

Fall 11-1917

## Volume 27 - Issue 2 - November, 1917

Rose Technic Staff

*Rose-Hulman Institute of Technology*

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# THE ROSE TECHNIC

NOVEMBER, 1917

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THE BACKWATER PROBLEM  
H. A. Thomas, C. E.

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THE CIVILIAN ENGINEER AND  
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ROSE MEN IN THE SERVICE  
ALUMNI NOTES  
ROSE LEAVES  
FOOTBALL

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BERGMANN — 10

VOLUME XXVII

No. 2



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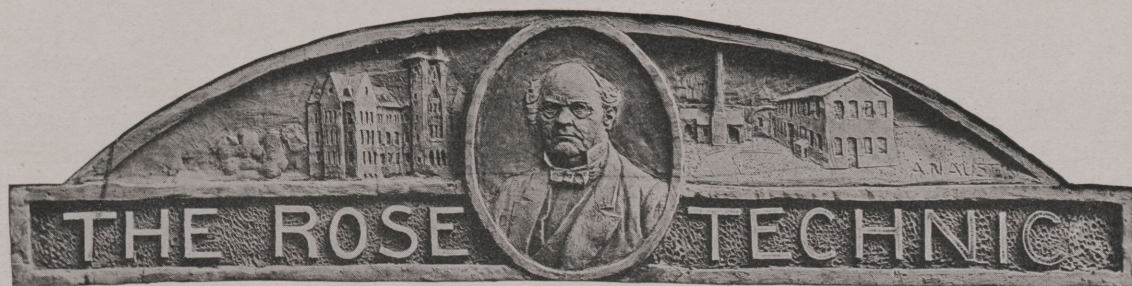
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VOL. XXVII

TERRE HAUTE, IND., NOVEMBER, 1917

No. 2

# THE TECHNIC

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ENTIRELY through an oversight upon our part, the name of Mr. Herbert Foltz, Consultant with Mr. John V. Van Pelt in making the plans for the new Rose buildings, was omitted in the superscription accompanying the General Plan of the new buildings, which appeared in connection with Mr. Van Pelt's article in the October issue of *THE TECHNIC*.

Mr. Foltz, an alumnus of Rose, has given study and assistance toward the early development of the new buildings that could hardly be overestimated, and our error in omitting his name in the superscription is more than regrettable.

It is our desire that this correction be brought to the attention of all readers of this publication.

FOR this year only, the Inter-fraternity Board has voted to advance the date of rushing season—and also to shorten the period—from the usual first two weeks of the second term to the first ten days of December, provided one of the chapters, that of Alpha Chi Sigma, is able to obtain the consent of its Grand Council to participate in rushing at such a time.

This action followed a discussion brought up by one of the representatives advocating the advancement of the rushing season to a date prior to the graduation of the present Senior Class. On another page of this issue a more detailed account of the recent Inter-fraternity Board meetings will be found.

With the rushing season now but a short time off, the Freshman should familiarize himself with the system adopted in the inter-fraternity agreement of 1915. With the exception of the dates therein, the agreement for this year is identically the same.

So many regrettable incidents have occurred in the past as a consequence of a misunderstanding—or of absolute ignorance—on the part of the rushees regarding certain rules of the system that we wish to emphasize this statement.

The Freshman who takes it upon himself to live up to the rules undoubtedly profits by doing so. In reserving his decision until the proper time, the one purpose for which the present form of bids is intended is accomplished; and the Freshman himself invariably enjoys the highest respect of all with whom he has become acquainted.

At the present time a most friendly spirit exists between the fraternities at Rose, and it is to be hoped that the coming rushing season will not terminate in any such embarrassing and annoying experiences as those of previous years.



**I**N our leading article of this issue, Professor H. A. Thomas offers an original solution of "The Backwater Problem," in connection with a discussion of the methods of solution now used, their applications and accuracy.

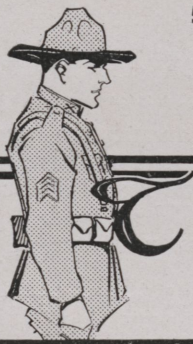
Through his articles in *The Engineering News-Record*, Professor Thomas is becoming well known among Civil Engineering authorities, and we congratulate ourselves upon being able to publish his solution of "The Backwater Problem" for the first time.

**F**OR our Alumni article for this month, Mr. John D. Galloway, '89, of San Francisco, has contributed "The Civilian Engineer and the Army."

As Major, Engineers' Officers' Reserve Corps,

Mr. Galloway is well qualified to write upon such a subject. His comprehensive description of the organization of the Army, especially of the engineering branches, will undoubtedly be of considerable interest to all Rose graduates or students contemplating entering the service, for whom in particular the article was written.

**S**INCE the publication of the October issue, Mr. George L. Brown, '20, and Mr. Edward R. Ronald, '21, have been selected for positions on the staff of *THE TECHNIC*, the former as Assistant Business Manager, and the latter as Freshman Locals Editor. Both men have had experience in student publication work, and we feel confident of their ability to make good as members of *THE TECHNIC* staff.



## THE COLLEGES and THE WAR



THE pamphlet, "British Universities and the War," gives some interesting statistics regarding the number of college graduates and students

in military or civilian service up to the end of 1916—or after approximately twenty-eight months of England's participation in the great conflict.

At that time 11,176 Oxford University men had entered the service; Cambridge had furnished 13,128 of its alumni, students or faculty; the University of London, approximately 20,000; the University of Durham, 2,024; Manchester University, over 1,600; Liverpool University, 1,310; Leeds, over 1,500; Sheffield, 705; Wales, 1,350; St. Andrews, 670; Glasgow, approximately 3,000; Aberdeen, over 2,220; Edinburgh University, over 5,000; Dublin, 2,882.

From the figures available, over 5,000 of the men from these institutions had gained honors of more or less importance. At the time the statistics were compiled, nearly 5,000 of the total number from British universities had been killed in action.

The Case School of Applied Science has appointed a committee of its Faculty to visit some of the army posts at which officers' schools are

located. This body has been selected to study at first hand the work given at these schools, and to determine what change in the course of study could profitably be made, in order that Case graduates might be more efficiently prepared for army service without detracting from their training for efficient engineering work in civilian life.

It was found that the courses were characterized by many problems—a much larger number than Rose students encounter in their courses. The problems emphasize fundamental principles, for the most part, and practical applications are continually made. The responsibility is placed upon the student, and not the instructor; emphasis is laid upon recitation work, which embodies nearly all the technical subjects to be met with in military training and service. Only ten men are under each instructor, and military discipline prevails in each class.



# The Backwater Problem

By

H. A. THOMAS, C. E.

Associate Professor in Civil Engineering, Rose  
Polytechnic Institute.

## SYNOPSIS.

THE inaccuracy of the common methods of solving the backwater problem is discussed in this paper, with especial reference to cases arising in connection with flood-control studies on large rivers, and a new semi-graphic method is proposed for handling the problem to obtain accurate results.

## THE BACKWATER PROBLEM.

The "backwater problem," as understood in the following, is the problem of predicting the immediate effects produced on the depths and slopes of the water in a river by changes in any part or parts of the channel. The prediction of the gradual effects of silting and scour is not directly included in this problem.

In a natural river channel the depths and surface slopes corresponding to any given flow adjust themselves at all points to certain definite values which remain constant as long as no change takes place in the channel in contact with the flowing water. This fixed relation between the conformation of the channel and the depths and slopes of the water at all points is called the "regimen" of the river for the given flow. In any portion of a stream the regimen depends not only on the shape, size, and nature of the bed in that particular portion, but on influences acting in the channel for long distances upstream and downstream. For this reason the regimen of a river may be affected for many miles by a natural or artificial change in any part of its channel, such as the forming of a cut-off across a bend, opening of a crevasse or diversion channel, building of a dam or a levee system, or the obstruction of the flood channel by bridges or embankments. In cases of changes of this kind where the planning of engineering structures depends on the prediction of a new regimen, it is desirable to have an accurate solution of the backwater problem.

## ORDINARY SOLUTIONS.

*The Chezy Formula Method.* The simplest method of attacking the backwater problem is

by the use of the ordinary channel or Chezy formula. The following quotations are interesting as showing how this method is advocated by two eminent hydraulic engineers.

D. W. Mead in "Water Power Engineering": "The backwater curve can be determined by the use of the simple formula  $v=c\sqrt{rs}$ . . . . This method will permit of a more practical solution of the problem than by the use of formulas based entirely on theoretical considerations which can never be approximated in practice."

G. S. Williams in "American Civil Engineer's Pocket Book": "Formulas usually given consider only a change in depth without the necessarily corresponding change in width. For practical application, except in the extremely rare case of backwater in an artificial channel with vertical sides, such formulas are valueless. The practical method of solving the problem is to divide the channel into reaches such that both the velocity and the hydraulic radius will be substantially constant throughout each reach, and to compute for each reach beginning with that next the obstruction a mean value for  $v$ ,  $r$ , and  $s$ . . . . . By making the several sections sufficiently short, any desired degree of accuracy can be obtained within the limits of the formula used for the loss of head."

This solution for the backwater problem is also explained in detail in the recent work on "Hydraulics" by Hughes and Safford, no other method being mentioned. It is also recommended in Daugherty's "Hydraulics."

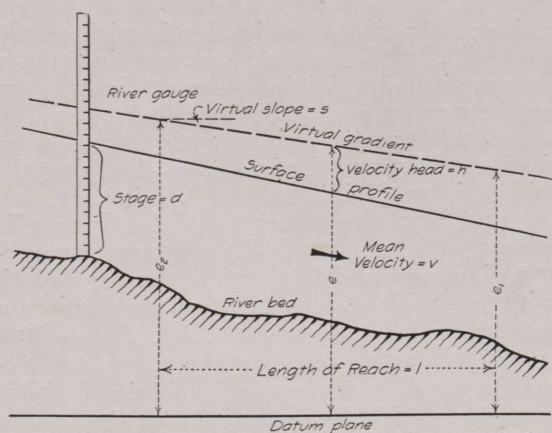
*The Extended Chezy Formula Method.* Many writers on hydraulics call attention to the fact that the ordinary Chezy formula does not accurately apply to channels of varying cross-section, but that it may be modified to fit this case by introducing terms depending on the different areas of cross-section of the stream at the ends of the reach considered. The formula thus obtained is designated in this



paper as the "extended Chezy formula." It may be written as shown in Fig. 1.

Among the writers who advocate the use of the extended Chezy formula, or its equivalent, in solving the backwater problem are Russell and Merriman, the latter however remarking that the calculus formulas are more accurate.

*The Calculus Method.* Since the slope of the backwater surface varies in a gradual curve, it would seem that an accurate determination of this curve might be made by means of the calculus. The integration of the differential equations has however been found difficult in all but the simplest cases. Practically all the published information on this solution refers to the case of an infinitely broad rectangular channel. The following quotation from the author of the most widely used text book on Hydraulics shows that the calculus formulas are not in disrepute among all authorities. The calculus formulas are given in Fig. 1.



"Ordinary Chezy Formula":  $v = c\sqrt{rs}$  or  $q = cf\sqrt{s}$

"Extended Chezy Formula": 
$$v = \frac{c\sqrt{rs}}{\sqrt{\left(\frac{a_1}{a_2} - \frac{1}{a_2}\right) \frac{c^2 r}{2gsl} + 1}}$$

where  $a_1$  = cross sectional area at lower end of reach  
 $a_2$  = cross sectional area at upper end of reach

"Calculus Backwater Formula": 
$$l = \frac{a_1 - a_2}{i} + D \left( \frac{1}{i} - \frac{c^2}{g} \right) \left[ \phi \frac{a_2}{D} - \phi \frac{a_1}{D} \right]$$

where  $\phi \frac{a}{D} = \frac{1}{6} \log_e \frac{\left(\frac{a}{D}\right)^2 - \frac{1}{D} - 1}{\left(\frac{a}{D} - 1\right)^2} - \frac{1}{\sqrt{3}} \cot^{-1} \frac{\frac{a}{D} - 1}{\sqrt{3}}$

where  $D$  = original depth of the stream  
 $a_1$  = new depth at lower end of reach  
 $a_2$  = new depth at upper end of reach  
 $i$  = inclination of river bed

FIG. 1. NOTATION AND FORMULAS.

Mansfield Merriman in "Treatise on Hydraulics": "The width of the channel will be taken as constant, its cross-section will be regarded as rectangular, and it will be assumed that the stream is wide compared with its depth, so that the wetted perimeter may be taken equal to the width and hydraulic radius equal to the mean depth. These assumptions are closely fulfilled in many canals and rivers."

Among other American writers who give or advocate the use of the calculus backwater formulas are Bovey, Slocumb, and Hoskins. A brief summary of the method is given by Russell.

*Inaccuracies and Limitations of the Ordinary Solutions.* The simple Chezy formula solution, while accurate enough for practical purposes where the velocities are low, does not take into account the velocity-head effects of the flowing water, and may lead to considerable error where high velocities of flow are involved. Such cases arise in connection with flood-control studies on large rivers, where the great depth of the water at times of flood makes possible the existence of a very rapid current. Velocities of over fourteen feet per second were measured by the writer in the Wabash River during the flood of 1913. This velocity corresponds to a velocity-head of over three feet, and errors of this order of magnitude might exist in computations by the simple Chezy formula to determine the effects of proposed embankments or levees on the flood heights of this stream. Such errors might disastrously reduce the margin of safety in a closely figured design.

The statement is made in a quotation above that any desired degree of accuracy in the solution of the backwater problem may be obtained with the ordinary Chezy formula by making the sections sufficiently short. Since the velocity-head effect in the varying channel is neglected by this formula, this statement is plainly in error in cases where the velocity of flow is high.

The "extended Chezy formula" is arranged to take account of the velocity-head effect of the current. However, this formula is very inconvenient for use in practice, as it has to be solved by successive approximations. The end-areas, average area, and average hydraulic radius appearing in this formula, are all functions of the slope, which is usually the required unknown quantity. Moreover, on account of the impracticability of determining the aver-



age area in a reach in which the surface is an unknown curve it is necessary to apply the formula to successive reaches so short that the curvature of the surface in any one of them will be inappreciable. When applied in this way the formula is likely to introduce an unknown element of error into the determination of the backwater curve by assigning excessive importance to the particular cross-sections which happen to be chosen as the ends of the reaches considered in the summation.

The limitations of the calculus formulas have been expressed in quotations already given. In many rivers, for example the Wabash, the width of the surface broadens out so greatly in times of flood that the hydraulic radius becomes smaller as the stage increases, instead of varying directly with the depth as is assumed in the calculus formulas. For this and other reasons the case is certainly exceptional where the application of the "backwater tables" to the estimation of flood heights on a natural stream is not valueless and misleading.

#### NEW SOLUTION.

*Use of the Virtual Gradient.* The following method of handling the backwater problem is suggested to avoid the uncertainty and error of the common solutions. It is based especially on the consideration of what is here called the "virtual gradient" of the river in reaches affected by new conditions of flow. The virtual gradient is a line on the profile of the stream, whose elevation above the grade line of the actual water surface is equal at all sections to the velocity-head corresponding to the average velocity of the water at those sections. The term is taken from railway engineering, where it is used in a similar sense to denote the effective profile as modified by the velocity effects of a moving train.

The slope of the virtual gradient at any cross-section of a stream depends only on the rate at which energy is being dissipated from the water passing that section. The slope of the real surface gradient depends not only on this, but on the taper of the channel or rate of change of the area in passing the section. In other words, the simple Chezy formula expresses the relation between the hydraulic properties of a cross-section of a channel and the slope of the virtual gradient of that cross-section, while the more complicated and inconvenient "extended Chezy formula" is required

to express the relation between these properties and the slope of the real surface gradient at the cross-section. For this reason a considerable simplification of the problem of determining a new regimen in a river of varying slope and cross-section may be secured by the use of the virtual gradient as a reference line.

*Data Required.* For the most accurate solution of the backwater problem it is desirable to have a continuous contour survey of the channel in the reaches affected, together with the "rating profile" of the river at all stages which may be reached by the water surface under the new regimen. By "rating profile" is meant a series of profiles of the river at various stages corresponding to known rates of flow. Where this data is incomplete, the precision of the solution will vary with the accuracy with which information equivalent to this can be estimated or supplied by interpolation or extrapolation from whatever data is available.

*Constant Discharge Assumed.* In many cases where the backwater problem is encountered in practice it is only necessary to consider a single rate of discharge of the river, for instance the maximum flood flow on record. This case is considered in the following explanation, a single constant rate of discharge being assumed except where other rates are specifically mentioned.

*Division of the Channel Into Reaches.* The first step in the solution of the problem is to divide the portion of the river under consideration into a series of "reaches" of such length that the profile in each will not vary sensibly from a straight line. The permissible length of these reaches will depend on the degree of precision required. In the method of working here considered it is desirable, where possible, to use reaches of approximately equal lengths.

*Notation.*  $l$ —length of a reach.

$a$ —average cross-sectional area of flow in a reach.

$r$ —average hydraulic radius in a reach.

$c$ —average channel coefficient in a reach.

$v$ —average velocity of flow in a reach.

$f=a/r$ —average section factor in a reach.

$h=v^2/2g$ —average velocity head in a reach.

$s$ —average slope of virtual gradient in a reach.

(Note. In the common and extended Chezy formula solutions  $s$ —the slope of the water surface).

$d$ —stage of the river.



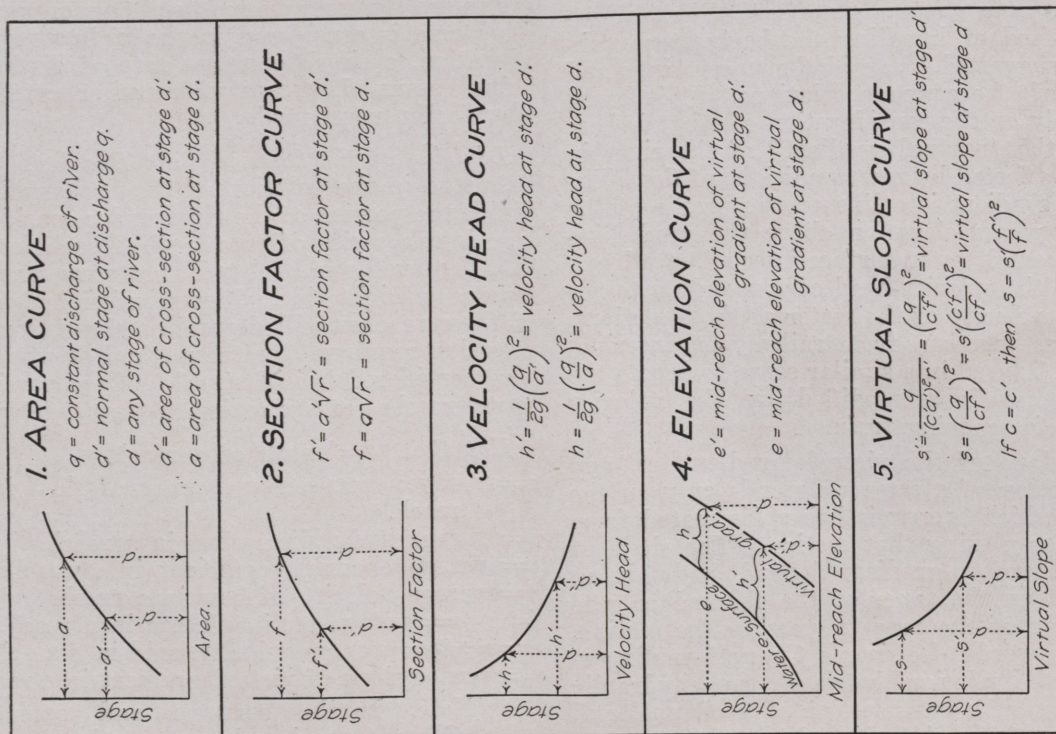


FIG. 2. PRELIMINARY CURVES, CONSTANT DISCHARGE.

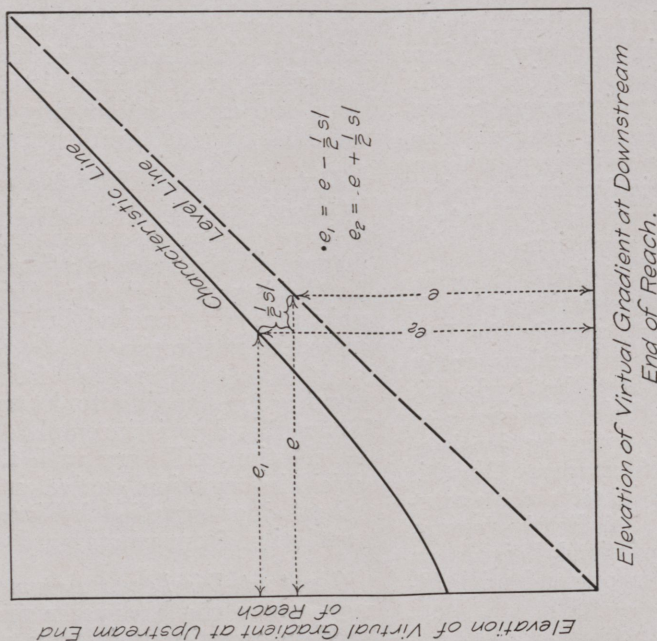


FIG. 3. REACH CHARACTERISTIC AT CONSTANT DISCHARGE.



$q$ =rate of discharge of the river, assumed constant.

$g$ =acceleration of gravity.

$e$ =elevation of the virtual gradient at the mid-point of a reach.

$e_1$ =elevation of the virtual gradient at the downstream end of a reach.

$e_2$ =elevation of the virtual gradient at upstream end of a reach.

$a', r', c', f', h', s',$  etc., represent the values of these quantities for the original or unmodified regimen of the river at a time when the discharge has the given constant value  $q$ .

*Preliminary Curves.* For each reach the following curves should be plotted, or the corresponding data tabulated, as a preliminary to constructing the "reach characteristic." It is only necessary to draw those portions of the curves which include elevations that may be reached by the new water surface. The formulas for constructing these curves are given in connection with Fig. 2.

1. The "Area Curve" shows the average area of cross-section of the reach at different stages. By "stage" is meant the depth of the water at some particular place where a river gauge or reference mark has been established.

2. The "Section Factor Curve" shows the average section factor of the reach at various stages. The "section factor" is the product of the area by the square root of the hydraulic radius. It is the factor which shows the effect of the size and shape of a cross-section on the relation between the discharge and the virtual slope.

3. The "Velocity-head Curve" at constant discharge gives the velocity-heads corresponding to the velocities which would exist if the constant discharge  $q$  were forced to flow through the cross-sectional areas at the various stages shown on the area curve.

4. The "Elevation Curve" gives the elevation of the water surface at the mid-point of the reach for each stage under consideration, and also the elevation of the virtual gradient at this point for the given constant discharge  $q$ .

5. The "Virtual Slope Curve" at constant discharge shows the slopes which the virtual gradient would have if the constant discharge  $q$  were forced to flow through the reach with its surface at different average elevations cor-

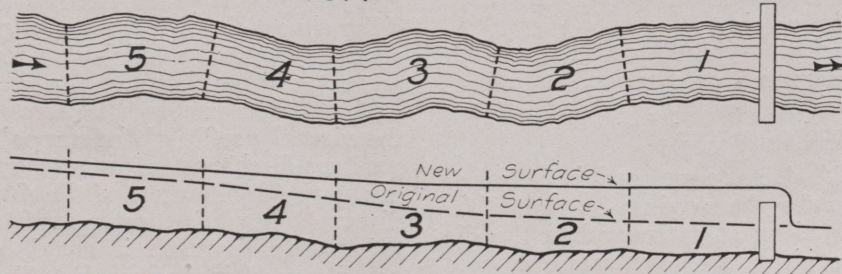
responding to the various stages shown on the section factor curve. The formula which is given for plotting this curve involves the normal virtual slope  $s'$  and channel coefficient  $c'$  for the reach at the given constant discharge, and the channel coefficient  $c$  for the reach at any stage other than the normal, the discharge  $q$  being the same in all cases. To obtain  $s'$ , the virtual profile of the normal stream at the constant discharge may be constructed by drawing on the profile sheet of the river a line whose distance above the water surface at the mid-point of each reach is equal to the average velocity-head in the reach. The value of  $c'$  may then be obtained from the relation  $q = c' f' \sqrt{s'}$ . The values of  $c$  must be determined on the basis of the best information available. Where the proposed changes in stage are small in comparison with the depth of the river,  $c$  may be taken as constant and equal to  $c'$  without serious error. Where a complete rating profile is at hand the values of  $c$  at different stages may be accurately found by plotting the virtual profiles of the river for these stages. In cases where the new backwater surface will lie above the highest recorded normal flow the values of  $c$  will have to be estimated by extrapolation and studies of the form and roughness of the new channel.

*The Reach Characteristic.* The "reach characteristic" at constant discharge is a curve (see Fig. 3) showing the relations which must exist between the elevations of the virtual gradient at the two ends of the reach in order to maintain a given constant discharge  $q$ . To construct the reach characteristic, find from the "elevation curve" and "virtual slope curve" the mid-point elevation  $e$  and the slope  $s$  of the virtual gradient when the average depth of the water in the reach is equivalent to any stage  $d$ . Multiplying the slope by half the length of the reach and adding the product to the mid-point elevation gives the elevation  $e_2$  of the virtual gradient at the upper end of the reach, while subtracting gives its elevation  $e_1$ , at the lower end. Any desired number of points on the reach characteristic may be located in this way.

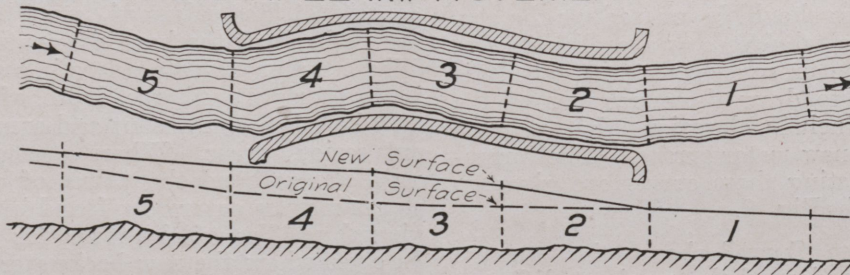
When a characteristic has been constructed for every reach in the portion of the river under consideration, it is a simple matter to trace upstream or downstream the effect of any given raising or lowering of the virtual gradient at the end of any particular reach, for the new



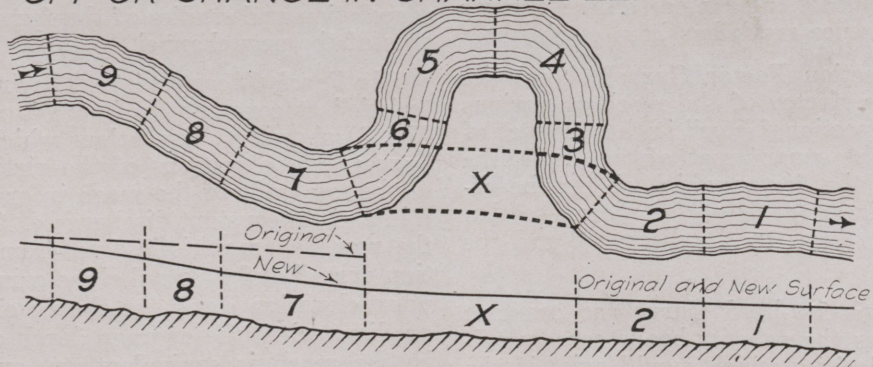
## 1. DAM OR OBSTRUCTION



## 2. LEVEES OR CHANNEL IMPROVEMENT



## 3. CUT-OFF OR CHANGE IN CHANNEL LENGTH



## 4. CREVASSE OR DIVERSION CHANNEL

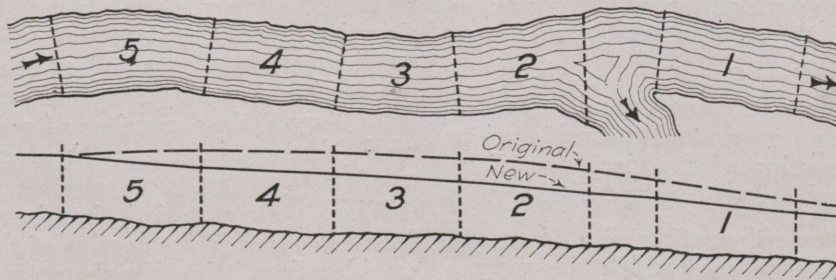


FIG. 4. APPLICATIONS OF BACKWATER PROBLEM.



elevations of the virtual gradient at the ends of the successive reaches may be read directly from the successive reach characteristics. When the new virtual gradient has been determined in this way, the elevation of the new water surface at the mid-point of each reach may be read from the elevation curves, thus locating the desired backwater surface profile.

#### APPLICATIONS.

The method of applying the above solution to some of the cases commonly met with in practice, is illustrated in the following explanation and in Fig. 4.

1. *Dam or Obstruction.* The height to which the water of a river will be raised by a dam or obstruction may be computed by the use of suitable weir or orifice formulas, and the elevation of the virtual gradient immediately upstream from the obstruction can be determined by computing the velocity-head at this section. The backwater effect may then be traced upstream as far as desired by using the reach characteristics as described above. The river downstream from the obstruction remains unaffected.

2. *Levees or other Contractions or Enlargements of the Channel.* For the changed reaches construct new characteristics which take into consideration the changes in the section factor and channel coefficient. Starting with the lower end of reach 1 at the normal water level in any reach below the changed portion of the channel, the backwater curve may be followed upstream as before.

3. *Cut-off or other Lengthening or Shortening of the Channel.* In these cases certain reaches are eliminated or replaced by others. Construct the characteristics for the old and new reaches which make up the new channel. Starting with the normal water level in any reach below the changed section, the backwater curves may then be traced upstream through the successive reaches as explained above.

4. *Crevasse or Diversion Channel.* Subtracting from the original flow of the river the amount to be diverted gives the new flow below the point of diversion. Taking the lower end of reach 1 at the normal elevation of the water surface corresponding to the new flow in any reach below the point of diversion, trace

the backwater curve upstream from reach to reach as in the preceding cases.

#### SOURCES OF ERROR.

To assist in forming a judgment regarding the precision of the proposed new method for handling the backwater problem, it is interesting to classify the principal errors to which it is subject.

1. *Errors inherent in the summation formulas:* These errors may be diminished indefinitely by making the reaches sufficiently short. (a) The curvature of the virtual and surface profiles in any reach is neglected. (b) The average area and section factor within any reach are assumed to depend only on the elevation of the water surface at the middle of the reach, and not on the slope.

2. *Errors dependent on the method of computing the velocity-head:* (a) The velocity-head as computed from the average velocity in a cross-section varies from the sum of the velocity-heads of the individual filaments by an amount which depends on the distribution of the velocity in the cross-section. Where the cross-sections of successive reaches are of similar shape, the error from this source is practically eliminated.

3. *Errors dependent on the use of the Chezy formula:* As used in this paper, the Chezy formula may be separated into two statements: (a) "With a given cross-section the discharge varies as the square root of the slope." This relation is probably exact in ordinary cases. While Kutter's formula contains a slope term which does not correspond with this relation, it is well known that this term was put in to allow for certain measurements on the Mississippi river which are now generally conceded to have been in error. Bazin's and other modern channel formulas give this relation as exact. (b) "With a given slope the discharge varies directly as the section-factor." This statement requires the introduction of the variable channel coefficient  $c$  to make it exact. Where the backwater surface lies far above the original surface, or the nature of the channel is changed in other ways, the degree of uncertainty in the solution due to possible errors in the selection of  $c$  is the same as is encountered in similar problems in channel hydraulics.

In those cases where the rating profile can be used to determine the values of  $c$  for the



new regimen, this source of error can be eliminated entirely.

4. *Errors due to neglect of silting and scour:* The backwater formulas are intended to directly predict only the immediate and not the ultimate changes in regimen which will be produced by a given engineering construction. It should not be forgotten that in rivers which carry silt or whose channels are in soft materials, any changes in the depths or velocities of flow will be followed by changes in the channel itself. This consideration, however, applies more forcibly to constructions which affect the low and moderate stages of the river, than to structures built to control floods which may occur but once in a lifetime.

According to a statement issued by the Bureau of Foreign and Domestic Commerce, 78 per cent. of the more than six billion dollars' worth of American goods exported during the year ending June 30, 1917, consisted of wholly or partly manufactured goods. Chemicals, dyes, etc., amounted to \$182,040,380, as compared with \$22,714,611 in the year ending June, 1914.—*Metallurgical and Chemical Engineering.*

The General Electric Company, of Schenectady, N. Y., has developed a temperature indicator for electrical machines, operated by electricity itself.

This device consists of feeder coils, connecting wire, a few small switches and a voltmeter. The feeder coils are placed in the dynamo or motor in parts where overheat is especially feared, and are then connected to the voltmeter, which is really the indicating instrument. When the dynamo heats up, the coils also become warm, causing the indicating needle of the voltmeter to move over a scale graduated in degrees centigrade. The reading over the voltmeter gives the temperature of the machine in the part where the feeder coils are located.

The voltmeter or indicator is mounted on a suitable panel, which may be located at any desired distance from the generating dynamo.—*Metallurgical and Chemical Engineering.*

#### SUMMARY.

From the discussions and explanations which have been given, the following conclusions may be drawn regarding the various possible methods of solving the backwater problem: (a) The ordinary Chezy formula solution is sufficiently accurate for practical purposes, except where the velocities of flow are high. (b) The extended Chezy formula solution as ordinarily applied is inconvenient and of uncertain accuracy. (c) The calculus backwater formulas are rarely suitable for use on natural rivers. (d) The proposed new method may be used where the Chezy formula method is unsuitable, and in certain cases appears to be capable of high precision.

The Government has recently issued a pamphlet giving the best methods of saving coal for domestic purposes. The pamphlet, known as "Technical Paper 97," may be had by applying to the Bureau of Mines.

Forty-two per cent. of the teaching staff of the School of Medicine of the University of Pittsburgh have enlisted in the medical service of the Government.

#### LITHIUM IN STORAGE BATTERIES.

L. C. Turnock of the Carnegie Institute of Technology, Pittsburgh, Pa., described an investigation made to determine the magnitude of the effect of various additions of lithium hydrate to the potassium hydrate electrolyte of the Edison storage battery. Comparative tests of the capacity of Edison storage batteries were made with 0, 10, 24, 30, 40 and 50 grams per liter of lithium hydrate added to the usual 21 per cent. caustic potash electrolyte. Test runs showed increased capacity up to 12 per cent. with the largest amount of lithium hydrate, in spite of the fact that the addition increased the electrical resistance of the electrolyte 21 per cent.

In reply to a question by Prof. Baucroft as to whether both electrodes or only one was affected, the author stated that while the point had not been definitely determined he was of the opinion that it was the positive electrode.—*Metallurgical and Chemical Engineering.*





## ALUMNI



## The Civilian Engineer and the Army

By

J. D. GALLOWAY, '89.

Major, Officers' Reserve Corps.

THE European war and the final entrance of America into the struggle has so changed the conditions of American life that to every thinking citizen there have come questions which have demanded answers not easily arrived at. We have found ourselves, whatever may have been our former ideas or knowledge, as a part of the world and the burden and responsibilities of the world have become ours either with or without our consent. Long separated from the complex affairs of Europe, we of this generation have known nothing of war and we have given the subject little, if any, consideration. Engrossed in commercial pursuits, in developing this enormous land, we have lost sight of a storm which has been gathering until now we find ourselves in the midst of it. We have lived in an isolation which has now vanished and whether we desire it or not, we must think and act as citizens of the world.

It follows as a natural result that this sudden plunge into the maelstrom of world politics has found many of us mentally unprepared for the change. Habits of thought formed through long years of peace and actions guided by the pursuits of peace have caused this nation to be averse to war. What we are now doing is being done as a disagreeable necessity and not with any particular liking for the adventure. The individual is called upon to alter his whole attitude towards life and to readjust his affairs to fit a condition unfamiliar and distasteful. It is, therefore, not surprising that practically all of us are questioning whether such a change is really necessary, whether we cannot get this war over with as soon as possible and then go back to our old

safe isolation as a nation and our old ambitions as builders. We all prefer to construct railroads, bridges, engines, power plants—all the varied works of peace—instead of guns, bombs, submarines, battle airplanes—the instruments of war and destruction.

To the Americans the old time will never come again. Whether intentionally or not, we are involved in world affairs. Our empire stretches half way round the globe and our influence is felt in all the councils of the world. By assisting in the defeat of Germany we will affect the course of events in the oldest of nations. Our action will determine the life to be led on the Nile and the Euphrates, the rivers of the dawn of history. The individual may object, but he is borne upon a swift current that carries him along to an unknown destination. He owes responsibilities to the state that are his because he is a citizen and he cannot shirk them. Hence, the individual who would play his part must examine the world as it is, consider his duties thereto and prepare for the things he must do. Owing to the prominent part which engineers play in modern life, we who are engineers must not be found lacking when the call has sounded for us to leave the small things of the past and to assume a position in the more complex world life of the future.

At the present time events are taking place which will profoundly affect the future of peoples for generations to come. Germany has challenged the civilization of the world as we understand it to a life and death struggle in which there is no compromise. The world must be either free or bound. The principle of liberty and equality before the law must



definitely overcome the theory of the German states where there is neither liberty nor equality but where there is rather dominance, the rule of force and the right of the strong over the weak. This condition is not new—it is rather the struggle of ages, and in order that we here in America may form correct conclusions as to our course of action now and in the future, let us examine some of the forces which act in this world and the results which follow. In making such an examination we must detach ourselves from the events which are transpiring around us today and look at this war as merely one of many wars in order that our judgment be true and our conclusions correct.

#### THE TEACHINGS OF HISTORY.

It is one of the most melancholy conditions in human life that war is the most definite and outstanding fact in all history. From the time when the Egyptians carved upon the pylons of the temples the great king slaying his victims, through five milleniums down to the Germans standing the helpless Belgians by hundreds against a wall and murdering them, all written history is but a record of war and the destruction of human life. In fact, the law of nature is that the strong exterminates the weak—that all life exists but by the destruction of other life. In some dim and distant future when men and nations have become subject to human reason, wars may be abolished, but at the present stage of human development, such a state must be considered as but a far-off, visionary dream. In the world of nature in which we live, reason is the only force that counteracts and opposes nature. All that we have on the material side of life represents but the dominance of reason over nature—the things we have are wrung from a world antagonistic to the individual and his welfare. While in affairs between individuals the dominion of reason has been more or less well established so that we live peaceably in large communities called nations, yet between nations the rule of nature prevails and wars of extermination are common.

Wars have been caused by many things—religion, ambition, economic conditions—all have been cited as the major reason, but in all wars, whatever may have been the principal cause, there have usually been many correlated and different impulses connected therewith. We in America have been so free that it is

difficult to understand the spirit of dominance that possesses some peoples which makes them endeavor to extend and exercise their rule over others. Yet nothing is more evident in the history of the world. The strong have ruled and the weak have had to submit. It has, however, been left to the Germans to revive an ancient idea—that of the superior race with a God-given mission to exterminate the weak and to possess themselves of their lands and belongings. It is the same formula under which the Jews exterminated the people of the land of Canaan so many years ago. Von Bernhardt in his introduction says: "These were the considerations which induced me to regard war from the standpoint of civilization and to study its relation to the great tasks of the present and the future which Providence has set before the German people as the greatest civilized people known to history."

The present war comes as a direct teaching of the necessity and glory of war to the Germans by an autocratic and irresponsible set of rulers. For nearly a century the poison has been fed to the people, but largely in the past fifty years. From Clauswitz to von Bernhardt, their military leaders have prepared for war, their philosophers have written of it as the ideal state, and their professors and teachers have glorified it. Von Bernhardt says, "War is not merely a necessary element in the life of nations, but an indispensable factor of culture in which a true civilized nation finds the highest expression of strength and vitality." Treitschke, their greatest historian, says, "God will see to it that war always recurs as a drastic medicine for the human race."

The object in making these quotations is not to prove or disprove the guilt of Germany. They are given to show how and from what causes wars may arise. A little over one hundred years ago the French, under the inspiration of their revolution and the leadership of Napoleon, carried war into all corners of Europe and for over twenty years the nations were banded together in order to make one submit and to stop war. If one reviews the nineteenth century only, it is found to be one long succession of wars in which the principal nations now at war have fought now as friends again as enemies. In this, the twentieth century, wars have occurred which in numbers of men engaged have dwarfed all former struggles and we are now in the fourth year of the greatest of them all. In fact, the magnitude



of wars has been measured only by the organizing ability of the nations involved. The present war, judged by the number of men and by the application of mechanical inventions, is an epitome of the mechanical age in which we live.

None of these statements are made to support the doctrine that war is beneficial. I believe war to be wholly bad. I once thought it had some virtue in keeping alive the spirit of men, but the peaceful workers of Europe have proved the fallacy of this statement. The men from the fields and workshops of Europe have passed through a hell of battle undreamed of in the wars of the past—poison gas, high explosive shells, attack from the air and from beneath the sea. Peace had not destroyed their valor or their courage. War is wholly destructive. The material things can be replaced but the men who have died cannot be replaced and they were of the best. Poverty, sickness, all the ills that wait on war ruin greater numbers. Yet all of this was known before and it did not prevent the Germans from starting this war. Knowledge of the destructive effects never yet has prevented war. Isolated as this nation has been, one year in every eight of its national life has been passed in war, not counting the Indian struggles.

Thus, if one passes in review the history of the world, he finds war as the central fact. Nothing in recent history indicates a diminution of warfare, but all signs point to contests growing greater and more destructive as time goes on. Waterloo or Gettysburg would get but a day's notice in our present time. Financial considerations cannot prevent war. Thus, although all wars are bad, it is equally true that they are inevitable. One cannot say from what point the next war will come, but the increasing friction caused by commercial rivalry, together with rapidly increasing number of people in countries too poor to support them, all point to the next wars as economic in their origin. The present war was caused by ambition of Germany's rulers, the megalomania of the people and economic pressure. A scientific mind, viewing the long history of the race and finding these conditions true, can draw but one conclusion. For many years—centuries to come—wars will prevail. Any other conclusion is based upon hope and not upon reason, and hope is a poor guide, however much it may help as a comforter.

#### THE DUTY OF ENGINEERS.

What, then, should be the action of engineers—students in schools such as Rose or graduates out in the world? There is but one answer—they must prepare for war, for war will come. They are citizens of a free country and as such must assume obligations if they accept the benefits. What we in America receive so lightly as if it were a natural right—freedom, equality, a chance to develop ourselves in accordance with our abilities—came to us not by natural law but was rather inherited from our fathers who fought for themselves and for us. Through many centuries men have died that we might be free, and what we have we hold in trust to be passed on undiminished to those who will follow us. To accomplish this we must be prepared to fight, and if necessary to die. Any other course is impossible to any right thinking man. Again, as an engineer must prepare for his life work by study, so if he is to go to war, either in the present one or in some future struggle, he must be prepared. To be prepared he must affiliate himself with the fighting machine, the national army. There is no other way of preparing himself. Distasteful as this procedure is, bad as an army is and wholly bad as war is, it must be done. An army is bad or good, depending upon the use to which it is put. The German army is wholly bad, for its purpose is bad, but the French army is fighting a defensive war and eternal glory surrounds its brave actions. If, then, the engineer must affiliate himself with the army, it is of interest to examine its organization.

#### THE UNITED STATES ARMY.

The small army which we had at the beginning of the war had the organization which is now being applied to the large army. Briefly stated, it is divided into twelve sections known as the arms and branches of the service, as follows:

- 1—Infantry.
- 2—Cavalry.
- 3—Field Artillery.
- 4—Coast Artillery.
- 5—Medical, including Dental and Veterinary Corps.
- 6—Adjutant General.
- 7—Judge Advocate General.
- 8—Inspector General.
- 9—Quartermaster.
- 10—Engineer.
- 11—Ordnance.
- 12—Signal.



The work of the various corps can be determined from the name, but a short review of the work of sections in which engineers may find a place is of interest.

(1) *Infantry.* The infantry remains as always, the main fighting unit of the army. Developments of trench fighting on the western front in France have made it necessary for infantry officers to be familiar with field fortifications such as trenches, shelter stations, strong points, entanglements, etc., for the reason that infantry must prepare such works immediately after an action. Formerly such work was done by the engineer troops, but the great extent of field fortifications now used was beyond the ability of the engineer troops and the infantry, men and officers, had to undertake it themselves. The development of weapons other than the rifle, such as hand bombs, trench mortars, liquid fire, gas, etc., has also raised the technical requirements for an infantry officer, and engineers can find a place in this branch of the Service.

(3) *Field Artillery.* This is a place where trained men are very necessary. Formerly the field artillery consisted of mobile guns of small calibre, drawn by horses. Developments of transport on railroads and upon roads by powerful motor trucks have made it possible to use guns of calibres from 9 inches to 12 inches and some naval guns of 16 inch calibre have been used by the British. The nature of the contest makes necessary an intense artillery preparation before an infantry advance, and for this reason the field artillery corps has become a large and complex organization, relatively one of the most important in modern warfare.

(4) *Coast Artillery.* \*The Coast Artillery Corps is that branch of the military arm which is charged with the care and use of the fixed and movable elements of the seaward and landward defense of the coast fortifications, including guns, mortars, submarine mines and torpedoes.

In general terms the Engineer Corps of the Army constructs the permanent works of fortifications; the Ordnance Department, Engineer Corps, and the Signal Corps furnish the material for installation in the fortifications. It remains for the coast artilleryman to oper-

ate and care for the material furnished by these departments. In other words, the coast artilleryman is the engineer of maintenance and operation.

The modern rifle is mounted on a carriage which admits of its being fired at any elevation between fixed limits and in any horizontal direction. The rifles in our service are generally mounted on carriages of the disappearing type which permit the rifle to be raised above the parapet for firing and allow the gun to be kept in a protected position below the parapet at all times except for the few seconds it is in the firing position immediately preceding the firing of a shot.

Electricity plays an important part in the gun carriage of the present day; the piece is elevated, depressed, traversed, retracted and also fired by electricity. In addition to the electrical agencies provided for these purposes, the carriage is equipped with auxiliary mechanical means for accomplishing the same results through the medium of man-power.

The ammunition for the service of the piece is, as a general rule, stored in magazines several feet below the level of the loading platform and it is necessary to have facilities for transferring the projectiles and powder from the lower to the upper level. To accomplish this, ammunition hoists are provided which are electrically controlled with auxiliary mechanical devices which admit of their operation by man-power.

The modern sea coast battery would be practically useless were no system of range finding and fire control provided by means of which the necessary data is made available for use in laying the guns. These data are secured and furnished the gun crew through the medium of position finding equipment. The essentials of the position finding equipment are observing instruments, plotting apparatus, ballistic correction devices, and means of communication.

The company officer of coast artillery will be often called upon to lay off and measure with accuracy base lines for use in the position service of his battery. This requires a knowledge of the theory of triangulation and the accurate measurement of base lines when corrections for sag, temperature, pull, etc., are applied. He is called upon to use a transit frequently in the orientation of the guns and the determination of the azimuth of datum points. He must be skillful in the use of

\*Information regarding the various sections of the Army has been obtained from Bulletin No. 8, Headquarters Western Department.



clinometers and similar appliances for the adjustment of the range scales on the guns and the quadrants on motors.

In general terms a company officer of coast artillery serving with a gun company must have a knowledge of machines, of electricity, of surveying, and of ballistics.

Mine companies are called upon to handle and operate all the material connected with the submarine mine defense, and to serve rapid fire guns assigned for the defense of the mine field. The mines are fired by electricity from a casemate on shore and it is essential that this casemate be manned by men having a good knowledge of electricity and the care of electrical apparatus. The mines are planted by a boat known as a "Mine Planter"; the work of planting is done by the personnel of the mine command, who must not only understand how to lay the cable from the casemate to the mine field and make the necessary electrical connections, but something of seamanship, as well.

(9) *Quartermaster Corps.* The Quartermaster Corps is charged with the duty of providing means of transportation of every character, either under contract or in kind, which may be needed in the movement of troops and material of war. It furnishes all public animals employed in the service of the Army, the forage consumed by them, wagons and all articles necessary for their use, and the horse equipments of the Quartermaster Corps. It furnishes clothing, camp and garrison equipment, barracks, storehouse and other buildings; constructs and repair roads, railways, bridges; builds and charters ships, boats, docks and wharves needed for military purposes; supplies subsistence for enlisted men and others entitled thereto; supplies articles for authorized sales and issues; furnishes lists of articles authorized to be kept for sale; gives instructions for procuring, distributing, issuing, selling and accounting for all quartermaster and subsistence supplies; has charge of the supply and distribution of and accounting for funds for the payment of the Army; and such other financial duties as are specially assigned to it; and attends to all matters connected with military operations which are not expressly assigned to some other bureau of the War Department.

Engineers are required, in connection with the work of the Quartermaster Corps and pertaining to the branches thereof, as follows:

1. Supply, subsistence, etc.; textile engineers and chemists.
2. Transportation, land and water; Civil, mechanical, hydraulic, railroad and marine engineers.
3. Construction pertaining to buildings, barracks and quarters, storehouses, roads, railroads (in time of peace), wharves, electric light plants, power plants, water supply, sewage purification, machine shops, motor transportation shops, etc.; engineers of the various classes indicated.

(10) *Engineer Corps.* The U. S. Army Regulations charge the Corps of Engineers with various duties which might be properly divided into two classes; peace and war duties. The latter, however, include the former. The peace duties include reconnoitering and surveying for military purposes, the construction and repair of fortifications, the installation of electric power plants connected with sea-coast batteries, the design and operation of field searchlights, the planning and construction of defensive and offensive works for troops assigned to the mobile defense of permanent fortifications, the training of Engineer troops, militia organizations, and civilians in engineer duties incident to actual warfare, and the planning and construction of such river and harbor works as are authorized by Congress.

In time of war the above duties are extended to include military demolitions, the construction and repair of wharves, roads, ferries, fords, bridges, and incidental structures, the laying out and improving of camp sites, the construction, operation and repair of military railways, including the operation of armored trains, the planning and construction of defensive and offensive works for troops in the theatre of operations, military sanitation as applied to camps, cantonments, forts, and other occupied places, and the supplying of the necessary engineering tools and equipment to other arms of the service.

It is evident from the above that engineers of practically every description would find work in the Corps of Engineers suited to their particular tastes and training. To make it more definite however, the following list is given showing the classes most needed to perform the above duties:

Bridge	Mining
Constructional	Railroad
Electrical	Sanitary
Highway	Topographic
Hydraulic	Mechanical
Irrigation	



Engineers of any one of the above classes would be well fitted to perform almost any duty that might be assigned them due to the fact that modern engineering problems are so complex that success in any one branch of the science requires a working knowledge of all the others. However, specialists are as necessary in engineering as in any other profession. The following will show how the above-listed specialists would be employed on engineering work under the Corps of Engineers:

#### **Bridge Engineers.**

Bridge engineers would be called upon to construct and repair all kinds of bridges as well as to handle the portable bridge equipment of the Engineer troops. Their work would generally be in the nature of rapidly planned and constructed "make-shifts" to replace bridges destroyed by the enemy or to span streams at places where no bridges exist.

#### **Constructional Engineers.**

Constructional engineers will find employment in the planning and construction of all kinds of fortifications, both seacoast and inland. They will be used to lay out and build field works, special forms of intrenchments, bomb-proofs, magazines, machine-gun emplacements, siege works, shafts, mines and tunnels; to assist in the planning and construction of temporary intrenchments and the building of obstacles; to construct wharves, terminals and warehouses, and temporary buildings for the housing of troops and other purposes.

#### **Electrical Engineers.**

Electrical engineers will be required to design and operate field search-lights, portable field power plants and systems; to install and keep in repair the lighting and power systems of permanent fortifications; to operate power plants, electric railways and systems put to military use in time of war; and to devise and construct obstacles, flares, etc., of an electrical nature.

#### **Highway Engineers.**

The duties particularly applicable to highway engineers will be all those involving earthwork, grading, cuts and fills. They will include the construction of new roads and trails under all kinds of conditions; the repair of existing roads and trails; military demolitions; the construction of shafts and mines, approaches to bridges, ferry landings and wharves.

#### **Hydraulic Engineers.**

Hydraulic engineers will be charged with the construction and operation of water supply systems; the operation of water power systems when same are put to military use; the opening and preservation of channels in rivers and harbors; the construction of canals and the diversion of streams to serve as obstacles or to flood the enemy's works, or to remove obstacles.

#### **Irrigation Engineers.**

Irrigation engineers will be called upon to reclaim land for various purposes, such as for remov-

ing obstacles, construction of roads, preservation of health, building of approaches to bridges and boat landings, etc.; and to construct canals and divert streams for the purposes enumerated under "Hydraulic Engineers."

#### **Mining Engineers.**

Mining engineers will be required to construct underground fortifications such as bomb-proofs, magazines and the like; to plan and construct intrenchments in difficult ground; to sink shafts and run mines under the enemy's work; to construct and repair tunnels; and to carry out military demolitions.

#### **Railroad Engineers.**

To railroad engineers will be allotted the construction, operation and maintenance of military railways. In most cases this will be limited to the operation and maintenance of existing railways taken over by the military authorities and put to their use. However, cases will arise frequently requiring the construction of new roads, and all the duties incident thereto will fall to the Engineer officers in charge.

#### **Sanitary Engineers.**

Sanitary engineers will be charged with the draining of swamps for various purposes, such as for the improvement of the health conditions of the surrounding country, or for draining possible camp sites; they will be called upon to design and construct sewage disposal systems for camps, cantonments, fortifications, and similar places; to drain camp sites, entrenchments, and other field works; and to construct and operate water supply systems.

#### **Surveyors.**

Surveyors will be at a greater demand than any other type of engineer. They will be employed in connection with railroad, road, and trail construction for making preliminary and location surveys; they will assist in the laying out of fortifications, in locating intrenchments, siege works, mining operations and the like; and for all the duties incident to the making of military maps.

(11) *Ordnance Department.* The Ordnance Department, U. S. Army, is charged with the duty of procuring by purchase or manufacture and distributing the necessary ordnance and ordnance stores for the Army and the Organized Militia and for this purpose establishes and maintains arsenals and depots for their manufacture and safe-keeping.

Ordnance and ordnance stores include cannon and artillery vehicles and equipments, such as the great guns used in the seacoast defenses, with their carriages, as well as the lighter guns used by the marine artillery; apparatus and machines for the service and maneuver of artillery; small arms, ammunition and accoutrements; horse equipments and harness for the field artillery, and horse equipments for cavalry and for all mounted men ex-



cept those in the Quartermaster Corps; tools, machinery, and materials for the ordnance service; and all property of whatever nature supplied to the military establishment by the Ordnance Department.

The duties of Ordnance officers are generally those connected with the direction, management, control and supervision of the work of manufacture, test and repair of ordnance and ordnance stores at manufacturing arsenals and depots, with the issuing and receiving of such supplies and with the inspection and test of such materials when purchased by contract.

Officers and men should have both a theoretical and practical knowledge of steam boilers, engines, shop tools, including the handling of such tools; electricity and electrical machines, particularly dynamos and motors; and experience in the manufacture of articles composed of steel, of wood, and of leather.

They should have had practical experience in the management of shops and the handling of operatives. Their experience should also be such as to enable them to take up the work of inspection of all classes of ordnance stores if manufactured by private concerns under contract, to insure that such materials are of standard design and workmanship and in accordance with Ordnance Department drawings and specifications.

The classes of engineers who on account of their education, training and experience would probably be best equipped for technical duty in the Ordnance Section are mechanical engineers and electrical engineers. To a more limited extent chemical engineers having a theoretical and practical knowledge of metallurgy and the chemistry of explosives are needed in the Ordnance Department.

(12) *Signal Corps.* The transmission to the supreme commander, of information, whatever the source, is the vital and principal work of the Signal Corps.

Signal Corps officers must have a well founded knowledge of the machines which constitute their working tools. General efficiency or ability is not sufficient. They must be specialists trained along some line which bears directly on the service of communication and the transmission of information.

Science is progressing with such rapid strides in the development of apparatus for the transmission of thought that it is imperative that the Signal Corps should obtain elec-

trical and mechanical engineers who have the ability and determination to study and master the existing apparatus and to improve or apply it in obtaining for the Army the best of this type of service.

It is obvious that it would be too expensive an undertaking to maintain in time of peace a force of such experts in adequate numbers for war conditions; so dependence must be placed on a corps of trained specialists held in reserve for conditions of war.

#### SIGNAL CORPS PROPER.

The following engineers will find their proper sphere of activity and work in the Signal Officers' Corps; Main Branch:

#### *Electrical and Mechanical Engineers:*

1. Telephone Engineers.
2. Telegraph Engineers.
3. Radio Engineers.
4. Cable Engineers.
5. Signal Engineers.

#### SCOPE OF WORK.

1. **Telephone Engineers**—Design, inspection, supply and operation of telephone apparatus, the supervision of the construction and maintenance of telephone lines.
2. **Telegraph Engineers**—Design, inspection, supply and operation of telegraph equipment, supervision of installation and maintenance of telegraph lines.
3. **Radio Engineers**—Design, inspection, supply and operation of radio equipment, supervision of the construction of radio stations and maintenance of same.
4. **Cable Engineers**—Design and inspection of cables, supervision of laying and maintaining submarine, deep sea, and other submarine cables.
5. **Signal Engineers**—General supervision of construction work. Special reference to work in connection with military railroads, and to the design and supply of all electrical equipment used in transmission of information.

#### AVIATION SECTION.

The following named engineers are needed in the Aviation Section of the Signal Corps:

#### *Mechanical and Electrical Engineers:*

1. Aeronautical Engineers, Aviators and Balloonists.
2. Experts: Internal Combustion Engines.
3. Experts: Aeroplane Motors.
4. Radio Engineers.
5. Experts in Pyrotechnics and Automatic Cameras, and other specialists.



## SCOPE OF WORK.

1. **Aeronautical Engineers, Aviators, and Balloonists**—The design, inspection, construction and operation of aeroplane and balloon equipment.

2. **Experts, Internal Combustion Engines**—The design, construction, inspection and supervision of installation and maintenance of this type of engine.

3. **Experts, Aeroplane Motors**—The design, construction, inspection, supervision of installation and maintenance of motors of this type. Special reference to improving the present motors.

4. **Radio Engineers**—The design, supply, inspection and operation of radio equipment for air craft and their land stations.

5. **Experts in Pyrotechnics and Automatic Cameras**—The design, inspection and general knowledge of this class of work, especially the design of automatic cameras for aeronautical work.

Pyrotechnics have a wide field of use in signaling between air craft and land stations. Automatic cameras for use of aeroplane observers are of vital importance in connection with aerial reconnaissance.

During the present period when aviation is used so extensively in modern warfare, the desirability of having a reserve of experienced aeronautical men for service with the aviation section of the Army in case of war needs no argument. As there are comparatively few men in this country skilled in this art, it is all the more important that a large reserve be trained and that every facility and encouragement be afforded men desiring to perfect themselves in this work.

The above gives in a more or less complete way an outline of the work of the modern army in which engineers may play a part. Changes are taking place constantly but everything is growing more complex. This is especially true of the Aviation Section, which is rapidly becoming one of the offensive arms of the service and which may in time be made a separate branch.

## JOINING THE ARMY.

Up to July 1st, 1916, officers for the army were obtained from graduates of the Military Academy at West Point, from enlisted men and from civilians who were selected by competitive examination. Privates and non-commissioned men were enlisted.

On July 1st, 1916, a law providing for an Officers' Reserve Corps and an Enlisted Men's Reserve Corps became effective. Men joining the Reserve Corps entered the army for five years after examinations and agreed to train at least two weeks each year. They were sub-

ject to call to active service at any time. Under this law large numbers of men entered the Reserve, especially as officers in the various corps, commissions being issued up to and including the rank of Major.

On the commencement of the war, it was recognized that none of the former methods would produce sufficient men for officers and the training camps for officers were established. On completion of the first camp a second one was ordered, and at this writing the training at the second camps is proceeding.

It has been announced that no more training camps for officers will be held, and some time ago all examinations for entrance to the Officers Reserve Corps were closed. It was stated that any additional officers needed, more than those already obtained, would be commissioned from the ranks of the army. Circumstances may alter that procedure, but at present there is no direct way in which an engineer can receive a commission as an officer. The enlisted reserve is also closed but engineer regiments are being formed. An engineer may enlist in the army in one of these regiments and if proficient may rise to the grade of non-commissioned officer or may receive a commission in a short time, as trained men are needed. If new training camps are established or if the Reserve Corps are again thrown open, public notice will undoubtedly be given.

## SUMMARY.

It is the hope of the writer that some form of training for all young men will be the outcome of the war. Provision should be made at Rose for military training of the undergraduate such as prevails in many similar institutions. During the present war, engineers should freely offer their services even if they have to serve in the ranks at first, for skilled men are needed and promotion is certain. In spite of the dreamers, war which is wholly bad will not cease at the conclusion of this one. Other circumstances will bring struggles as they have in the past. Natural laws which have prevailed for ages will not cease on the moment, and in the future like causes will produce like effects. Under such conditions, engineers, in accordance with their training, must be ready in order that they may pass on to future generations those things which they have received as an inheritance—freedom and the privilege of being an American.



## ROSE MEN IN THE SERVICE.

W. G. Arn, '97, is Captain and Adjutant, First Battalion, 13th Regiment Engineers (formerly 3rd Regiment U. S. Reserve Engineers of Chicago), American Expeditionary Force, now in France.

In the October issue of *THE TECHNIC*, the name of S. S. Roberts, '98, was included in the list of Rose men now in the R. O. C. Mr. Roberts is not at present in any branch of the service.

John T. Montgomery, '98, has accepted a commission as Captain of Engineers, and has been at Fort Leavenworth, Kansas, since September 1st.

Among the list of those who have received commissions in the E. O. R. C., published in *The Engineering New-Record*, appears the name of W. Ellis Ford, '98, as Captain.

Claiborne Pirtle, '98, of Cleveland, Ohio, is serving on the National Council of Defense.

O. E. Reynolds, '05, holds a commission in the E. O. R. C.

E. B. Hunley, '08, is now stationed at Camp Lewis, Washington.

Edward M. Brennan, '09, is First Lieutenant, 309th Engineers, at Camp Taylor, Louisville.

Chas. M. Struck, '10, is in the Second R. O. T. C., Fort Benjamin Harrison, Indianapolis.

O. E. Reagan, '12, has been commissioned as Second Lieutenant, Aviation Service. He is now in the Construction Department of the Garden City Aviation Concentration Camp, Garden City, Long Island.

Chesleigh Gray, '13, has received a commission as First Lieutenant, Air Service, Signal Corps, in the Construction Department. He is now at Garden City, Long Island, expecting to be sent to France in the near future.

J. M. Schoonover, '14, First Lieutenant, Signal Corps, was recently transferred from Ft. Leavenworth, Kansas, to Camp Custer, Battle Creek, Mich.

E. D. Brauns, '15, Aviation Corps, is now at Mineola, Long Island.

Homer A. Howe, '15, First Lieutenant, Ordnance Department, is now stationed at the Watertown Arsenal, Watertown, Mass.

C. F. Carlisle, '16, was recently transferred from Camp Funston, Kansas, to the Bureau of Gas Defense, Washington, D. C.

R. A. Weinhardt, '16, has reported to the San Antonio Aviation Camp No. 2, at San Antonio, Tex.

R. P. Jones, '20, has enlisted in the Aviation Corps, and R. J. Owen, '19, has passed examination for the rank of Second Lieutenant, Construction Dept., Aviation Corps.

W. H. Bruning, '19, is now in France with the 42nd Division, American Expeditionary Forces (formerly First Indiana Field Artillery).

Willys P. Wagner, '20, has enlisted in the Medical Corps as Ambulance Driver, and is now stationed at Jefferson Barracks, St. Louis, Mo.

Ralph P. Buck, Ex-'19, now in the Aviation Corps, was recently transferred from Newport, R. I., to Pensacola, Fla.

## ALUMNI NOTES.

Cale Wamsley, '98, is with the C. B. & Q. R. R. at Lincoln, Nebraska, in the Valuation Department.

Invitations have been received to the marriage reception of Albert A. Krieger, '03, and Miss Eugenia McCulloch, on November Twenty-sixth, at Louisville, Ky.

Mr. Krieger is Erecting Engineer for the New York Continental Jewell Filtration Co., Jersey City, N. J.

Harry M. Kauffman, '11, who has been with the General Electric Company in St. Louis,

has been transferred to the New York office of that company.

Mr. and Mrs. Harold McComb, of Columbus, Ohio, announce the birth of a son, Robert Dickerson, September 8th, 1917. Mr. McComb is a graduate of the Class of '06.

S. P. Hall, '07, is Instructor in Physics and Chemistry, Quincy High School, Quincy, Illinois.

H. H. Boyd, '08, is now located at Omaha, Nebraska, with the C. B. & Q. R. R.



H. W. Heidenger, '08, formerly on the Indiana Inspection Bureau, Indianapolis, is now with the Arkansas Actuarial Bureau, at Little Rock, Ark.

Walter L. Uhl, '08, is studying Architecture at Columbia University.

Announcement of the marriage of Harry B. Hammond, '09, to Miss Carrie Kuntz, which took place September 6th, has been received. Mr. Hammond is in the Seventh Regiment of New York.

R. S. Wilson, '09, who has been Chemical Engineer for the Pennsylvania Lines at Terre Haute, has accepted a position as Chief Chemist for the Illinois Powder Manufacturing Company, at St. Louis.

Benjamin G. Elliott, '10, formerly at the University of Nebraska, is now Associate Professor of Mechanical Engineering in the Extension Division of the University of Wisconsin.

Chas. E. Bell, '11, formerly Assistant Superintendent of the Paducah Light, Power and Traction Co., Paducah, Ky., has been transferred to Baton Rouge, La., as Superintendent of the Gas Company, for the Stone and Webster Engineering Corporation.

H. R. Voelker, '11, General Foreman, Pennsylvania Lines at Louisville, was recently

married to Miss Burah Treadway, of Terre Haute.

Announcement of the marriage of Frank H. Wentz, '12, to Miss Cecile Ryan, of New York City, which took place on October Twenty-seventh, has been received.

Kenneth V. Wood, '13, has been transferred from Gallion, Ohio, to Mount Carmel, Ill., as night engine house foreman, N. Y. C. Lines.

G. O. Klingman, '14, with the Denver Gas and Electric Co., has been transferred from Knoxville, Tenn., to Denver, Colo.

George G. Stoner, '15, formerly with the Pennsylvania Lines, at Indianapolis, is now Construction Engineer for the American Coal Mining Company, at Bicknell, Indiana.

R. D. Leitch, '16, has been transferred from the Naugatuck, Conn., plant of the United States Rubber Co., to the Mishawaka, Ind., branch.

R. A. Stuart, '16, is now with the Diamond Chain Company, of Indianapolis.

D. B. Weaver, '17, was married on August 11th to Miss Ruth Bowman, of Troy, Ohio.

B. L. Combs, '18, and Miss Dorothy Beck were married in Terre Haute, August Thirty-first. Mr. Combs was recently transferred from Camp Taylor, Louisville, to Washington, D. C., where he is now serving in one of the departments of radio-instruction.

## THE COST OF THE WAR.

The average person does not readily appreciate the enormous activity of the United States in the present war. A few figures which are the result of estimates made by government mathematicians will readily bring out this fact.

Congress just before adjourning authorized the expenditure of \$21,000,000,000 by the United States for carrying on the war for twelve months. Of this amount \$12,000,000,000 is to be spent directly in offensive work, in an effort to bring the war to a quick and successful close. The remainder is to be used for enlarging our military departments, and to be loaned to our allies. This \$21,000,000,-

000 is three times as much money as the total spent by the United States in all of its wars. The money represents more than ten per cent of the total wealth of the country, for, according to the latest figures, the total wealth of the United States is \$188,000,000,000.

Ordinary governmental expenditures in time of peace amount annually to \$1,041,000,000, about five per cent of this year's total, while annual military expenditures have averaged only \$9,000,000. In view of these figures it does not require a great deal of imagination to realize that the United States is playing her part in this great world struggle, and playing it to win.



# ROSE LEAVES

## THE Y. M. C. A. \$35,000,000 CAMPAIGN.

Several months ago the Y. M. C. A. asked for \$5,000,000—and got it. Now it is asking for \$35,000,000. The second campaign may bring the question of what became of the \$5,000,000, and of what is to become of the \$35,000,000 for which the Association is now campaigning.

One of the best examples of how the Y. M. C. A. spends its money is found in the letter-writing service it has established for the soldier or sailor. Approximately one million sheets of letter paper are furnished each day to men in military service. This is done at a cost of \$4,000 to \$5,000 a day, or \$1,500,000 a year, not including Sundays. No small amount of time and work is involved in printing all this stationery and shipping it to the different camps. Consequently large supplies have to be carried ahead, and it is estimated that at least \$100,000 is tied up in this branch of Y. M. C. A. activity—stationery alone—all of the time.

At the various cantonments from \$350 to \$450 worth of postage stamps are sold daily in each Y. M. C. A. building; some of these cantonments have as many as ten such buildings. At the very reasonable estimate of \$200 worth of stamps sold daily, in the five hundred Y. M. C. A. buildings there is \$100,000 involved. The several days' supplies which must be carried increase this figure by several hundred per cent.

The Y. M. C. A. buildings themselves constitute an item calling for a huge initial expenditure. For buildings, tents and their equipment fully two and one-half million dollars have been spent. The Association is working at two hundred thirty-four places where soldiers and sailors are camped. In these places it has a total of five hundred seventy-eight units, either a building or a tent being considered as a unit.

One whole department of the Y. M. C. A. is devoted to the purchase and distribution of

supplies and equipment to the separate buildings in this country. Six immense storehouses, located in New York, Boston, Atlanta, Chicago, San Antonio and San Francisco, are required for storing supplies and equipment. Each building or tent must have an outfit consisting of nearly one hundred separate items—paper, stamps, pencils, pens, postcards, pocket Testaments and other articles sold or given to men in the camp. A piano, a moving picture machine, phonograph, books, magazines and athletic equipment also go to make up the equipment of each one of the Y. M. C. A. units.

With the item of salaries, which as a rule are very moderate compensations, plus that of the buildings and supplies, practically all the \$5,000,000 which the Y. M. C. A. has used has been accounted for. Today the Association is serving fully one and one-half million soldiers, sailors and marines; and this represents only its activities in the United States. As our fighting men go abroad, the Y. M. C. A. goes with them—or rather ahead of them. When the first Americans troops landed in France, \$1,800,000 had already been spent in establishing the Y. M. C. A. "over there."

When the German troops drove into Belgium and started for Paris after forty years of the most painstaking and detailed preparation, the world held its breath. During those fall months of 1914, it did not seem as though any human power could stop the advance of the Teutons. The French Army and the whole of Belgium had to meet this thoroughly equipped enemy with inadequate artillery, making a living wall of its men to stand against big guns and high explosives. Great Britain's little army—the famous "Old Contemptibles"—sacrificed itself to hold one infinitesimal space in the enormous battle line.

Yet the German were stopped and turned back. And what did it, against all odds, was the element in armies which generals call *morale*—an element of spirit and character



greater than big guns and high explosives, something compacted partly of patriotism and partly of training. Morale may be present in an army, but unless it is brought out by polishing and faceting, it will not be in evidence when the test of battle comes.

The Y. M. C. A. is bringing out the morale of our fighting force. At a hundred points in the program of preparation it supplements military training, developing character, spirit and ideals; and it is for this work that the \$35,000,000 fund is being raised.

Compared with the billions spent by the Government to draft, equip, train and transport overseas the fighting force upon which so much depends next spring, the amount asked for seems moderate. It is a sum designated to finance the work for nine months, from October first to the end of next June, based on the best estimates of what was accomplished with the first \$5,000,000. It will cover the work in this country and abroad. For the men in the Army and Navy camps in the United States there has been apportioned \$11,120,000; for our Army and Navy overseas, \$11,994,000; for Y. M. C. A. work in the Russian Army, \$3,305,000; in the French Army, \$2,649,000; in the Italian Army, \$1,000,000; and among the prison camps in Europe, \$1,000,000. This, with \$3,932,000 provided for inevitable expansion, makes the grand total of \$35,000,000. That

is less than one day's outlay for the war by the United States Government, for Uncle Sam is now spending over \$50,000,000 daily; and it will provide for work among 1,500,000 fighting men, 14,000,000 of our Allies, and 6,000,000 prisoners of war.

Old Rose, exceeding her pledge of \$900.00 to this fund by more than thirty-five per cent, and with a record of not one member of the Institute having failed to contribute, has set an example of which she has every reason to be proud. The campaign was started on Tuesday, October Second, following a General Assembly at which Professor Eckhard of DePauw University gave an address on Y. M. C. A. war work. The minimum was passed Thursday, and by Saturday evening the total was more than \$1,300.00, with some pledges yet to be reported.

Credit for the success of the campaign at Rose is to be given to the Campaign Committee, composed of Fred M. Crapo, Rudolph F. Wiedemann, John C. Zimmerman, R. E. Woodruff and Professor Faurot, the Faculty advisor, and the class committees appointed by the Student Council for soliciting the funds.

The Faculty subscriptions amounted to \$221.00, the total of the Seniors, \$219.00; Juniors, \$192.50; Sophomores, \$445.50; and Freshmen, \$302.50, making a grand total of \$1,380.50, and an average subscription of \$6.64.

#### INTER-FRATERNITY BOARD MEETINGS.

The first Inter-fraternity Board meeting of the year was held on Thursday, October 18th, in the Descriptive Geometry Room. The representatives for A. T. O. were McKee and Crapo; for Sigma Nu, Falls and Mikels; for Theta Xi, Bergmann and Schlaman; for Alpha Chi Sigma, Bolton and Curtis; for P. I. E. S., Owens and Osmer; for V. Q. V., Abbett and Hearn. Beta Phi had no representative present.

Doctor White, Chairman, opened the session with a few remarks regarding the purposes of the Inter-fraternity Board, calling the attention of the representatives to the inter-fraternity agreement now in effect. This was followed by his discussion of the advancement of the rushing season to a date prior to the graduation of the Class of 1918, a change advocated by one of the representatives. After

presenting the matter to the Board, Doctor White called for further discussion of the question on the part of the members attending.

Bergmann, Theta Xi, presented arguments in favor of setting forward the date of the rushing season, suggesting as the most logical time a period of two weeks some time between Thanksgiving and Christmas. With the statement that a ruling of the Grand Council of Alpha Chi Sigma prohibited the pledging of any students until the Second Term Freshman, Bolton spoke for A. X. S. as being unable to favor any such advancement of the date of rushing season. None of the suggestions offered to cope with this technicality proved satisfactory. Bergmann then suggested that the matter be presented before the various chapters by their representatives, that an effort be made to effect some sort of an ar-



rangement with Alpha Chi Sigma whereby the above technicality could be removed, and that a subsequent meeting be called to put the question to a vote.

Thursday, October 25th, was set as the date of this meeting by Doctor White.

After two postponements, the second meeting of the Board was held on Thursday, November 1st. The representatives for A. T. O. were McKee and Crapo; for Sigma Nu, Grafe and Mikels; for Theta Xi, Bergmann and Schlaman; for Beta Phi, Stoner; for Alpha Chi Sigma, Bolton and Curtis; for P. I. E. S., Long and Owens. V. Q. V. was not represented.

Doctor White again took up the question of the desirability of setting forward the date of the rushing season, stating that the Faculty had expressed no opposition toward the change. The point was raised as to the probable time to which the rushing season could be advanced; owing to the Minstrel Show, and for other reasons, it was found advisable to shorten the period of rushing from the usual two weeks to ten days, December 1st to December 10th. A tentative vote showed Sigma Nu, A. T. O., Theta Xi, Beta Phi, and P. I. E. S. in favor of this arrangement. Bolton, for A. X. S., offered to vote in favor of the plan, reserving the right to withdraw the decision in case

the local chapter was unable to secure the consent of its Grand Council to participate in first term rushing. The compromise was accepted.

"Grafe moved, Bergmann seconded, that: 'For this year *only*, the dates for the fraternity rushing season shall be December 1st to December 10th, inclusive, provided that the Alpha Chi Sigma Fraternity is able to secure the consent of its Grand Council for it to participate in rushing at such time; otherwise, the present rules regarding the date of the rush season shall prevail.'"<sup>\*</sup> The resolution was carried.

Doctor White appointed the following as a committee to look after the stationery and supplies in connection with the rushing season: Grafe, Long and Stoner.

"Grafe moved that a committee be appointed by the chair to investigate and report at a later meeting of the Inter-fraternity Board recommendations looking toward the mitigation of the penalties attached last year to the Sigma Nu Fraternity in connection with violations of the rushing rules. This motion was seconded and carried; the following were appointed as a committee: Long, Crapo and Curtis."<sup>\*</sup>

No further discussion of importance took place.

#### FRATERNITY NOTES.

The Theta Xi Fraternity gave its first informal house dance of the year on the evening of November Second. About thirty attended the function, which was chaperoned by Mr. and Mrs. A. H. Lyon.

Throughout the evening, punch and candy were served, followed by other refreshments later in the evening. The Kerner-Charman Orchestra furnished the music for the dance.

The P. I. E. S. Fraternity entertained on Friday evening, November Second, with a Halloween party and dance. The affair was attended by sixteen couples, among which were A. G. Butler, '10, and wife, of Cleveland, Ohio, C. X. Pigg, Ex-'16, and O. L. Stock, '07, and wife.

The fraternity masked in similar costumes, and remained so until the first ceremonies of the evening were over, after which dancing took place. Refreshments were served at a later hour.

<sup>\*</sup>Minutes of Inter-fraternity Board Meeting, Nov. 1st.

#### HALLOWEEN DANCE.

The Halloween Dance given in the Rose gymnasium Saturday evening, November Third, proved quite a success. Rose and white streamers were festooned from the center of the ceiling, and shocks of corn were used to decorate the walls of the building. Cider was served throughout the evening. The music was furnished by the Kerner-Charman Orchestra.

Doctor White, Doctor and Mrs. Johonnott, and Professor and Mrs. Coles acted as chaperons. Antonio Gouvea, '18, A. H. Barnes, '19, Claude M. Gray, '20, and W. C. Skinner, '21, composed the committee in charge of the dance.

#### ATHLETIC ASSOCIATION.

At a recent meeting of the Athletic Association, James E. Orr, '18, was elected President, and Clark Foulkes, '21, Secretary.

R. F. E. Wiedemann, '19, has been elected Assistant Football Manager.



## JUNIOR BANQUET.

The annual Junior Halloween Banquet was observed by the Class of 1919 at the Terre Haute House. Nearly every member of the class attended, with Doctor Mees and Gilbert present as guests.

After a five-course dinner, Toastmaster Barnes first called upon Woodruff, who took as his topic "Don't Let Your Studies Interfere with Your College Duties." Wiedemann then told why the publication of *The Modulus* had been given up, and discussed the coming issue of THE TECHNIC, which is to take the place of the annual. Reinhard related his experiences in his efforts to solve the old, old point of debate—"Why Girls Leave Home"—and all listeners were decidedly shocked when "Ick" bared the fact that such supposedly honorable members of old '19 as the Hon. Aaron Richardson and Ivan S. Mendenhall, Esq., had been deciding factors in his extensive investigations. Stinson told of the past achievements of the class, and of plans for the future. Crapo talked of the Students' Million Dollar Friendship Fund, telling of conditions "over there" as described by Mr. Eddy, one of the foremost Y. M. C. A. workers abroad, who has just returned to this country. "Lefty" Gilbert discussed the coming R. P. I. Minstrels, confidentially springing some of the jokes (which will *not* be used). Doctor Mees then gave a most interesting talk—one which will not soon be forgotten by any of those present. Tilley concluded the program by asking Doctor Mees to read the following self-explanatory letter:

## SOPHOMORE BANQUET.

On Thursday, November First, the Sophomore Class held their annual banquet in the Hotel Deming Tavern. Fifty-three members of the class attended, having as their guests Doctor Mees and Coach Gilbert.

A five-course dinner was served, and between courses President Gray called on Doctor Mees, Gilbert, "Jim" King, "Hen" Manson, Joe Engelhard and others for short talks. Pence, Everingham, Froeb and Phillips composed a quartet that scored a hit with their singing. Stone and Phillips, in the "Hicky-Boola," gave some original exhibitions of esthetic dancing.

The banquet committee was composed of A. P. Woolfolk, Willys Wagner and Glenn Maxwell.

Terre Haute, Ind., Oct. 31, 1917.

*To the Board of Managers of  
Rose Polytechnic Institute.*

Gentlemen:—

In accordance with the time honored custom established by the many classes which have preceded us, it is with much pleasure and the sincerest feelings of loyalty to our school, that we, the members of the Class of 1919, enclose herewith certificate which evidences the purchase of a "Liberty Bond" of the Second Issue of 1917, of the value of \$100.00, which we desire to be used by your honorable body in the purchase of an article to be placed in the new school, and which will, at once, be of value to succeeding students and will serve as a memorial to this class.

In a "Liberty Bond" we feel that we have selected the most tangible means of expressing the aspirations of every true American heart, and which are wholly in keeping with the example of so many of the children of "Old Rose" who are today offering their lives and fortunes in defense of Democracy.

THE CLASS OF 1919.

The decision of the class not to pay the annual time-honored Halloween visit to the campus (in which it generally came out second best) was highly commended by Doctor Mees.

The balance of the evening was spent in singing the twentieth century version of "We Rumbled," and a new class song introduced by H. W. Streeter.

The members of the banquet committee were L. S. Stinson, John R. Cain and R. P. Gillum.

## THE FRESHMAN BANQUET.

The Freshman Banquet, held on November 7th, will long be remembered by the members of the Class of 1921. Never was there such food or such speeches. The banquet was a howling success from every standpoint—such a howling success, in fact, when the music started that the hotel manager threatened to oust the Frosh.

W. C. Skinner, able president and silver-tongued toastmaster, talked at length without saying much, and then introduced Doctor Mees, who spoke on "Perseverance," or "Bulldoggish-hang-onativeness," warning the Freshman against getting too discouraged.

Coach Gilbert was next on the program. His subject was "Hot Air," and he managed to exhaust a good deal of it without getting any-



thing thrown at him. "Gil" and the doctor both proved themselves to be "regular fellows."

After "Lefty's" eloquence had subsided, Mr. Arthur Hill and the famous Baum Brothers—Green and Rosey—entertained with some rare music. They tortured mandolins and violins until the feline population of the vicinity exhibited fiendish jealousy.

This was all, as far as the banquet was concerned, and '21 left, some to start a real party and some—very few—to go home.

### STUDENT COUNCIL MEETING.

October 26, 1917.

Called to order at 7:40 P. M. by President Long. Cain present for Barnes. Y. M. C. A., Scientific Society, and Symphony Club not represented.

For the *Modulus* committee, Bergmann reported that the Junior Class had decided not to put out a *Modulus*, but to put out the January number of *THE TECHNIC*; that a committee of Juniors had been appointed for the purpose of putting out this *TECHNIC*, and that the receipts of the *Modulus* dances had already been turned over to *THE TECHNIC*.

Skinner reported green caps ordered. Caps to be worn immediately after arrival.

President Long's financial report given. (Below)

The reading of Mr. Gilbert's report showed the total credits to be \$1,272.79, total expenditures \$1,223.31, and the balance \$49.48. Budget for November \$1,984.15.

Moved by Gray, seconded by Bergmann, that Mr. Gilbert be granted \$250.00 for his November budget. Carried.

Discussion of renewal of Mr. Gilbert's contract, which expires January 1, 1917. Moved by Bergmann, seconded by Wiedemann, that Mr. Gilbert's contract be renewed for the year 1918 at the present salary, granting to Mr. Gilbert the privilege of leaving on April 1, 1918, provided that he furnishes Rose with a competent baseball coach, and returns on September 1, 1918. Unanimously carried.

Bergmann reported that a committee consisting of Long, Bergmann, Stoner, Yatsko, and Furry had been appointed from the Senior Class to arrange a celebration for the night before the Rolla game, said celebration to take the place of the St. Patrick's Day Celebration.

Discussion of Y. M. C. A. war fund by Wiedemann and Crapo. Statement brought out that \$35,000,000 is to be raised in this country, \$1,000,000 to be raised by the colleges of America. Rose Polytechnic's quota given as \$1,000. The following committees were chosen from the four classes to obtain student pledges: Senior, Bergmann, Long, Grafe, Heedwohl, Wagner. Junior, Barnes (Chairman), Woodruff, Zimmerman, Wiedemann, Streeter, Stinson, Werbner, Owens. Sophomore, Gray (Chairman), Maxwell, Froeb, Engelhard, Cash. Freshman, Skinner (Chairman), Burns, Carnarius, Foulkes, Skidmore, Walker, Rosenbaum, Owens, Harley, Bolt.

Committees approved by Student Council.

Crapo appointed General Chairman of all of the above named Y. M. C. A. committees.

Adjourned.

GOLDSBOROUGH ROBINSON,  
*Recording Secretary.*

### Financial Report.

Student fund received to date from Mrs. Burton, Registrar...\$1,566.00

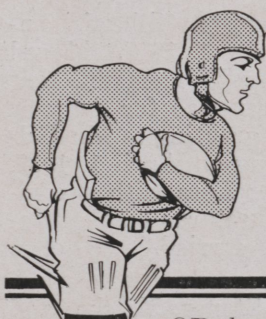
Distribution of funds:—

Athletic Association	.....60	%.....	\$939.60
Rose Technic	.....12	%.....	187.92
Symphony Club	.....3	%.....	46.98
Y. M. C. A.	.....5½	%.....	86.13
Scientific Society	.....½	%.....	7.83
Camera Club	.....1	%.....	15.66
General Fund	.....18	%.....	281.88

### Financial Standing of Organizations.

Organization.	Bal. from Student Last Term	Fund	Earned	Total	Expen- ditures	Balance Oct. 26, '17
Athletic Association	.....	\$939.60	\$238.00	\$1,177.60	\$918.00	\$259.60
Rose Technic	\$4.02	187.92	9.40	201.34	.....	201.34
Symphony Club	.....	46.98	.....	46.98	.....	46.98
Y. M. C. A.	.....	86.13	.....	86.13	.....	86.13
Scientific Society	.....	7.83	.....	7.83	.....	7.83
Camera Club	.....	15.66	.....	15.66	.....	15.66
General Fund	.....	281.88	.....	281.88	.....	281.88
Total	.....	.....	.....	.....	.....	\$899.42





# FOOTBALL

**F**OR the first time since 1911, Coach Gilbert's eleven promises to bring the I. C. A. L. championship to Rose. With seven games of the schedule now played, but one more contender, Butler, must be defeated in order to give the Engineers an undisputed claim to the secondary title.

Notwithstanding Gilbert's success with the 'Varsity, the season has not been without its disappointments. The loss of the DePauw and Washington games undoubtedly has cost us high ranking among the secondary colleges of this section of the country—an honor for which all followers of the team had reason to hope. Good as it may look to us, the I. C. A. L. championship this year will not mean as much as it has in the past. Almost without exception the teams are below their usual standard, and to stand at the top of this conference—which no longer includes DePauw—is not enough for an aggregation as strong as that representing Tech to accomplish.

A weak offensive and the team's attitude toward practice have been Gilbert's chief worries this fall. In a large measure the failure of some of the men to turn out regularly for practice has weakened the offensive, for no coach can build up a strong attack without the regular 'Varsity in suit every evening. The loss of Gale after the DePauw game also proved a hard blow, as Gilbert has been forced to resort to some costly experimenting in shifting his men, in an effort to find someone to fill the star fullback's shoes.

This season's schedule could hardly be improved upon, and with good trips and the chance to make the best Rose team in years before the 'Varsity, it would seem that the coach would experience no trouble in getting his men out for practice daily. Yet the indifferent attitude of his men in this respect has probably caused Gilbert as much concern as anything thus far. Rose is playing elevens representing schools from two to ten times its size, and a creditable showing against such opposition is impossible without constant practice and hard work on the part of every 'Varsity man. Not all the costly fumbles which have occurred this year should be attributed to the lack of practice, but this has been cited as the chief cause of many of the misplays, by Gilbert as well as others.

Of the remaining games—St. Louis University, Butler and the Missouri School of Mines—none can be dropped if the season is to be considered a success. The loss of the Butler game would cost Tech clear title to the I. C. A. L. championship, while defeat at the hands of either St. Louis University or Rolla would indicate a low standard of Indiana secondary college football this year.

With the team that represents Rose this year, victories over these three schools may certainly be expected. But over-confidence and the fumbling jinx are to be feared more than any opposition with which we have had or will have to contend.

## ROSE—WABASH.

Playing a consistent game of straight football, Gil's gladiators had no trouble in downing our old-time rivals, Wabash, 6 to 0. It has generally been conceded that the I. C. A. L. championship for 1917 would rest between Rose and the Scarlet, so by the triumph Tech has a good chance to cop the honor. The score

by no means tells the relative strength of the two teams—a fact which seems to hold true of the majority of our games this season. The Engineers outclassed Wabash in every department of the game.

Tech's lone touchdown came in the first few minutes of play as the result of making downs



five straight times after receiving the kick-off. Orr crossed the line with what proved to be the only tally of the game. Captain Grafe carried the ball over the line again in the second half, but dropped the oval on being tackled, a Wabash man recovering it.

To pick any one or two Engineers who "perhaps played best for Rose," or "who shone on the defense" is an impossible task. For the gains which Orr and Engelhard made on line bucks, as much credit is due the linemen as the backfield men. And it was seldom that either "Doc" or "Joe" was stopped before he had plowed through for five or ten yards. A curious incident which came to our notice on at least three occasions in the first quarter was that Wabash actually gained ground—or at least profited—by being penalized. On each of three penalties which were handed Wabash as the result of off-side tactics, Rose had already gained more ground on the play than the penalty gave.

"Chick" Springer and "Butch" Barnes again have the pleasure of seeing their names in print, as each saved the game by nailing a Scarlet runner after he had evaded the other ten Engineers.

The game in detail follows:

First half—Wabash kicked to Springer, who returned the ball fifteen yards. Howard hit the line for one yard. Engelhard and Orr went through center for ten yards. Engelhard hit off tackle twice, each time for six yards. Wabash was absolutely at sea, and the Rose halfbacks made yard after yard at will. With the ball on the ten yard line, Engelhard fumbled, Wabash recovering. Thompson punted out of danger, but Rose started another drive, Engelhard and Orr averaging five yards per down in off-tackle plays. Orr finally crossed for the only touchdown of the game. Engelhard missed goal. Score: Rose 6, Wabash 0.

Floyd kicked on-side on the following kick-off, and "Butch" Barnes recovered the ball while Wabash looked on. Howard attempted a pass, which was intercepted. Wabash had about twenty yards to make on the fourth down, and Thompson punted to Springer. Orr and Engelhard gained on line plays, but a forward pass was intercepted by Gavit, who ran twenty yards or more before Barnes got him from behind. "Butch" pushed a Wabash man aside and stopped the runner with a pretty tackle. Wabash made the distance to the twenty-five yard line, where a drop-kick was at-

tempted. The effort went wild, and play was resumed on the twenty yard line as the half ended.

Second half—Wabash kicked to Springer, who returned the ball to his thirty yard line. First down was made by Rose three times, Orr and Engelhard doing the bulk of the work. Tech was then stopped, and Wabash made first downs by line bucks by Huffine and Thompson. On the next play Wabash fumbled, and Rose took the ball to the Scarlet five yard line. Howard hit center for three yards, and Grafe crossed the line, only to drop the ball on being tackled. Wabash recovered, and play was resumed on the twenty yard line. The Scarlet started a rush down the field, Gavit getting loose around right end for a twenty-five yard run before Springer tackled him. Orr intercepted a forward pass, and Rose took the ball into Wabash territory as the game ended.

The line-up and summary:

Rose (6)		Wabash (0)	
Springer	L.E.	Madison	
Bake	L.T.	Neal	
Gray	L.G.	Cash	
Floyd	C.	Neighbors	
Henry	R.G.	Ott	
Barnes	R.T.	Larson	
Moses	R.E.	King	
Grafe (Capt.)	Q.	Huffine	
Orr	L.H.	Gravit	
Engelhard	R.H.	Saidlais	
Howard	F.B.	Thompson	

Touchdowns—Rose (Orr).

Rose	6	0	0	0—6
Wabash	0	0	0	0—0

Referee—Robinson (Indiana.) Umpire—Wilder (Purdue). Head Linesman—Stiles (St. Louis). Substitutes: Rose—Burns for Howard and Howard for Burns. Wabash—Clauves for Saidlais, King for Madison, Shaver for Ott and Garfield for Clauves. Time of quarters—Fifteen minutes.

#### ROSE—WASHINGTON.

Weak offensive play, several rank decisions on the part of one of the officials, and perhaps a little over-confidence cost Rose the Washington game, which had been expected to result in an easy victory. Washington displayed better form than in any other game so far this season, stopping nearly every attempt of the Engineers to gain on the shift formations which worked so successfully in the Wabash game. With the St. Louis newspapers "doping" us the game by forty points or more, the reverse at the hands of the crippled Washington eleven certainly upset the old bucket—and some of that over-confidence, let's hope.



During the greater part of the first period, Washington's punts, with the assistance of a good wind, forced the play into Rose territory. At no time, however, was the Rose goal line in danger, although one of Kling's attempts to goal from placement on the forty yard line went wide by only a yard or two.

In the second period, a long pass, Howard to Engelhard, put the ball within Washington's ten yard line. Referee Kelly called back the ball, however, claiming that the pass was incomplete because one Rose and one Washington man had touched the ball before Engelhard finally caught it. Umpire Grogan's efforts to convince Kelly that the pass was legal were of no avail, although Kelly admitted his mistake shortly after the close of this quarter. Rose continued the drive toward the Washington goal line until, with four downs to make the final five yards, a direct pass from center went over "Doc" Orr's shoulder for an eight yard loss. "Doc" recovered the ball, but the necessary thirteen yards couldn't be made in three downs.

During the entire first half, frequent penalties for off-side play cost Tech several first downs. Head-Linesman Pratt—who, along with one Shortstop Lavan, comprises the "hundred thousand dollar infield" of the St. Louis "Browns" (they finished seventh)—generously donated us all the setbacks, although Washington apparently deserved as much consideration in this respect as Rose.

The third round consisted of an uninteresting exchanging of punts, with honors about fifty-fifty. The only exciting play of the entire quarter occurred when Pratt penalized Washington five yards for something or other.

The final quarter proved as uneventful for the first five minutes. Washington had made but one first down the whole afternoon, and when the Missouri backfield had shown its usual offensive prowess for three downs, Captain Kling was called upon to kick from the fifty yard line. The play as executed was a place kick, but whether it was intended to serve the purpose of a punt or a goal from the field was hard to decide. The attempt—whatever it was—fell short by about twenty yards, and Springer allowed the ball to roll to the two yard line. A Washington man then pulled a star "boner" by fouling the ball for a touch-back. However, Referee Kelly promptly covered it up with another of his own in forcing Rose to put the ball in play on the two yard line, instead of the twenty yard line. Eighteen

yards mean a great difference any time, but when they're within the twenty yard line they look like eighteen miles of trenches full of machine guns. Our last alibi is that this one by Mr. Kelly must have affected the morale of our troops. On the first play, Benway caught Howard's punt and started through the Rose team. Good interference and some loose exhibitions of tackling by Rose men enabled him to score the only touchdown of the game. Kling kicked goal.

The line-up and summary:

#### Washington (7)

Kling (Capt.)	.....L.E.....	Springer
Grossman	.....L.T.....	Bake
Noble	.....L.G.....	Gray
Kremer	.....C.....	Floyd
Marquard	.....R.G.....	Henry
Kurrus	.....R.T.....	Barnes
Benway	.....Q.B.....	Grafe (Capt.)
Foelsch	.....L.H.....	Orr
Harvey	.....R.H.....	Engelhard
Meyers	.....F.B.....	Brophy

#### Rose (0)

Touchdown—Benway. Goal from touchdown—Kling. Referee—Kelly (Illinois). Umpire—Grogan (Holy Cross). Head Linesman—Pratt (Alabama). Substitution: Rose—Moses for Howard. Time of quarters—Fifteen minutes.

#### ROSE—FRANKLIN.

Rose annexed her third straight I. C. A. L. victory when Franklin was downed on the local campus, 12 to 6. Engelhard and Springer scored for Rose, and the Baptist tally came as the result of an intercepted forward pass followed by a sixty yard run.

The game was the most poorly played contest of the season. Both teams were off-color, Tech's fumbling again proving costly. Rose played the entire first half without Captain Grafe, who was suffering from a sprained ankle. Floyd and Brophy held down the full-back position in turn, and both men put up a scrappy game. Both elevens tried forward passes frequently, but very few were completed.

The game in detail follows:

First half—Franklin kicked off to Bake, who fumbled. A Franklin man recovered the ball. An end run was blocked, a forward pass was incomplete, and Pruitt dropped back to punt. The pass cleared his head, and Tech had the ball on the thirty-five yard line. Rose was penalized five yards for off-side play, but a forward pass, Floyd to Orr, netted twenty yards. Springer failed to gain on an end run, but Engelhard dodged through the line for five, and went over for a touchdown on the next play. He failed at goal.



After getting within the ten yard zone late in the first quarter, Rose fumbled, but recovered on the first play in the second period. Engelhard slashed his way through the line for six yards, and Bake added several. A fake pass netted Engelhard twelve yards, and Bake again smashed through for a short gain. Engelhard followed with a plunge through tackle that put the ball on the one yard line. Springer then ducked through center for a touchdown. Brophy failed in the try for goal. Score: Rose 12, Franklin 0.

Second half—Following the kick-off, Franklin tried a series of line plays which failed to net them any appreciable gain, and Pruitt was forced to punt. Then Rose began a march down the field. It looked promising, but after Orr had skirted end for a twenty-five yard dash, Ross nabbed a forward pass and sprinted sixty yards for a touchdown. Ross failed at goal, and the scoring for the afternoon was complete. Score: Rose 12, Franklin 6.

The line-up and summary:

Rose (12)		Franklin (6)	
Brophy, Springer	L.E.	Pruitt	
Bake	L.T.	Roberts	
Henry, Floyd	C.	Beck	
Boring	L.G.	Campbell	
Gray	R.G.	Riley	
Wiedemann, Henry		Yarian, Hoffman	
Barnes	R.T.	Patton	
Moses	R.E.	Ross	
Springer, Grafe	Q.	Knogle	
Engelhard, Reinking	L.H.	T. Campbell	
Orr	R.H.	Fonwall	
Floyd, Brophy	F.B.	Ragsdale	
Touchdowns—Engelhard, Springer, Ross. Referee—Herrick. Umpire—Palmer. Head Linesman—Maloney.			

As every stude knows, Rose and DePauw stand about 50-60.

On the Saturday following our 6 to 0 setback at Greencastle, the Methodists held Purdue 7 to 6, at Lafayette. Northwestern could beat Purdue by only one touchdown. From this we might be able to reach the conclusion that Tech is of Conference caliber—if DePauw hadn't caught the Boilermakers on an off day, and if those said Boilermakers could ever win a Conference game.

'T'as been murmured about the "James" that some more of those rare interclass scrambles for the basketball title will be staged this year. Be it known (Streeter writes) that the Class of '19 holds the cup at present!

## ROSE—DETROIT.

On Saturday, November Eleventh, the Rose eleven was handed the short end of an 84 to 0 count by the University of Detroit eleven at Detroit. Playing without the services of two of the "regs," Orr and Gray, Tech met a team that is claimed to be the strongest in the West, excepting that of Michigan University.

The game was a procession of gains for the powerful Michigan team, Tech threatening on only one occasion, when two forward passes brought the ball to Detroit's ten yard line. A third attempt at passing was intercepted by Halfback Allen, who raced ninety yards for another touchdown for the Detroiters.

The line-up and summary:

Detroit University.		Rose.	
Lauer	L. E.	Brophy	
Voss (Capt.)	L. T.	Floyd	
Bateson	L. G.	King	
Kenney	C.	Henry	
Harwood	R. G.	Howard	
Hogan	R. T.	Barnes	
Kane	R. E.	Reinhard	
Edwards	Q. B.	Springer	
Fitzgerald	L. H.	Grafe (Capt.)	
Allen	R. H.	Engelhard	
Hendrian	F. B.	Bake	
University of Detroit		26	19 13 26—84
Rose Polytechnic		0	0 0 0—0

Touchdowns—Lauer (3), Allen (3), Fitzgerald (2), Brennan (2), Kane, Edwards, Hendrian. Goals from touchdown—Allen, 4 in 9; Harwood, 1 in 1; Voss, 1 in 3. Referee—Lane (University of Michigan). Umpire—Austerheld (Colgate). Head Linesman—Lawton (University of Michigan). Time of quarters—Fifteen minutes.

Business Manager Stinson wishes it to be known that he played in the Franklin encounter. This is one of many special favors granted to those connected with the press.

"Head" Gray deserves special mention for his game fight against Wabash. Head had a bursted vein in his leg that would put anyone but an Engineer on the shelf, but he put up the game of his life against the Scarlet.

Referee Kelly earned his "W" in one game at St. Louis. Poor sportsmanship upon our part to say this, perhaps, but Grossman, Washington left tackle, was the star in this department that afternoon.

Tech's victory over Wabash marked the first Scarlet loss in the I. C. A. L. since 1913.





# REVIEWS

## Interesting Technical Articles of the Month

METALLURGICAL AND CHEMICAL ENGINEERING, Oct. 15, 1917.

*Storage, Weathering, and Spontaneous Combustion of Coal.*

Important information gathered by the National Electric Light Association, on the effect of time and weather on coal.

*Radio-Activity and Some Advances in Physical Science.*

By Howard H. Barker. A paper read before "The Teknik Club," of Denver.

METALLURGICAL AND CHEMICAL ENGINEERING, Nov. 1, 1917.

*How do the Warring Nations Obtain their Nitrogen Supply?*

By S. Nauckhoff. A comprehensive article, translated from the Swedish language, and giving a considerable amount of valuable information on the subject of the fixation of nitrogen, in the past, and at present.

JOURNAL OF INDUSTRIAL AND ENGINEERING, Nov. 1, 1917.

*The Future of the Chemical Industry in the United States.*

By L. H. Blackeland.

SCIENTIFIC AMERICAN SUPPLEMENT, Nov. 3, 1917.

*Synthetic Nitrogen Compounds.*

From *The Engineer*. Discussing a great German war industry.

SCIENTIFIC AMERICAN, Nov. 3.

*The Liberty Truck.*

By C. H. Claudy. Technical details of our newest substitute for the army mule.

THE ELECTRICAL JOURNAL, November.

*Phasing out High-Tension Lines.*

By E. C. Stone.

ELECTRIC TRACTION, October.

*The Electrification of the Montreal Terminal.*

By W. C. Lancaster. A description of some of the interesting features of the ten-mile electrified entrance into the downtown district of Montreal recently completed for the Canadian Northern Railway.

CEMENT WORLD, October.

*Circular Reinforced Concrete Retainers for Storage Fluids.*

By John Marr. Outlining the method of procedure in designing the walls and bottoms of concrete water tanks.

MUNICIPAL ENGINEERING, November.

*Design and Construction of 1,500,000-Gallon Concrete Reservoir.*

By H. F. Blomquist. A discussion covering features on which designing engineers differ.

ENGINEERING NEWS-RECORD, November 1.

*Steps in Turbine Runner Design that Engineers Should Know.*

By Walter C. Pomeroy.

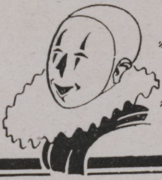
## BOOK REVIEW.

**Laboratory Guide and Manual**, by Allan Rogers, in charge of Industrial Chemistry, Pratt Institute, Brooklyn, N. Y. Second Edition. D. Van Nostrand Company, New York. \$2.00 Net.

In this enlarged and thoroughly revised edition, the experiments touch more closely the problems of today than the exercises of the first edition. By following actual factory practice, the author seeks to give the student experience in handling materials on a large scale, the care and use of machinery, the cost of raw materials, labor problems and shop discipline. A certain knowledge of Chemistry is pre-supposed.

Although the book is easily legible and clearly illustrated, it might have been reduced to a more convenient form by using a better spacing arrangement.





# DIFFERENTIALS

## Straight Football.

Frosh—"Why does this Lou Bake double his fists when he plays football?"

Senior—"So he'll have four."

R. P. I.

Peddle—"In what order do the cylinders of the Ford motor fire?"

Furry—"Generally go: one, one, one, one."

R. P. I.

"How is business?" asked the comedian.

"Oh, it's falling off," replied the tumbler sadly.—*Widow.*

R. P. I.

Temperance lady—"My good man, when you are tempted to drink, think of your wife at home."

*Hombre*—"Madame, when I am thirsty, I am absolutely devoid of fear."

## Fifty-Fifty.

A man went to Louisiana on a visit to a certain colonel there. It was bedtime when he arrived at the house, and as it happened that there were no mosquito-curtains to his bed, he suffered severely all night long. When the negro servant came into the room the following morning with water and towels, the unhappy victim asked why there were no mosquito-curtains in the room.

"Doesn't the Colonel have any in his rooms?" he finally inquired.

"No, suh," replied the negro.

"Well, how on earth can he stand it?" asked to visitor.

"Well, suh," came the reply, "I reckon it's jes' dis way. In de fo' part ob de night, de Colonel's mos' gen'ly so 'toxicated dat he don' pay no 'tention to de skeeters; an' in de las' part ob de night de skeeters is gen'ly so 'toxicated dat dey don' pay no 'tention to de Colonel."

—*Philadelphia Press.*

## NOVEMBER TECHNIC ADVERTISERS

Ed Sparks.  
Wm. Schonefeld, Druggist.  
Thorman & Schloss.  
Dr. James McCall.  
L. C. Smith & Bros., Typewriter Co.  
Swope-Nehf-Bloomer Jewelry Co.  
Derringer's Shave Shop.  
Colonial Dairy Lunch.  
M. Joseph's Sons.  
L. D. Smith.  
Max Frank.  
Great Northern Barber Shop.  
Engineering Magazine.

Plaza Cafe.  
General Electric Co.  
Grand Opera House.  
Tune Bros.  
Heinl's.  
Greek Candy Kitchen.  
Myers Bros.  
Freitag, Weinhardt & Co.  
Hood & Schley.  
Moore-Langen Printing Co.  
Charles M. Higgins & Co.

St. Nicholas Barber Shop.  
American Lead Pencil Co.  
Walk-Over Boot Shop.  
The House of Foulkes Bros.  
Bill Cody's \$2 Hat Shop.  
The Root Dry Goods Co.  
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Ermisch Cleaning & Dyeing Co.  
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Frosh—"When is a credit not a credit?"  
 Soph—"When it's in Military Training."

R. P. I.

Heading in *The American Machinist*:  
 WE HAVE NO ACCIDENTS IN OUR SHOP.

By Entropy.

R. P. I.

"Before I married you, you said you had money."

"See what one gets for lying."—*Puck*.

R. P. I.

"See here, there is a hair in my soda."

"Oh, it's that boy again. He's so careless in shaving the ice."—*Widow*.

R. P. I.

"He disappeared after he had borrowed ten dollars."

"And he was such a promising young man."

"That's how he got it."—*Froth*.

R. P. I.

Prof: Can anyone tell me how to draw the sine curve?"

Bright Student: "Put your chalk on the board and shiver."—*Case Tech*.

He (observing a white streak on his shoulder): "Never mind, dearie, it will all brush off."

She (starting to cry): "Oh, Harry, how do you know?"

R. P. I.

"Willie, does your mother know you smoke?"

"Naw, I want it to be a surprise."—*Life*.

R. P. I.

"Pa, what's a running account?"

"It's an open account in a dry goods store, my son, which keeps your mother running downtown all the time to buy things."—*Boston Transcript*.

R. P. I.

A miser saves every cent—a skunk doesn't.

R. P. I.

Employer: "We are lacking work ourselves and any work I would give you would be taking it away from my own men."

Senior: "Sir, the little work I would do wouldn't hurt anyone."

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It has given tangible form to invention, in apparatus of infinite precision and gigantic power.

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