be made, a pump would fail for no apparent cause. Then a fresh start would have to be made. After a week of fussing and fuming the job was completed. It was my first experience as Inspector, and now, looking back upon it from the retrospect of fifteen years, I know what the trouble was. *He didn't use his head!*

For it was only a couple of years later that another contractor working under my supervision had the identical problem in the same place because the supply line for a neighboring municipality had to pass this spot. The new contractor also had every modern facility at his disposal. But he had something more . . . *He had a head!*

In fact, strange as it may seem, he was a very likeable fellow. So, having "been there" before (and from the summit of three whole years of engineering experience) I condescended to offer the friendly remark, "You're going to have a tough time here . . . Better make sure your pumps are in good shape."

"Pumps?" he came back at me, "Pumps? . . . I'm not going to use any . . . I'll be through at three o'clock."

"*Maybe* you will," I replied, thinking to myself, "Another Wise Guy."

I watched. He laid the pipe right through the center of the peninsula to the bank of the brook and stopped. Then he backed up his clamshell digger to the place where the strip of land was the narrowest. Across it he dug a new channel for the stream and had the water flowing through it within an hour. Moving the machine forward again he scooped out the old stream-bed, now merely damp, lowered the pipe, poured the joints and backfilled. Finally he retraced the route with the digger and proceeded to fill in his newly-dug channel. This was finished with time to spare. The man was an Engineer, whether he knew it or not. *He USED his head!*

It has seemed to me ever since I came to appreciate what an Engineer really is, that the etymology of the word "Engineer" would show some link with the word "ingenuity." Somewhere, at some time, I recall someone defining an Engineer as an ingenious man. And while something more than ingenuity is a requisite, still I feel that one with marked ingenuity has the "makings" essential to the profession; and certainly one not so fortunately endowed is scarcely a true engineer . . . rather a "technician" only.

Not so long ago I visited a large well field, the property of one of the principal water companies of this State. The pipes ran down to a depth of 175 feet or so, and had vertical slots cut along the last few feet of their length in order that the water could enter the pipe proper without disturbance of the gravel packed at the bottom. These slots periodically became clogged with mineral matter: a "hard" water deposit.

To withdraw the pipe and clean these intakes would not, obviously, be feasible. And any chemical powerful enough to dissolve the incrustations would have a correspondingly deleterious effect upon the iron itself, to say nothing of the danger of introducing such matter to a source of potable water. What to do?

The Company's Engineer was one of those ingenious men. He knew that a certain type of force was needed to remove these clinging deposits . . . the problem was how to get that force where it was needed, for the lime was on the inaccessible *outside* of the pipe. *He used his head.*

He studied explosives . . . procured cordite, one coming in a most convenient lead-covered form somewhat like the radio "spaghetti" type of solder and about as large in diameter as a lead pencil. He experimented with very small charges lowered into and set off from the inside bottom of the well pipes. Shortly he had ascertained how many "inches" of cordite were necessary to produce the desired cleaning effect. The mild, graduated explosions shook off all the foreign matter and without injury to the heavy iron pipe —the only path for the force being through the slots themselves since the top of the pipe was effectively packed before detonation. The cost was practically negligible and the saving to the company amounted to thousands of dollars.

Other examples could be given . . . illustrations in the Electrical and Mechanical as well as in the Hydraulics field cited. But each would indicate a common denominator: native ingenuity combined with an inherent or acquired knowledge of physics.

The kind of person known for "using his head" either consciously or unconsciously follows the precept of Bacon,"Nature is commanded by obeying her." And perhaps another great Englishman might have added, "If you can think — and not make thoughts your aim . . . you'll be an Engineer, my son!"

Editor's Note: Malcolm Runyon, who graduated from Newark College of Engineering in 1927, received his M.E. degree from the same college in 1935. He is now associated as a junior partner with the consulting engineering firm of Runyon and Carey, and also Chief Engineer and Director of the Newark District Telegraph Company.

Mr. Runyon is a member of the National Society of Professional Engineers, the American Society of Mechanical Engineers, the New Jersey Society of Professional Engineers and Land Surveyors.

COMING ISSUES

Articles to appear in some of the next issues of NEWARK ENGINEERING NOTES are as follows: *Integral Equations*, by Professor Bedross Koshkarian; *Let's Consider the Technical Book*, by Martin Matheson; *The Ordeal of the Freshman*, by Dean James A. Bradley; *Molecular Spectra*, by Professor Frank D. Carvin; *Some Problems in Moisture Measurements*, by William B. Wible; *Isotopes as a Tool in Chemical Engineering*, by Professor Joseph Joffe; *Some Geological Features of Essex County*, by Stuart Faber; *What Has Happened to Our 1938 Graduates*, by Professor Robert Widdop; *Piloting the Pilot*, by Harry Cyphers; *Repulsion Motor Calculations*, by Professor Paul C. Shedd; *Management in the Small Business*, by Professor J. Ansel Brooks, and *The General Conic, or Quadratic, Angle and Its Functions*, by Professor Albert A. Nims.

SOME ELEMENTS OF MATRICES INDICATED FROM ANALYSIS OF 4-TERMINAL NETWORKS

By S. FISHMAN, B S. in E.E.

Assistant Professor in Electrical Engineering, Newark College of Engineering

For expediting the analysis of electric circuits electrical engineers have recently begun to investigate the applicability of matrices. This mathematical technique is primarily a system of notation which affords a means of expressing and operating with comprehensive relationships in a more compact form than with systems previously developed. The hope is that by means of these simplified forms of expression the solutions of more extensive electric circuit problems, which have not yielded to other methods of analysis, will be achieved.

These notes are an attempt to indicate some of the elements of matrix algebra by utilizing information and experience previously gathered from electric circuit analysis.

Definition of a Matrix

The presentation will be based on the generalized 4-terminal network composed of linear, passive, bilateral impedances.

For such a network it is known that the following equations obtain:

$$V_1 = AV_2 + BI_2 \qquad (1a)$$

$$I_1 = CV_2 + DI_2 \qquad (1b)$$

and

$$AD - BC = 1 \qquad (2)$$

The quantities V_1 and I_1 are the input voltage and current, V_2 and I_2 are the output voltage and current, and A, B, C, and D are the so-called general circuit coëfficients which are complex quantities whose values depend on the configuration of the impedances of which the network is composed.

Expressed in the form of matrices (1) appears as:

$$\begin{Vmatrix} V_1 \\ I_1 \end{Vmatrix} = \begin{Vmatrix} A & B \\ C & D \end{Vmatrix} \times \begin{Vmatrix} V_2 \\ I_2 \end{Vmatrix} \qquad (3)$$

An arrangement such as:

$$\begin{Vmatrix} V \\ I \end{Vmatrix} \quad \text{or} \quad \begin{Vmatrix} A & B \\ C & D \end{Vmatrix}$$

is a matrix. A matrix is an array of quantities arranged in rows and columns. It is not necessarily a square array; although a rectangular matrix may be converted into a square matrix by placing zeros on the borders. A matrix resembles a determinant in form, but there is a significant difference between them. A matrix is an array of quantities which is used to express symbolically mathematical relationships, such as a system of simultaneous equations. A determinant, on the other hand, is an array of quantities which is equal to a polynomial; it has a definite value. The expression (2) above, which will be used several times later, can be written as a determinant; that is:

$$|d| = \begin{vmatrix} A & B \\ C & D \end{vmatrix} = 1 \qquad (4)$$

In group (3) V_1 and I_1 are expressed explicitly in terms of V_2 and I_2. In the language of matrix algebra the array composed of the general circuit constants is called the transformation matrix, or more simply, the transform.

The Inverse

If it is desired to express V_2 and I_2 explicitly in terms of V_1 and I_1 the inverse of the transform is used, and the expression is:

$$\begin{Vmatrix} V_2 \\ I_2 \end{Vmatrix} = \begin{Vmatrix} A & B \\ C & D \end{Vmatrix}^{-1} \times \begin{Vmatrix} V_1 \\ -I_1 \end{Vmatrix} \qquad (5)$$

The significance of the inverse and its composition is established from conventional analysis.

Multiplying the voltage equation in group (1) by D and the current equation by B, then subtracting the latter from the former and solving for V_2 gives:

$$V_2 = \frac{D}{|d|} V_1 - \frac{B}{|d|} I_1 \qquad (6)$$

where $|d|$ is the determinant in (4).

Then multiplying the voltage equation by C and the current equation by A, and subtracting the latter from the former and solving for I_2 gives:

$$I_2 = -\frac{C}{|d|} V_1 + \frac{A}{|d|} I_1 \qquad (7)$$

Since for this particular case the determinant $|d| = 1$, (6) and (7) become:

$$\begin{Vmatrix} V_2 \\ I_2 \end{Vmatrix} = \begin{Vmatrix} D & -B \\ -C & A \end{Vmatrix} \times \begin{Vmatrix} V_1 \\ I_1 \end{Vmatrix} \qquad (8)$$

In general, however, the inverse is:

$$\begin{Vmatrix} A & B \\ C & D \end{Vmatrix}^{-1} = \begin{Vmatrix} \frac{D}{|d|} & \frac{-B}{|d|} \\ \frac{-C}{|d|} & \frac{A}{|d|} \end{Vmatrix} = \frac{1}{|d|} \begin{Vmatrix} D & -B \\ -C & A \end{Vmatrix} \qquad (9)$$

From an inspection of (9) the rule for forming the inverse is readily established as follows:

(1) Write the determinant of the transformation matrix as in (4).

(2) Set up the adjoint of this determinant by replacing each element by its cofactor. (The cofactor of an element is the minor of the element preceded by the algebraic sign as determined by the position of the element.)

(3) Replace the determinant symbol by the matrix symbol and multiply the matrix by the reciprocal of the determinant.

The above also indicates what is meant by multiplying a matrix by a factor.

Multiplication of Matrices

This operation can be illustrated by the determination of the composite general circuit coëfficients of two 4-terminal networks connected in cascade. Such an arrangement is shown in figure 1.

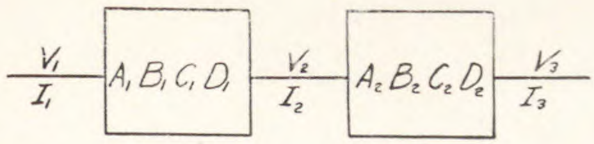


Figure 1

The usual procedure is by writing

$$V_1 = A_1V_2 + B_1I_2$$
$$I_1 = C_1V_2 + D_1I_2 \quad \text{......} (10)$$

and

$$V_2 = A_2V_3 + B_2I_3$$
$$I_2 = C_2V_3 + D_2I_3 \quad \text{......} (11)$$

The composite coëfficients are obtained by eliminating V_2 and I_2 from the two pairs of equations; this gives:

$$V_1 = (A_1A_2 + B_1C_2)V_3 + (A_1B_2 + B_1D_2)I_3$$
$$I_1 = (C_1A_2 + D_1C_2)V_3 + (C_1B_2 + D_1D_2)I_3 \quad \text{......} (12)$$

The procedure using matrices is as follows. For group (10) is written:

$$\begin{Vmatrix} V_1 \\ I_1 \end{Vmatrix} = \begin{Vmatrix} A_1 & B_1 \\ C_1 & D_1 \end{Vmatrix} \text{ x } \begin{Vmatrix} V_2 \\ I_2 \end{Vmatrix} \quad \text{......} (13)$$

For group (11) is written:

$$\begin{Vmatrix} V_2 \\ I_2 \end{Vmatrix} = \begin{Vmatrix} A_2 & B_2 \\ C_2 & D_2 \end{Vmatrix} \text{ x } \begin{Vmatrix} V_3 \\ I_3 \end{Vmatrix} \quad \text{......} (14)$$

For group (12) is written:

$$\begin{Vmatrix} V_1 \\ I_1 \end{Vmatrix} = \begin{Vmatrix} A_1 & B_1 \\ C_1 & D_1 \end{Vmatrix} \text{ x } \begin{Vmatrix} A_2 & B_2 \\ C_2 & D_2 \end{Vmatrix} \text{ x } \begin{Vmatrix} V_3 \\ I_3 \end{Vmatrix} \quad \text{......} (15)$$

or

$$\begin{Vmatrix} V_1 \\ I_1 \end{Vmatrix} = \begin{Vmatrix} A_0 & B_0 \\ C_0 & D_0 \end{Vmatrix} \text{ x } \begin{Vmatrix} V_3 \\ I_3 \end{Vmatrix} \quad \text{......} (16)$$

Since these matrices have particular forms the writing of them may be further simplified. For instance, (13) may be written:

$$\| S_1 \| = \| K_1 \| \text{ x } \| R_2 \| \quad \text{......} (17)$$

Hence (14), (15), (16) may be written:

$$\| S_2 \| = \| K_2 \| \text{ x } \| R_3 \| \quad \text{......} (18)$$
$$\| S_1 \| = \| K_1 \| \text{ x } \| K_2 \| \text{ x } \| R_3 \| \quad \text{......} (19)$$
$$\| S_1 \| = \| K_0 \| \text{ x } \| R_3 \| \quad \text{......} (20)$$

The rule for multiplication of matrices becomes apparent from the foregoing. The elements of the matrix $\| K_0 \|$ which is the product of $\| K_1 \|$ and $\| K_2 \|$ are composed as follows:

A_0 is the combination of the first row of $\| K_1 \|$ with the first column of $\| K_2 \|$.

B_0 is the combination of the first row of $\| K_1 \|$ with the second column of $\| K_2 \|$.

C_0 is the combination of the second row of $\| K_1 \|$ with the first column of $\| K_2 \|$.

D_0 is the combination of the second row of $\| K_2 \|$ with the second column of $\| K_2 \|$.

Obviously the commutative law does not obtain for multiplication of matrices; that is:

$$\| K_1 \| \text{ x } \| K_2 \| \neq \| K_2 \| \text{ x } \| K_1 \|$$

Addition of Matrices

This process is relatively simple as can be shown by considering a pair of networks in parallel.

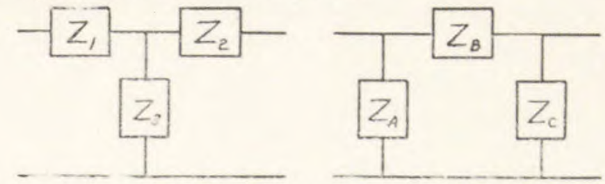


Figure 2

From (6)

$$I_1 = \frac{D}{B} V_1 - \frac{1}{B} V_2 \quad \text{......} (21)$$

From (1a)

$$I_2 = \frac{1}{B} V_1 - \frac{A}{B} V_2 \quad \text{......} (22)$$

Then

$$\begin{Vmatrix} I_1 \\ I_2 \end{Vmatrix} = \begin{Vmatrix} \frac{D_1}{B_1} & \frac{-1}{B_1} \\ \frac{1}{B_1} & \frac{-A_1}{B_2} \end{Vmatrix} \text{ x } \begin{Vmatrix} V_1 \\ V_2 \end{Vmatrix} \quad \text{......} (23)$$

and

$$\begin{Vmatrix} I'_1 \\ I'_2 \end{Vmatrix} = \begin{Vmatrix} \frac{D_2}{B_2} & \frac{-1}{B_2} \\ \frac{1}{B_2} & \frac{-A_2}{B_2} \end{Vmatrix} \text{ x } \begin{Vmatrix} V_1 \\ V_2 \end{Vmatrix} \quad \text{......} (24)$$

Since

$$I_s = I_1 + I'_1$$
$$I_r = I_2 + I'_2$$

$$\begin{Vmatrix} I_s \\ I_r \end{Vmatrix} = \begin{Vmatrix} \frac{D_1}{B_1} & \frac{-1}{B_1} \\ \frac{1}{B_1} & \frac{-A_1}{B_1} \end{Vmatrix} + \begin{Vmatrix} \frac{D_2}{B_2} & \frac{-1}{B_2} \\ \frac{1}{B_2} & \frac{-A_2}{B_2} \end{Vmatrix} \text{ x } \begin{Vmatrix} V_1 \\ V_2 \end{Vmatrix} \quad (25)$$

The sum of the two transformation matrices is another matrix, each element of which is the sum of same-positioned elements in the matrices which are added. This gives:

$$\begin{Vmatrix} I_s \\ I_r \end{Vmatrix} = \begin{Vmatrix} \frac{D_1}{B_1} + \frac{D_2}{B_2} & -\left\{ \frac{1}{B_1} + \frac{1}{B_2} \right\} \\ \frac{1}{B_1} + \frac{1}{B_2} & -\left\{ \frac{A_1}{B_1} + \frac{A_2}{B_2} \right\} \end{Vmatrix} \text{ x } \begin{Vmatrix} V_1 \\ V_2 \end{Vmatrix} \quad (26)$$

Equivalence of Matrices and Equivalent Circuits

Matrices are equivalent when the same-positioned elements are equal. This is useful for establishing the equivalence of 4-terminal networks by making the transformation matrices composed of the general circuit coëfficients equal. The equivalence of three impedances in T or π configuration serves as an example (figure 3).

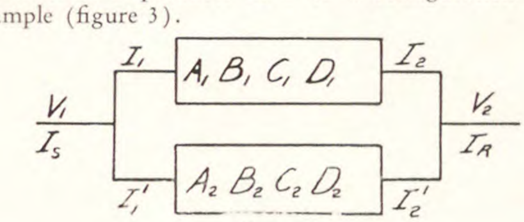


Figure 3

(Please turn to page 13)

PROFESSIONAL ENGINEERS AND LAND SURVEYORS

Some notes which were the basis of an address to the New Jersey Association of Professional Engineers and Land Surveyors, January 13, 1939, at Hotel Robert Treat in Newark, by Allan R. Cullimore, President, Newark College of Engineering

It is interesting to trace the beginnings of any particular movement back through successive stages until we find or think we find the real genesis. Particularly is it interesting to do this with one's own profession. And unconsciously perhaps as I have grown a little older it has been interesting to trace, rather spasmodically it is true, the development of the engineering profession.

As we go further and further back into history, it becomes more and more difficult because the documentary evidence, of necessity, becomes less and less. As we go from America to England into France and across France in the fifteenth century to Italy and trace the path of civilization down from Rome to Syracuse through Greece across perhaps to Carthage and from Carthage back into Egypt we find the material and the descriptions getting less and less as we proceed.

We know that the pyramids had a great geometrical significance. We know that the Egyptians were not only learned in arithmetic and calculations but were acquainted with many of the laws of the heavenly bodies. Yet the detail of their methods and their work is not clear, and comparatively little of it has come down to us. So that the recorded history down to about 1000 B.C. presents some considerable difficulties due primarily to lack of evidence in the way of sketches, details, etc., which would enable us to have a better conception of their abilities.

However, about the time of the mythical founding of Rome, if we can believe some of our early Roman historians, some very interesting things from an engineering standpoint were taking place.

About 700 B. C. Numa Pompilius, then king of Rome, mentioned among the great offices of state that of Pontifex Maximus, which means of course the head bridge builder.

Then followed the Roman Republic. About the time when A.D. superseded B.C. the position of Pontifex Maximus was one of great importance, so important that every Roman Emperor and every Pope of Rome was known as Pontifex Maximus or the master bridge builder. It is interesting to note that this title has persisted in the Roman Church until the present. The Pontifex Maximus is then the master of the building of bridges.

This gives us a rather interesting light on the whole question of design and construction from the earliest Roman times and gives some indication of the very close correlation which existed between the civil and the military and between the secular and the religious.

The whole system of military fortifications in Italy centered around protection by water, of which the bridge was the direct answer. The bridge, moreover, was absolutely necessary in the establishment of commercial routes in and out of the cities and the towns in Italy. It was the one point on which the ancient civil engineers and military engineers met on common ground, and of the highest significance in the life of these people was the building and the keeping of the bridge. Macaulay has well indicated this in his *Lays of Ancient Rome* which every school boy knows —the defense of the original Roman bridge by Horatius.

Then out spake brave Horatius,
The captain of the gate:
"To every man upon this earth
Death cometh soon or late.
And how can man die better
Than facing fearful odds,
For the ashes of his fathers,
And the temples of his gods."

As I say, this building of bridges and protection of bridges became not only a military and a civil responsibility, but a direct responsibility of the church as well. The church being the center of learning took over to a very considerable extent in Italy, and progressively in other countries, the building or construction of all important edifices such as palaces, churches, monasteries, and, strangely enough, bridges. The Pontifex Maximus or the Pope, as the head of the first professional society of engineers, built wonderful churches and wonderful palaces throughout Italy, culminating in the Italian Renaissance. In the famous century called Cinque Cento, construction, architecture, art and engineering so intimately intermingled that it was extremely hard to separate them.

A good example of this was the life of one Leonardo Da Vinci, who by common consent possessed a mastery of so many sides of human endeavor as to be at once the foremost engineer of history, the foremost painter, and a sculptor and a musician of the very first rank. Fortunately, much of the work of Leonardo Da Vinci has come down to us; his drawings, his sketches, his designs, his notes and computations which he made, even of such subjects as the flight of heavier than air machines.

It is very interesting to find an engineer at that date computing and attempting to solve problems in aero-dynamics. Da Vinci was not only the foremost engineer and thinker of his time, but the foremost painter as well. While his greatest picture has almost disappeared—his fresco of the Last Supper in Milan is ranked by many as the greatest painting in existence—it is perhaps not as well known as his Mona Lisa of the Louvre.

As a sculptor, Leonardo Da Vinci was second only to Michelangelo Buonarroti. As an example which is rather close to home he designed, possibly in toto, the statue to Bartolommeo Colleoni—one of the most perfect reproductions of which stands in Lincoln Park in Newark, another copy in the Metropolitan Museum in New York, with the original in Venice, the actual work being done by Verrocchio. In Leonardo we have a man, an engineer, who from the standpoint of his effect on culture and art *in toto* exceeded the effect of both Raphael and Michelangelo combined.

Through the efforts of Francis the first, Leonardo Da Vinci went to France and spent some time at the Chateau of Amboise where he designed that beautiful chapel of St. Hubert and, according to popular tradition, died there. Thus, largely through the efforts of one man, an engineer, there was transplanted from Italy to France the spirit of the Italian Renaissance.

Perhaps the debt was paid by the trip of Giovanni Da Bologna from the south of France to Florence, and it is very interesting to me to realize that a reproduction of the masterpiece of this French-Italian sculptor faces me as I write.

About the time of Leonardo Da Vinci, there lived another extremely clever man, one Benvenuto Cellini, who was perhaps the foremost mechanical engineer, at least the foremost foundryman, of his day. It must be remembered that an artist of those days was expected to carry his creations through the various stages and deliver them finished whether they were the work of the chisel or the pen or the musical instrument, and the foundrywork of Cellini and Ghiberti who preceded Cellini was perhaps the most delicate and artistic that the world has ever seen.

Ghiberti was generally held to be the better of the two technically, and his doors to the Baptistry in Florence elicited the comment from Michelangelo that they were fit to be the doors of Paradise. If I understand Michelangelo's character aright, any compliment from him was in the nature of a citation.

An interesting thing in Germany at this time was that Georgius Agricola or George Bauer, a German scholar, physician and miner, was writing the first treatise on Mining Engineering. It is also interesting to know that the first complete translation of this was made by one Herbert Hoover, an engineer of note in our country and once President. Together with his wife, Mr. Hoover worked out the translation and had it privately printed with the original woodcuts. My own particular interest in this was that during his presidency Mr. Hoover very kindly donated a copy of the book to the Newark College of Engineering for use in our library.

We might go on of course for many hours concerning the Italian Renaissance and the close interweaving of the engineering with the artistic, but as we have left out Archimedes and his repulse of the Roman army under Marsellus somewhere around 250 B. C. which was one of the most important engineering feats ever accomplished, we will have to skip something in the Italian Renaissance.

I think the most interesting thing about Archimedes' work was that he was the real inventor of the "press the button" technique. There was a little handle in the palace of King Hiero which when turned set in motion a series of gears and chains and levers which would lift one of the largest of the vessels in the harbor of Syracuse out on dry land, and when the soldiers of Marsellus had been exposed for some time to the machines of Archimedes on the walls of Syracuse, the story is that whenever they saw a stick or a bit of rope protruding from the walls they fled saying, "He is after us again."

To come back now to Amboise and follow our Society headed by the Pontifex Maximus, through France, we come to such tremendous architectural and artistic triumphs as Chartres and Mont St. Michel, the latter being by common consent the most marvelous, the most intricate, and the best example of the artistic welded to sound technical construction, and this was done perhaps under the direction of the master bridge builder.

One other thing is worthy of note, and that is that there was actually a particular band of bridge builders (men who wore a white tunic with the insignia of two arches and a cross above) who through the middle ages and perhaps earlier went abroad, throughout what we now call Europe, building bridges. They were known as the Order of Bridge Builders of which the Pope again was the titular head.

Of course we all realize that fundamentally we are more Norman-French than we are Saxon, and when William the Conqueror sailed across to England in 1066, he took with him the ideas and the ideals concerning the building of bridges, roads, and churches which had been so long characteristic of Normans and which followed the early occupation of Britain by the Romans.

It is interesting to note, speaking of some of the Romans in England, that we find hollow tile, as recently developed for a building material, was in common use in 50 B. C. and that lead pipes for conducting water and even air-conditioning in rooms was very common in those days as were many other things which we have rediscovered in engineering many times over.

Of course from now on we get pretty well up into the modern day, and it perhaps is quite easy to trace and to recognize the developments in engineering in these modern times.

One or two things, however, are quite striking. One of the greatest of our modern French works of literature, moreover, of romantic literature, is an epic of a wonderful and beautiful piece of engineering. It seems rather strange that Victor Hugo, the great French romanticist, poet and novelist should have chosen a subject of this kind as a vehicle for his art, his *Toilers of the Sea.*

Up to this time we have shown pretty definitely how closely engineering was integrated with the life of the people, both in war and peace, developed through the bridge. We have shown how bridges and temples and churches and palaces came to have a tremendous religious significance, and we have shown the effect of engineering upon the arts and the cultures and the development of our civilization through the Renaissance and its ultimate development in France. It is a record of which it seems to me any profession should be proud and which should bear some particular interest to us. For if we read, as most of us do, and if we travel at all, it furnishes a tremendously interesting avenue of approach in the life and the culture and the traditions of any country on earth whether it be the marine engineering in the wonderful ports of the Scandinavian people or the structural engineering in the temples of the Greeks.

In America the contribution of engineers, and let us include by all means land surveyors, has been tremendous, not only in the building of those public works which fall most directly in the line of our responsibility, but in the broadest sort of way. Interestingly enough, the two greatest men which this country produced were land surveyors, George Washington and Abraham Lincoln. Strange, is it not, that these two men who took such a part in the general shaping of the Republic should have both embraced this particular branch of the profession.

George Washington's work in Surveying is perhaps generally known to you—how as a young man of sixteen he accompanied Lord Fairfax on the surveys of some of his land in Virginia and Pennsylvania and acquired a considerable knowledge of the science and art of Surveying. And how in 1749 he was appointed County Engineer of what is now Culpepper County, Virginia. Swearing allegiance in the Culpepper Courthouse to his Majesty George II, he was aged seventeen.

And Lincoln, as Assistant County Engineer of Sangamon County, Illinois, trying to learn Surveying in six months, accepted the appointment only to have his horse and instruments attached by his creditors. He got them back again, however, through the kindness of a friend who bought them up and presented them to him. He included in his practice a survey laying out the Town of Petersburg, Illinois.

Another very interesting case in point is one Benjamin Franklin who perhaps was not the first electrical engineer but one of the first who dabbled in electricity. I think it would perhaps be straining a point to call Benjamin Franklin the first electrical engineer and fortunately it is not necessary to do so. His inventions were many in engineering along many lines, from the Franklin stove to the republic, for Balzac, the great French novelist, is credited with saying that Franklin invented the republic. I think it would be perfectly safe to say that he was the first great sales engineer, for he certainly sold the thirteen American colonies to the French and through his efforts in France almost single-handed he was enabled to finance the American revolution with French capital.

Those of us who read our American history aright know that this inventor of stoves and republics was a many-sided man whose worth and philosophy are beyond question. He meant to America almost what Seth Boyden meant to Newark. You will remember Seth Boyden's inventions extended from steam engines to strawberries. We have one of the engines with automatic cut-off now at the Newark

College of Engineering, and the Hilton strawberry, another of his inventions, is still famous.

Another interesting bit of American surveying is that furnished by Henry David Thoreau who was a surveyor by profession, and when he earned any money at all he earned it by surveying. Most of the time, as you know, was spent philosophizing in the woods on Walden Pond, and while he was not as great a philosopher as Emerson he is considered today perhaps our second greatest philosopher.

Perhaps the last note to strike would be that tremendously moving and interesting story of Major John Wesley Powell who just after the Civil War with a party of eight traveled through the whole Grand Canyon. The story is told in the Proceedings of the Smithsonian Institution, and instead of being a dry document is perhaps as wild a tale as a man would like to read on a stormy night. Interesting from the standpoint of the profession, the trip resulted in the formation of the United States Geological Survey of which Powell was made the first Director.

We could go on with many of those but you could find many cases in your own experiences where the contribution of engineering and surveying has been tremendous in fields seemingly far apart. And yet if those of us who perhaps feel that this profession is somewhat neglected, if in comparison with the professions of medicine and the clergy we feel somewhat over-awed by a supposedly rich heritage, it may be perhaps a help to know that there is a background which it seems to me is deep enough and rich enough for the most fastidious or the most exacting engineer, and while I have only been able to carry it as a matter of interest back to about one thousand years before Christ, it might be interesting to some of you to start from there and follow it back the two or three thousand years which lie between that point and the beginning of recorded history; but that would seem to be another speech.

MANAGEMENT IN THE SMALL BUSINESS

On February eighth, Professor J. Ansel Brooks of the Industrial Engineering Department presented a paper before the Metropolitan Section of the American Society of Mechanical Engineers entitled "Management in the Small Business." Professor Brooks says that in writing this paper he had two purposes in mind; first, to show that the Principles of Scientific Management can be applied to small business; second, to stimulate and create more interest in the subject of modern management in small business. This paper will be printed soon in the NEWARK ENGINEERING NOTES.

PROFESSOR NIMS, ONE OF THE EARLY PIONEERS IN THE DEVELOPMENT OF WELDING GENERATORS

Professor Nims, of the Electrical Engineering Department of the Newark College of Engineering, has been credited with one of the earliest designs of self-regulating generators supplying direct current for the electric arc welding of iron and steel.

The following letter to the Editor is from Mr. C. J. Holslag, President of the Electric Arc Cutting and Welding Company. Mr. Holslag, a graduate of Columbia University, was one of the earliest promoters of arc welding with alternating current. More than twenty years ago he organized the firm of which he is now president.

To the Editor:

In the talk you and Mr. Widmark* had me give before the American Society of Swedish Engineers, which sort of developed into a historical account of arc welding, it develops that you have in your Faculty Professor Nims, who designed the first self-regulated single operator motor generator set in this country. Furthermore, after a cycle of changing through considerable evolution this type of differential regulated generator has become the standard.

I have three classmates, Columbia, 1908, working for the Crocker-Wheeler Company and they tell me that Professor Nims designed this type of generator entirely himself and he was twenty years ahead of the trade's ability to acknowledge its correctness. The Crocker-Wheeler Company also made the first single operator welding sets of any kind in this country in the shape of contactor-resistance regulated 90 volt motor generators furnished to the New York Central Railroad through the Siemund-Wenzel about 1909. These sets as built mechanically and electrically, except for the writer changing the control somewhat when welding supervisor of the New York Central Railroad, are still in active daily use.

One of Professor Nims's early generators, if not the first one, we have here in our rental service and it is still performing as correctly, if not more so, as any of the most modern types including our own. As a reflection of this, we rented this generator to the Federal Ship and one of their employees wanted to buy this generator only. I sold him one of our make, explaining I wanted to keep this particular number one self-regulated generator, but it was hard work to show him that our latest style machine is as good as the one made by Professor Nims.

Very truly yours,

G. J. HOLSLAG.

Newark, N. J., January 5, 1939.

Mr. G. Williamson, Engineer with Crocker-Wheeler Electric Manufacturing Company, writes:

To the Editor:

Following our conversation last month I have been digging over old files . . .

The first single operator machines for which I find data were built in 1911 for Siemund-Wenzel, and used the control system involving a contactor and resistor utilized to give a reasonably steady generator load by cutting in the resistor as load when not welding, and cutting it out as weld is struck.

There were several varieties of this general type with slight modifications of windings or control, but they were all essentially constant voltage generators.

The first self-regulating generator built at Ampere was developed by Professor Nims while in our Engineering Department under the writer's direction. This was a differential generator with inductance in the arc circuit, and satisfactory welding was done with it in March, 1915.

In September, 1915, a generator of the perfected three-field type was built and operated, this using self and separately excited shunt fields and a differential series field. This type generator, essentially unchanged, working today on our own fabricating operations, gives performance comparing very favorably with modern units in the same service.

As I told you, Professor Nims carried through the entire development of this self-regulating generator. The writer may have made an occasional suggestion or two, but credit for the working out of the successful constant current welding generator as far as this company is concerned, belongs solely to Professor Nims.

I am returning Mr. Holslag's letter, which you left with me, and which is very interesting in its confirmation of our experience that modern welders have not improved markedly on the performance obtained twenty-three years ago.

Yours very truly,
G. WILLIAMSON, D. C. Engineer,
Crocker-Wheeler Electric Mfg. Co.

Ampere, N. J., February 6, 1939.

What Professor Nims says:

Electric arc welding as a practical art was introduced in this country by Mr. H. L. J. Siemund of the firm of Siemund & Wenzel of Hamburg, Germany. In 1908 Mr. Siemund inaugurated a welding service for the repair of steamship boilers with equipment that was housed on a barge and towed from point to point about New York Harbor. From steamship boilers to locomotive boilers is not a long step, and, therefore, in 1911 the Siemund Wenzel Electric Welding Company was formed to promote arc welding in railroad repair shops and supply welding equipment.

The early generators delivered about 70 to 90 volts, the difference between that

*Chief Engineer, Star Electric Motor Company, and Vice-President, American Society of Swedish Engineers.

value and the 20 to 25 volts across the arc being consumed in resistance. A welding arc is started by touching the electrode to the work and withdrawing it quickly. The electromagnetic reactions within the generator resulting from such a sudden demand for more than normal current delayed the recovery of voltage across the gap between the electrode and the work and made it difficult to "draw the arc." One method of overcoming this weakness was to keep a load on the generator at all times, shifting it from a resistor to the arc circuit by an automatic relay. Another method was to start the arc through a high resistance which was automatically reduced by a relay after starting the arc, so that the current would build up to its normal value.

Many single and multiple arc equipments were built during 1913 and 1914 by the Crocker-Wheeler Company (now the Crocker-Wheeler Electric Manufacturing Company) with which the writer was connected at that time. Early in 1915 the Siemund Wenzel Electric Welding Company reported that they were faced with prospective competition from suppliers of single-arc welding generators which would be self-regulating and would not need the power-consuming ballast resistance hitherto used in the arc circuit, nor the control relays required to short circuit the starting resistance. To protect their business the Crocker-Wheeler Company undertook the development of a machine with similar characteristics, the details of the design being turned over to the writer under the direction of Messrs. Treat and Williamson of the Direct Current Office of the Engineering Department.

At that time it was considered desirable to have an open circuit voltage of 50 to 60 to start the arc; when the arc was struck the voltage was to drop to 15 to 20, according to the length of arc maintained, while the current was to be maintained as nearly constant as possible at any selected value between 50 and 200 amperes. The drooping voltage could be easily obtained with a separately excited generator having a differential series field. The short circuit current of a machine of this kind at the moment of striking the arc was found to be so high that frequently the electrode stuck to the work and the arc could not be drawn.

The drooping voltage could also be obtained from a shunt generator with a weak field, but striking the arc overloaded the machine so that it "broke down" magnetically; the electrode could be withdrawn from the work, but the machine would not build up voltage fast enough to maintain the current. It was thought at first that a cumulative series field would help and one machine was built with a series field strong enough to provide the necessary current at low voltage. It was found to be slow in recovering the voltage whenever there was any reduction in current and the arc was therefore very sensitive and hard to maintain.

The design finally adopted was a combination of the shunt generator and the separately excited machine with a differential series field, all in one frame. The current at short circuit is less with this combination than with the separately excited machine, and the voltage recovery is more rapid than with the shunt generator. Even so, some smoothing out of the current and voltage fluctuations, caused by the short-circuiting of the arc by globules of molten metal is required. Fortunately this ballast can be inductive reactance instead of power consuming resistance. The problem of designing smoothing reactors was thus presented here for circuits carrying large direct currents at the same time that it was being faced in circuits with small direct currents in the choke coils of vacuum tube amplifiers.

It was soon discovered that tests with a steady resistance load gave no indication of the performance of the generator on welding duty. As no experienced welders were available then, except for customer's acceptance tests, it was necessary for the designer to learn to weld so as to be able to judge at first-hand the performance of the different designs and their modifications. For several months many hours were spent over a welding arc in the testing department; this time was not only productive of information but was turned to good account otherwise, as more than one steel casting was salvaged by filling blowholes.

Testing welders were also developed by the Test Department of the Company, and Professor Metzenheim, now Comptroller at Newark College of Engineering, who was then in that department, soon took over the testing of these generators. Once the design was settled and construction standardized, these generators, each usually directly connected to its own motor, found their way into many railroad shops of the country and some of the shipyards.

One of the interesting by-products of this development was a graphical method of predicting the performance of direct current generators which is simpler and more informative than those in use at that time. This method became the standard means of determining the performance of generators of all kinds that were designed by the writer while with the Crocker-Wheeler Company and has formed the basis of his instruction in this phase of the work in Electrical Machines at the College.

ALUMNI PROFESSIONALITIES

Paul R. Cunliffe, Class of '27, has been with the Carrier Corporation since 1936 and is now located at the Chicago office as an Engineer in the Contract Engineering Department. This Department makes field surveys, reviews estimates, and issues final drawings and material lists in connection with air conditioning installations.

In recent correspondence, Mr. Cunliffe was enthusiastic about his work and was gratified that his course in Electrical Engineering had emphasized basic engineering principles rather than specialized training. He points out that while air conditioning is fundamentally thermodynamics, all types of engineering problems are encountered in its practical application. These include problems in electricity, steam and internal combustion engines, structural design for the support of equipment, hydraulics for various piping problems, and even problems of vibration and sound created by mechanical equipment.

For several yearse after his graduation Mr. Cunliffe was employed in the radio tube industry. Later, he engaged in real estate management, and insurance sales until 1936 when he entered the training course of the Carrier Corporation in Newark.

John M. Roche, Class of '28, recently joined the organization of the National Safety Council as Industrial Safety Engineer and is now located at the Chicago headquarters. His duties include writing and editing magazine articles, originating industrial safety data sheets and developing industrial safety codes.

Previous to this connection, Mr. Roche had been with the Travelers Insurance Company, first as an Inspector in 1931 and later as an Engineer, servicing large nationally known risks from an accident prevention viewpoint. This work entailed considerable writing for safety and technical magazines, and speaking before safety conferences and technical conferences on safety subjects. This outside activity led to the offer from the National Safety Council.

Immediately after his graduation in Mechanical Engineering, Mr. Roche entered the employ of the Public Service Corporation as a technical assistant at Kearny station. A year later he became a sales representative for the Edison Storage Battery Company covering New England, New York and Philadelphia and continued in this work until his connection with Travelers in 1931.

IS THE DEAN IN?

Favorable comments are still being received about Dean Bradley's article, "Is the Dean In?"

The article was not only reprinted in its entirety in *Everybody's Digest* for January, 1939, but was also made basis for a featured story in *Sunday Call* (Newark) of January 29, 1939.

THE STUDENT ENGINEERING SOCIETIES

On February 6, the Newark College of Engineering student chapter of the American Society of Civil Engineers heard a very interesting talk on Sanitary Engineering given by Mr. L. E. West.

Mr. West, who is chief engineer for the Elizabeth Valley Sewer Commission, began his talk with a brief account of the history of sewerage systems. American practice in the years immediately following the year of 1855 was primarily one of trial and error in the design of sewerage systems. The past fifty years have seen great developments in the field of sanitary engineering, until the present day, in which advancements have reached a high degree.

The contrast between the terms, "sewage" and "sewerage," as emphasized by Mr. West, is that sewerage pertains to all of the appurtenances such as pipes, manholes, etc., that conduct the sewage (wastes and storm water) to a point where it can be treated.

The three types of sewage that are met with are: industrial wastes, domestic wastes, and storm water. The industrial wastes are by far the most difficult to deal with in treatment plants.

The two types of sewerage systems, as explained by Mr. West, are the separate system and the combined system. The separate system embodies two separate sewer lines; one for the industrial and domestic wastes, called sanitary sewers; and the other for storm water, called storm water drains. The combined system consists of one sewer line that handles both the wastes and storm water.

Another interesting phase in the design of sewerage systems is the selection of the materials for sewers. In modern practice, vitrified pipes, concrete pipes, and cast-iron pipes are generally used. In olden times brick was used in large sewers.

After discussing the various other factors concerning sewerage systems, Mr. West gave a detailed account of the problems that are encountered when a sewage treatment plant is designed.

Mr. West supplemented his talk by showing a number of slides that depicted the various sections of the Elizabeth Sewage Treatment Plant. The sewage from eleven municipalities in the Elizabeth valley is treated at this plant. Of particular interest, concerning the treatment plant, is the unique device used to concentrate the sediment in the sedimentation tanks near the influent end, which aids in the removal of the sediment.

At the next meeting, the chapter will hear a talk on "Traffic Engineering," to be given by Mr. Roger Gilman. Mr. Gilman is the junior contact member for the student chapter.

(Reported by Paul Carlino, Secretary of Student Chapter, A. S. C. E.)

At the meeting of the Student Branch of the American Society of Mechanical Engineers held on December 5, 1938, Mr. Kissam, a representative of the Linde-Air Products Corporation, spoke. His talk was accompanied with interesting films, and a very educational demonstration of gas-welding.

The newly elected officers of the society were introduced at the January meeting. Mr. Gosta Ambro, in charge of the power plants of Colgate Palmolive Peet Company, was the speaker of the evening. He spoke of the distribution of steam in the industrial power plant, and power plant problems. In the course of his enlightening talk there were two discussion periods in which the members asked many questions on power plant equipment and practices.

(Reported by R. P. Johnson, Secretary of the Student Branch, A. S. M. E.)

On December 29 a group of about twenty members of the Student Branch of the American Institute of Chemical Engineers made an inspection trip through the plant of the Koppers Products Company under the direction of the chief chemist, Mr. H. J. Meredith, who discussed in considerable detail the manufacture of coke and its by-products.

On January 19 Dr. A. E. Edel, Essex County toxicologist, gave a talk on his work and experiences before the Student Branch. Dr. Edel in his formal lecture described the kind of work that a toxicologist does. After the lecture, the meeting was thrown open for discussion, and Dr. Edel was asked to talk more fully on certain topics which interested the members, such as lead poisoning, mercury poisoning, hazards arising in the lacquer industry, and cases of drowning.

(Reported by Dean James A. Bradley.)

Friday, January 27, 1939, marked the date of an unusual type of meeting on the calendar of the Student Chapter of the A. I. E. E. The Okonite Company took the members present on a "trip" through their cable-making plant at Paterson, N. J. The "trip," which was conducted by Lowell Thomas by means of sound film, traced the details by which the insulation was made and applied to cable. The picture showed the group scenes on the rubber plantation where raw material was obtained and initially processed. The compounding of this material with certain chemical ingredients was the next step. The manner by which the insulation was applied to the cable demonstrated the high quality of the finished product. The night's program also included sound pictures of the bombing of the gunboat Panay.

Two Okonite Engineers, Mr. C. Finkel and Mr. G. Everitts, took over the meeting to answer the questions of the students. Considerable interest was evidenced in oil filled and gas filled cables.

The next two meetings of the branch will be devoted to the presentation of the student papers which are in competition for the branch and district prize. The final selection is for that paper to represent the branch at the student convention which this year will be held at The Cooper Union in New York City.

(Reported by C. H. Stephans, Counselor of the Student Branch, A. I. E. E.)

THE GYURIS STORAGE BATTERY

Professor Stewart's article in the November issue of the NEWARK ENGINEERING NOTES on "The Gyuris Storage Battery" appears to have appealed to the readers.

Many inquiries by mail and telephone have been received about one phase or another of the Gyuris Storage Battery. Among others were the New Jersey Telephone Company, National Lead Company, E. I. du Pont de Nemours and Company, Inc., Air Cruisers, Inc., and Eastman Kodak Company. A lawyer in New York telephoned a request for 12 copies of the article. A graduate of the Newark Technical School, living in New Orleans, was interested. More or less extended abstracts of the article are appearing in *Industrial Equipment News, Research and Invention*, the journal of the Ohio State University Research Foundation and Chemical Abstracts of the American Chemical Society.

AN ANNOUNCEMENT

The Newark College of Engineering Student Chapter of the American Society of Civil Engineers announces with pleasure the receipt of a letter of commendation from Henry E. Riggs, President of the Society. This is the second time in the last three years that the Newark Chapter has been so honored. Letters, similar to the one received by Newark, were sent to three chapters in each of four regions—the north-central, eastern, southern, and western. These "awards are made to Student Chapters whose activities and reports for the academic year 1937-38 have been outstanding." The other two Student Chapters in the eastern region to receive the awards were New York University, and Thayer School of Engineering (Dartmouth).

In announcing these awards in the February issue of *Civil Engineering*, the Committee on Student Chapters emphasized the difficulty which they encountered in selecting the three chapters to receive the awards in each region. This difficulty was occasioned by the general excellence of the programs and reports of a majority of the Chapters.

While all of the officers of the Chapter for the year 1937-38 contributed to its success, special credit is due Mr. Joseph Williams, Recording-Secretary, who prepared the annual report, the excellence of which is a big factor in determining the awards, and Professor William S. La Londe, Jr., Faculty Advisor.

(Reported by Professor Robert W. Van Houten.)

SOME ELEMENTS OF MATRICES

(Continued from page 7)

For the T configuration the transformation matrix derived in the conventional manner is:

$$\left\| \begin{matrix} 1 + \dfrac{Z_1}{Z_3} & \dfrac{Z_1Z_2 + Z_2Z_3 + Z_3Z_1}{Z_3} \\ \dfrac{1}{Z_3} & 1 + \dfrac{Z_2}{Z_3} \end{matrix} \right\| \qquad (27)$$

For the π configuration:

$$\left\| \begin{matrix} 1 + \dfrac{Z_b}{Z_c} & Z_b \\ \dfrac{Z_a + Z_b + Z_c}{Z_aZ_c} & 1 + \dfrac{Z_b}{Z_a} \end{matrix} \right\| \qquad (28)$$

By equating the same-positioned elements conditions are obtained thus:

$$Z_b = \frac{Z_1Z_2 + Z_2Z_3 + Z_3Z_1}{Z_3}$$

$$Z_c = \frac{Z_3}{Z_1} \quad Z_b = \frac{Z_1Z_2 + Z_2Z_3 + Z_3Z_1}{Z_1}$$

$$Z_a = \frac{Z_3}{Z_2} \quad Z_b = \frac{Z_1Z_2 + Z_2Z_3 + Z_3Z_1}{Z_2}$$

and:

$$Z_3 = \frac{Z_aZ_c}{Z_a + Z_b + Z_c}$$

$$Z_1 = \frac{Z_b}{Z_c} \; Z_3 = \frac{Z_aZ_b}{Z_a + Z_b + Z_c}$$

$$Z_2 = \frac{Z_b}{Z_a} \; Z_3 = \frac{Z_bZ_c}{Z_a + Z_b + Z_c}$$

Another example is the determination of the T circuit which is equivalent to a transmission line. The transformation matrix for the former is that given in (27); that for the latter is:

$$\left\| \begin{matrix} \cosh pS & Z_c \sinh pS \\ \dfrac{\sinh pS}{Z_c} & \cosh pS \end{matrix} \right\|$$

Hence the impedances in the equivalent T circuit are:

$$Z_3 = \frac{Z_c}{\sinh pS}$$

$$Z_1 = Z_c \frac{\cosh pS - 1}{\sinh pS} = Z_c \tanh \frac{pS}{2}$$

$$Z_2 = Z_1 = Z_c \tanh \frac{pS}{2}$$

WHAT OUR READERS SAY

DUPLICATING THE CUBE BY RULE AND COMPASS

This article, written by Professor James H. Fithian and published in the December issue of NEWARK ENGINEERING NOTES, has been commented upon favorably by several engineers, as for instance can be seen by the following letter:

To the Editor:

It was really a pleasure and a thrill reading the article on "Duplicating the Cube by Rule and Compass," by Professor Fithian.

Not so much the graphical solution, which is extremely ingenious, but the straight-forward mathematical derivation is what held my interest. I am always drawn to these mathematical analyses with a combination of interest in the novelty of the solution, and anticipation of the benefit of a review of the subject. In this particular case, both desires were fulfilled, and in addition, the comforting vision of myself at the blackboard at N. C. E. (in room 307, if I might hazard a guess) puzzling out a problem similar to the one above.

Pleasant memories as above can give one such bountiful pleasures that no current occasion could even closely approach. My association at N. C. E., particularly in my mathematics program, gives me that pleasure.

With kindest regards,

L. L. MONROE, '36.

Syracuse, N. Y., January 19, 1939.

To the Editor:

Please accept my thanks for the copies of NEWARK ENGINEERING NOTES as well as my congratulations on the contents. The various papers and regular features have been of considerable interest to me.

As a graduate of the College, I feel proud that Newark College of Engineering is identified with the publication of a periodical of such high quality and wide technical appeal. I sincerely hope that the publication will be continued, because I believe that it is a worthwhile means of bringing to the attention of the industry the high quality of training being given at the College as well as the rapid growth and progress being made.

Sincerely,

R. E. ROEHRENBECK, '35, Chief Chemist,
Swan-Finch Oil Corporation.

Newark, N. J., January 27, 1939.

To the Editor:

Allow me to extend to you my sincere thanks for sending the NEWARK ENGINEERING NOTES to me at this distant point.

The receipt of your paper makes the distance seem as naught and as I read it I realize that I am actually closer to the N. C. E. than when I used to drive past the front door.

The articles are interesting and instructive and it is with enthusiasm that I proceed from cover to cover.

Looking forward to your next issue and wishing you continued success, I am,

Sincerely yours,

FRANCIS X. LAMB, '30.

Tokyo, Japan, January 1, 1939.

To the Editor:

I would like to add my praise to this very interesting periodical, not as an alumni magazine, but as a worthy technical publication. There can be no doubt about its continued success.

Very truly yours,

H. F. RITTERBUSCH,
Instructor in Mechanics and Machine Design,
Stevens Institute of Technology.

Hoboken, N. J., January 12, 1939.

To the Editor:

Your publication, NEWARK ENGINEERING NOTES, has created a stir of genuine interest in the College on the part of several engineers in our Company.

Respectfully yours,

M. H. NOVEMBER, '37,
Breeze Corporations, Inc.

Newark, N. J., January 9, 1939.

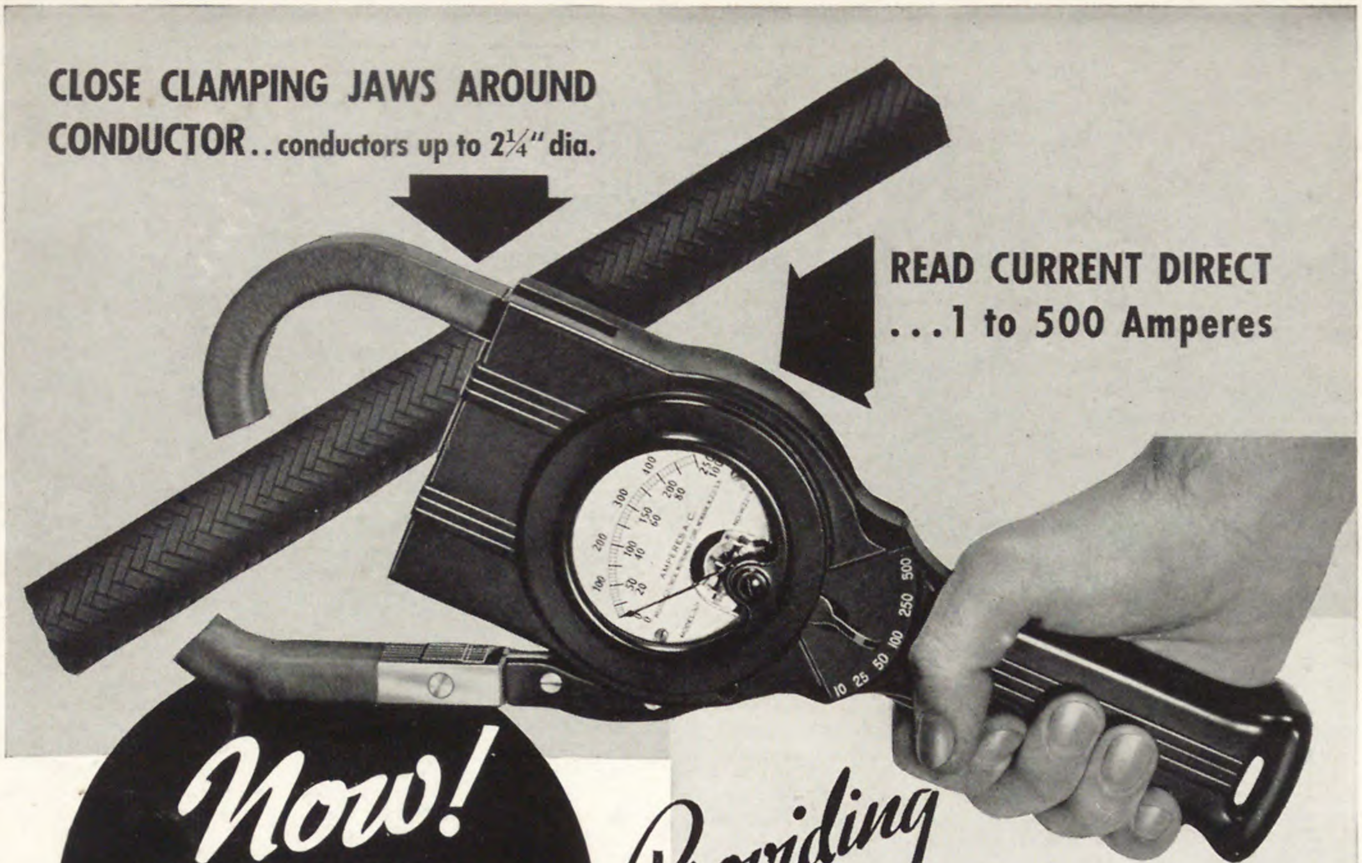
To the Editor:

After examining the NEWARK ENGINEERING NOTES, I am agreed that we ought to keep a file of your progressive magazine. . . . Would it be possible for you to send us copies of all previous numbers so that we would have a complete file?

Very truly yours,

E. F. BERRY,
Acting Professor of Civil Engineering,
Syracuse University.

Syracuse, New York, January 28, 1939.



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