The Wisconsin engineer. Vol. 30, No. 7 April 1926

Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

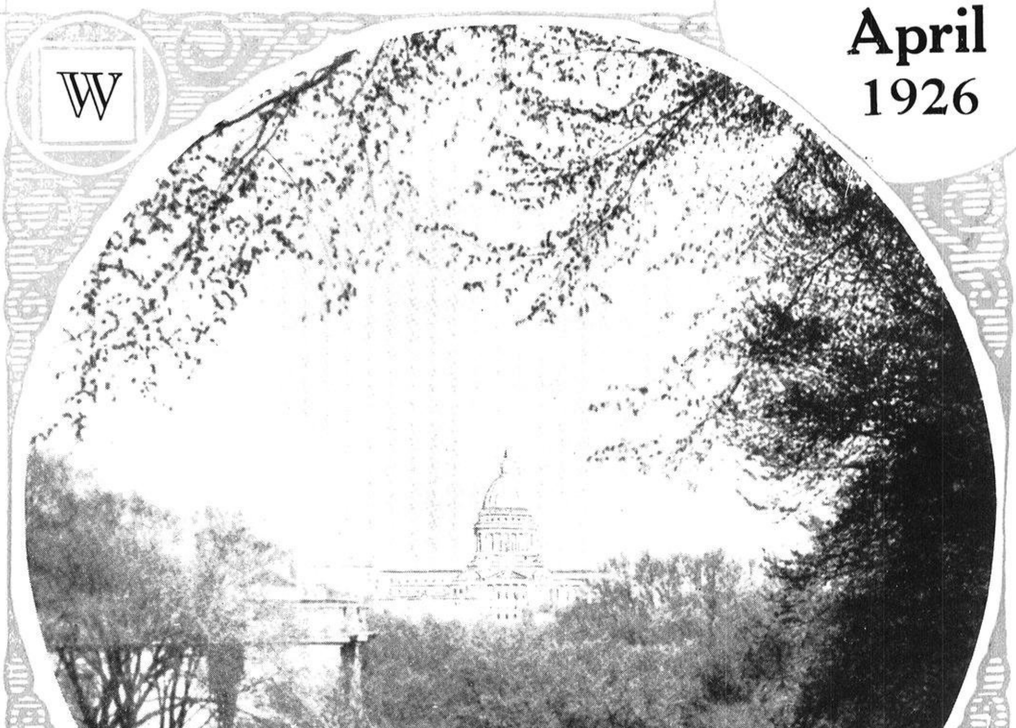
https://digital.library.wisc.edu/1711.dl/7P3DBZ6M5SIJV8I

The Wisconsin Engineer

MEMBER
OF
ENGINEERING
COLLEGE
MAGAZINES,
ASSOCIATED

April
1926

W

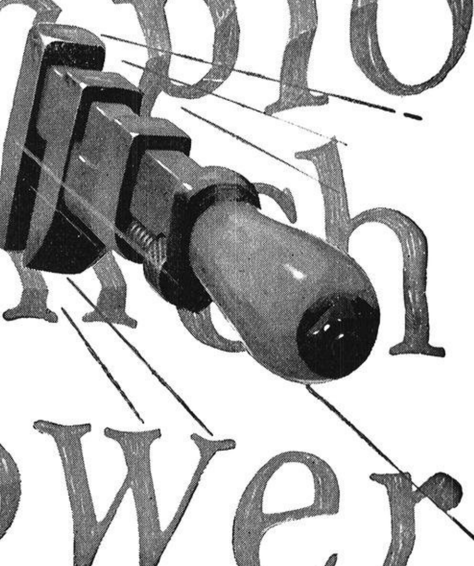


VOL.
XXX

NO.
7

The College of Engineering
University of Wisconsin
Madison

Waste!— World's Champion Wrench Thrower



WASTE throws wicked wrenches at machinery, in the form of excess friction, needless wear and misalignment. Today engineers in every field are applying Timken Tapered Roller Bearings to protect their designs from Waste.

Timkens put steel-to-steel rolling motion in place of the old sliding bearings. This alone saves up to 30% of power costs where Timken Bearings are used. And far less lubricant is needed, another great economy.

Timkens, with their tapered design, also give machinery higher capacity for bearing stresses from all directions, while simplifying the bearing mountings. Size, weight, and costs are thus reduced. Resistance to every form of wear is far increased.

Added factors in Timken endurance are Timken-made bearing steel, and the exclusive design which produces positive roll alignment in Timken Bearings.

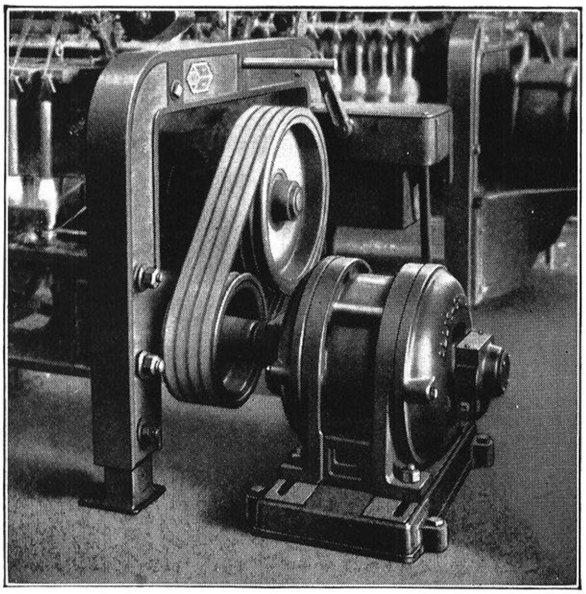
Having so many possibilities for improving machinery in every way, Timken Bearings are of vital interest throughout manufacture, construction, mining, agriculture and transportation. Timkens are bound to enter still more deeply into the career of the engineer of tomorrow. You can inform yourself by sending for the valuable little stiff-covered Timken book, mailed free.

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

TIMKEN Tapered Roller BEARINGS

ALLIS TEXROPE DRIVES

(Patents Pending)



Where Smoothness Is Paramount—
Allis Texrope Drive Applied to Cotton Twister

The Balloon Tires of Industry

Like Ballon Tires, Texrope Drives carry the loads without transmitting the shocks and jars. They are smooth and flexible, yet slipless, powerful and durable. In addition, they are silent, clean, simple, troubleproof and not affected by moisture, dust and dirt.

Just as Balloons are replacing high pressure, unyielding tires, Texrope Drives are replacing unflexible short center drives and space wasting long center drives thruout industry.

Write for Bulletin 1228

ALLIS-CHALMERS MANUFACTURING CO.

MILWAUKEE, WIS. U.S.A.

PRINTING

GETS THINGS DONE

It builds sales, creates good-will, wins friends retains old customers, adds new ones. It taps hidden reservoirs of business, opens new markets, carries your message to the four corners of the world.

BLIED PRINTING COMPANY

MADISON, WISCONSIN

The Wisconsin Engineer

25c A Copy

Published monthly from October to May, inclusive, by
THE WISCONSIN ENGINEERING JOURNAL ASSOCIATION
306a Engineering Building, Madison, Wis. — Telephone University 177

Founded 1896

$1.50 A Year

CONTENTS

VOLUME 30 APRIL, 1926 NO. 7

The Wisconsin Engineer
UNIVERSITY OF WISCONSIN

VOL. XXX, No. 7 MADISON, WIS. APRIL, 1926

HOW COME, MATHEMATICS

By PATRICK H. HYLAND, *Associate Professor of Machine Design*

A review from *A Short History of Science,* by *Sedgwick & Tyler.*

WHILE mathematical science first assumed definite form in Greece, the Greeks were indebted to older civilization for primitive forms of arithmetic and geometry. Man, from the time when he had first reached the stages of intercourse with his fellow beings, had need of some system of numbers, and it was but natural that fingers and toes were first used as counters. This is the well known anatomical basis for our denary or decimal number system. The choice of notation determined the rate of progress; and however great the capacity for inventing words to represent numbers, it soon became necessary to employ some system which would lead to a development of higher from lower names. We do not realize the extent of our indebtedness to the comparatively recent Arabic notation, in which numbers of any magnitude may be expressed in ten symbols. (These symbols are of Hindu origin, borrowed by the Arabs).

Babylonian Arithmetic: The Babylonians used but three symbols; arrow-head shaped characters employed on tablets.

The position of the arrow head indicated the number it represented. The arrowhead pointed down equalled 1, if pointed to the left equalled 10, a combination of two arrowheads, one pointing down and one to the right equalled 100, etc. With such a system of combinations, numbers running into the hundreds of thousands could be represented. The use of the words "thousand" and "ten thousand" to designate a multitude, occurs in many passages of the Bible. The Babylonians employed fractions to a limited extent, they used a table of squares and cubes, and employed arithmetical and geometrical progressions. They also introduced a system of weights and measures, the unit of weight depending on that of length, as in the modern metric system.

Babylionian Geometry: The use of the circle led to the discovery that a chord equal to the radius subtends one sixth of the four right angles at the center, and becomes one side of a regular inscribed hexagon. This figure is common in Babylonian monuments. The assumption that the chord and arc were equal led the Babylonians to fix the first approximation of the ratio of the circumference of a circle to its diameter, $\pi=3.0$ They also used 360 degrees for divisions of the circumference of the circle.

Egyptian Mathematics: About 2000 B. C. the Egyptians used a well developed system of whole numbers and fractions; a method of solving equations of the first degree with one unknown quantity; and an approximate method of finding the circumference of a circle of unknown radius.

Along the Nile the land was so divided among the Egyptians that each one received a triangle of the same size, and he was taxed accordingly. When the river overflowed its banks, some land was lost, and the owner would report to the King to have his tax adjusted. The king would send a priest to measure the loss and make a proportionate adjustment of taxes. Hence, the necessity for some system of land measurement, requiring the study of arithmetic and geometry; also, this was one of the early uses of the art of surveying.

Engineering construction in Egypt had developed to a high degree as early as 4000 B. C. The pyramids are evidence that at that time there was an appreciation of geometric form, since in nearly all of the pyramids the slope of the sides is 52°, and the bases are nearly uniform. In the third century A. D., Porphyry says, "From antiquity the Egyptians have occupied themselves with geometry, the Phoenecians with numbers and reckoning, the Chaldeans with theorems" (The Phoenecians at that time were the world's merchants and traders).

Greek Mathematics: The Greek philosophers drew a sharp distinction between the art of calculation (logis-

"Fingers and Toes were first used as counters".

tica) and the science of numbers (arithmetica). They deemed the art of calculation unworthy of the attention of philosophers, and perhaps to this attitude may be attributed the fact that the Greek mathematics was weak on the analytical side, and reached its highest development after about two centuries.

It was in geometry that the Greek philosophers excelled, perhaps because the Greeks loved symmetry in form and had a gift for logic.

The date of the birth of Pythagoras is doubtful, but to him is attributed proof for the "Pythagorean proposition", familiar to almost every high school boy.

The fifth century B. C. is famous as the "Golden Age of Greece." Hippias of Elis (420 B. C.) invented the famous quadratrix, a curve which served to solve the celebrated problems of the times, viz., the quadrature of the circle and the trisection of an angle. About this time the well known scheme of "reductio ad absurdum" was employed in the proof of theorems.

It was under Plato's influence, altho he himself was not a mathematician, that accurate definitions were formulated, methods of proof criticized, and systematized, and pure logic insisted upon in the study of mathematics. Such axioms as "equals subtracted from equals leave equals", date from this period. Plato speaks of the ignorance of his countrymen: "He is unworthy of the name of man who is ignorant of the fact that the diagonal of a square is commensurable with its sides". Plato is credited with having discovered the analytical method thru which mathematics was raised to a science comparable with the science of medicine. A large number of the followers of Pythagoras and Plato contributed new discoveries to mathematical science, many of them at the time being considered as the unprofitable amusement of a speculative brain.

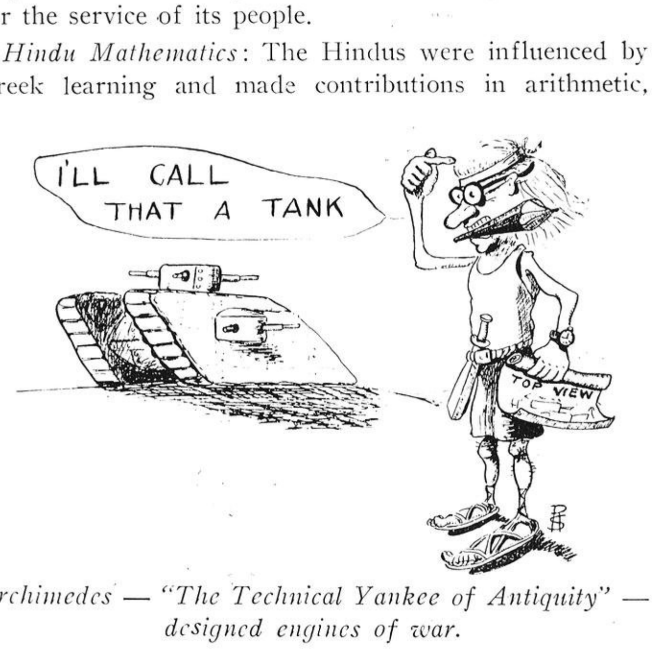
The Alexander school of Greek mathematicians was brought about by the subjugation of Egypt by Alexander the Great in 330 B. C. The fame of Alexandria soon eclipsed that of the Athens, and the scholars of the times flocked to Alexandria as a scientific center. It was here that Euclid wrote his elements, a series of thirteen books and a systematic introduction to Greek mathematics.

Book I was on triangles and the theory of parallels; Book II on quadratic equations which to us seem less obscure than they appeared to the Greeks at that time. Book III deals with the circle, and Book IV with inscribed and circumscribed polygons. This series of books contained a general treatment of arithmetic, algebra and geometry. The Elements of Euclid have exerted an immense influence upon mathematical development, especially upon mathematical pedagogy. Archimedes (278 B. C.) was a great mathematician and engineer. He laid the cornerstone of mechanics, and, it is said, anticipated the calculus. The works of Archimedes (278 B. C.) include books on the parabola, the sphere, circle, spirals, conoids, and spheroids. Plutarch says that it is not possible in all mathematics to find more difficult problems and more intricate questions, and more simple and lucid explanations than those given by Archimedes. This was due to his incredible effort, but to all appearances, easy and unlabored results. As an engineer, Archimedes has been given the title of "the technical Yankee of antiquity". This skill was used extensively as a military engineer to build, devise and handle, engines of war used by the Syracusans to repel the attacking Roman armies.

The ancient mathematicians had not the resources of analytical geometry and the calculus, which, tho anticipated by them, were not invented until some centuries later.

With the decline of Alexandrian learning, the Roman Empire was in the ascendancy, and one of the striking facts of history is the total lack of any evidence of real interest in science or scientific research under Roman dominion. There is one notable exception, however, in that the Romans were far superior to all their predecessors and, until very recent times, to all their successors, in military and civil engineering, Roman forts, roads, acqueducts, theatres, baths, and bridges show evidences of it; and never before or since has any empire built so many and such enduring monuments for the service of its people.

Hindu Mathematics: The Hindus were influenced by Greek learning and made contributions in arithmetic,



Archimedes — "The Technical Yankee of Antiquity" — designed engines of war.

algebra, and trigonometry, branches in which the Greeks were weak. Ara-bhata (530 A. D.) used the value π as 3.1416, and compiled tables of sines for certain angles. That the Hindus were acquainted with the so-called "humanizing of knowledge" is shown in the problem book of Bramagupta. "Two apes lived at the top of a cliff of height 100, whose base was distant 200 from a neighboring village. One descended the cliff and walked to the village. The other flew up a height x, and then flew in a straight line to the village. The distance traversed by each was the same. Find x."

"Beautiful and dear Lilavati, whose eyes are like the fawn's! Tell me what are the numbers resulting from one hundred and thirty-five taken into twelve? If thou be skilled in multiplication, by whole or by parts, whether by subdivision or form or separation of digits. Tell me auspicious woman, what is the quotient of the product divided by the same multiplier?"

The Hindus had no mathematical order, gave no definitions, and were indifferent to fundamental principles.

Arabian Mathematics: The Arabs themselves were not given to scientific study, but their relation to Greek and Hindu thinkers is important. It appears that about 900 A. D., the Arabs were familiar with arithmetic and algebra, and had a decimal system, they knew of the chief works of the Greek mathematicians, some of which have come down to us only thru Arabic translations.

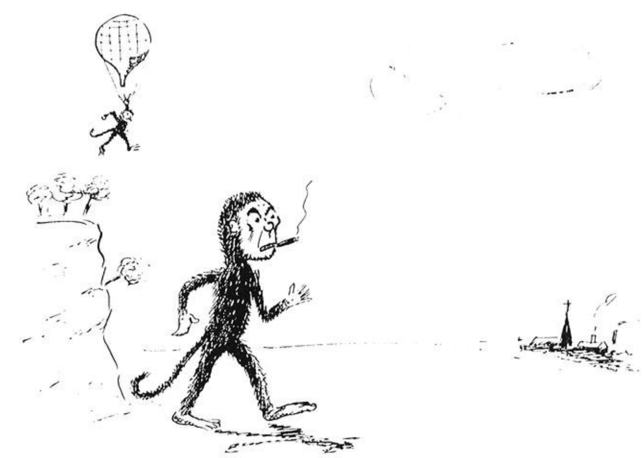
The Beginning of Modern Mathematics: About the beginning of the sixteenth century, Leonardo de Vinci turned from art to science and engineering, and he is regarded as the world's most versatile genius and the first engineer of modern times. The printing press was invented about the year 1450 and from that time on mathematics made rapid headway. Arabic numerals were known, but the mathematics in the early universities did not go beyond the solution of simple problems in quadratic equations. The application of mathematics in early times had been connected with trade, accounts, the calendar, the needs of the military engineer, and with the sines and tangents of the navigator and astronomer. During more recent times the applications became more important, and mathematics was being cultivated for its own sake. Mathematicians became more and more a distinctive class of scholars, and text books took shape.

The earliest printed book in arithmetic and algebra was printed and published at Venice in 1494 by Lucas Pacioli, a Franciscan monk. Rules are here given for the use of arithmetic and the extraction of square roots. An example from this text was "to find the original capital of a merchant who spent a quarter of it in Pisa and a fifth of it in Venice, who received on these transactions 180 ducats, and who had in hand 224 ducats". Addition was denoted by p or p-, equality by ae. The introduction of the radical sign and of the signs + and — date from this time.

Geometry was used by the architects and artists of the early Renaissance, especially in perspectives. Raphael includes himself in a group of mathematicians.

Robert Recorde published a book on arithmetic in 1540, which was one of the earliest mathematical books printed in English. His book was called *Grounde of Artes* and ran thru twenty-seven editions. He employed the symbol +, "whyche betokeneth too muche, as this — plaine without a cross-line betokeneth too little." He used the sign = for equality, which he says he selected because "noe 2 thynges can be moare equalle" than two parallel straight lines.

Niccola Fontana won fame about this time by meeting a challenge to solve mathematical problems which involved cubic equations. He wrote a treatise on *Numbers and Measures* in 1560, from which the following example is taken: "Three beautiful ladies have for husbands three men, who are young, handsome, and gallant, but also jealous. The party is traveling, and finds on a bank of a river over which they have to pass, a small boat which can hold no more than two persons.

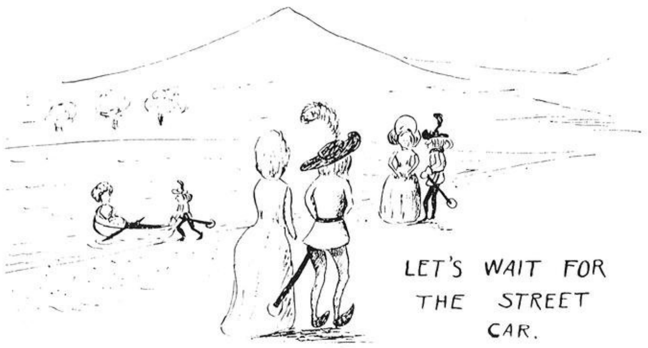


"One walked to the village — one flew up a height 'x' and then flew in a straight line to the village"

How can they pass, it being agreed that, in order to avoid scandal, no woman shall be left in the society of a man unless her husband is present?"

Girolamo Cardan was a professor at Milan and Pavia. He was a man who had led a wild life, and his publication Ars Magna (1545) contained the solution of cubic equations fraudulently obtained from a rival named Tartaglia. When Tartaglia read the book, he was aroused and challenged Cardan to meet him in a mathematical duel.

This took place in Milan on August 10, 1548. Cardan got cold feet and sent his pupil Ferrari in his place. Tartagalia was accompanied only by his brother, but Ferrari brought along a bunch of rooters. (In the mean time Cardan had left for parts unknown). As Tartagalia began to explain to the crowd the origin of the battle and to criticize Ferrari's 31 solutions, he was interrupted by the demand that judges be chosen. Knowing no one present except his brother, he refused to choose, but said, "Let all be judges". Finally the duel was allowed to proceed, and Tartaglia accused



"No woman shall be left in the society of a man unless her husband is present"

his opponent of a wrong solution, but he was overwhelmed by the rooting of the crowd which demanded that Ferrari be allowed to have the floor to criticize his solution. In vain did Tartaglia insist the he be allowed to finish, after which Ferrari might talk to his heart's content. Ferrari's friends were good loyal rooters. Ferrari gained the floor and chattered about a problem which he claimed Tartaglia could not solve; the game was called on account of darkness and Tartaglia lost by one field goal.

George Joachim (1514-1576) worked out the table for natural sines for each 10 seconds to fifteen places, and invented the familiar formulas for sin 2x and sin 3x. The notation sin, tan, etc., and the determination of the area of a sperical triangle date from this time.

In 1582 the Julian calender was superceded by the calendar of Pope Gregory.

John Napier published at Edinburgh, in 1614, his *Mirifici Logarithmorum Canonis Descripto.* The time was ripe for the discovery of logarithms, and his table received an enthusiastic reception. Napier had been so interested in trigonometric application that his table consisted not of abstract numbers but of seven place logarithms of the trigonometric functions of each minute. In 1615 Henry Briggs of Oxford developed methods of interpolating between, and testing the accuracy of logarithms. He gives the logarithms from 1 to 20,000, and from 90— to 100,000 to fourteen places, and also a ten place trigonometric table with an angular interval of 10 seconds.

Vlacq of Leyden soon after filled the gap in Brigg's tables and this is the basis for the tables since published. The first tables to the base of e, commonly called Napierian, were published in 1619. In more recent times, methods of interpolation have been employed which are more powerful and less laborous.Among the computations of the sixteenth century was Ludolph von Ceulen's computation of π to thirty-five places, using regular polygons of 96 and 192 sides. German writers sometimes attach von Ceulen's name to this important constant.

Galileo Galilei (Galileo) (1638), Stevinus of Bruges (1548-1620), and Bruno (1548-1600) contributed to mathematics in its application, especially in astronomy and mechanics.

Descartes invented analytical geometry in 1637. The great step made by this invention was the recognition of the equivalence of an equation and the geometrical locus of a point whose co-ordinates satisfy that equation.

Projective geometry was developed by Desargues (1595-1662), an engineer and archiect of Lyons. But for the still more brilliant achievements of Descartes in analytical geometry, the art of projective geometry did not lead to immediate development. The discovery of projective geometry was the result of observation on the cutting of stone in architecture.

To Fermat (1601-1665) and Pascal (1623-1662), we are indebted for the theory of numbers and probability. Some writers credit Fermat as being "the true inventor of the differential calculus". He discusses problems in maxima and minima and enunciates the interesting theory that "Nature, the great unknown that has no need of our instruments and machines, lets everything happen with a minimum outlay".

John Wallis (1616-1703) in his *Arithmetic of the Infinites* employed a process similar to integration for simple algebraic cases. His analytical conic sections made the ideas of analytical geometry more intelligible, and his *Algebra* marks an important step in the use of formulas.

Isaac Barrow (1630-1677) in his work on optics and geometry has a notable discussion of the tangent problem and what he calls the differential triangle,

"The game was called on account of darkness, and Tartaglia lost by one field goal"

so important in the modern elementary differential calculus. Barrow was a teacher of Isaac Newton at Cambridge. Isaac Newton was born December 25, 1642, within a year after the death of Galileo. He was destined to become a farmer, but, fortunately, at the age of seventeen, he was sent to college where he quickly mastered the work of Euclid, Descartes, and Wallis. He discovered the binomial theorem and attacked the great problem of gravitation by comparing the motion of the moon with that of a falling body near the earth.

(*Continued on page* 256)

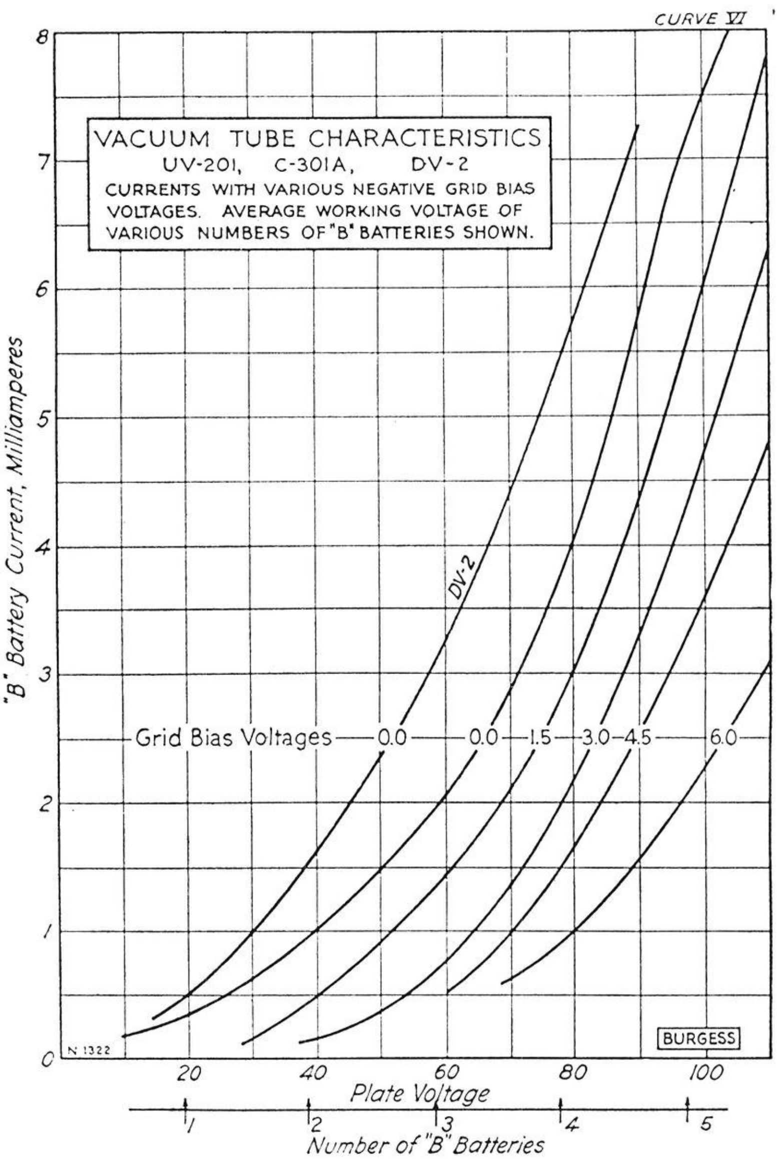
SUGGESTIONS FOR MAKING GRAPHS

By L. S. BALDWIN, *Instructor in Mechanical Drawing*

EXCELLENT technical and scientific articles and reports are so frequently weakened by the crudely drawn curves and graphs accompanying them that a few random notes on standard practice in regard to the preparation of diagrams may be of some value to students and others who are familiar with such work.

Most curves are rough plotted on graph paper and later traced for blueprinting or photographing for cuts and printing. Before tracing the curves it is well to consider the proportions of the graph rectangle, and the amount of space on the page which it will occupy. The original plot may have awkward proportions on the page. The average report or bulletin page allows a printed area of four by six and one-half inches. If the cut is to fill the entire page, these dimensions may be slightly exceeded; but if some type is to appear on the same page, the width of the cut should be exactly four inches, and the height not more than two-thirds of the printed area, and less if possible. Two or three lines of type above or below the cut makes a bad looking page. The desired proportions are easily obtained by changing either the horizontal or vertical scale. If necessary, special lines can be ruled on blank paper and the curves replotted.

Curves plotted on graph paper should not ordinarily be photographed for the final cuts. If the scale lines are blue they will not photograph. This feature is, however, often valuable, for complex masses of curves need not be traced and such scale lines as are desired can be ruled in with black ink. Red lines photograph as well as black, but the multiplicity of lines is confusing, the resulting dark tone spoils the appearance of the page, and the lettering is difficult to read. It is much better practice to trace the original graphs and include only a few of the scale lines, which will make a clear and open cut, as illustrated.



A good illustration of how it ought to be done

The relative weights of the various lines are of importance. As the curves themselves should stand out in contrast to everything else, they should, of course be heaviest, the border lines somewhat lighter, and the scale lines lightest. If the latter are numerous, those corresponding to important numbers may be of double weight. The appearance of the pamphlet or bulletin is greatly enhanced if all graphs appearing therein are uniform in arrangement, line weight and height of lettering. This can be accomplished only by systematic standardization of line weights and letter heights for the entire series of drawings, and is more difficult when the originals are of various sizes. If such is the case, lines of equal weight on the originals will reduce unequally in cuts of equal size. Line widths and letter heights for the larger sheets must be heavier and higher in proportion. The publishers of technical journals have carefully worked out systems of standards for lines and letters for reductions from one to eight. Only by such method can anything like uniformity be obtained.

When several curves are plotted on the same graph

(*Continued on page* 260)

A NEW TYPE OF SPILLWAY

By ADOLPH J. ACKERMAN, *Senior Electrical*

THE past three years witnessed an outstanding development in the design of water power plants, resulting in a great reduction in the cost of such projects.

In the Alcona Development, completed in 1923, and the Hodenpyl Development, completed in 1925, both in Michigan, the usual type of outside spillway has been replaced by the new Conduit or Tefft Tube Spillway, and instead of the spectacular water falls over the dam only a churning and hurried tailrace below the power house indicates the passage of excess water.

The new design is applicable to low head developments where the power house acts as a section of the main dam, and merely requires sufficient additional excavation to permit the construction of sluice-ways under the power house. The sluices are provided with suitable control gates and direct the excess water from the upstream side of the power house directly to the draft tubes, where it joins the turbine discharge water and after dissipating its energy, continues down the tailrace. Thus the Spillway Tubes merely act as a by-pass around the turbines as may be readily seen from figure 1 showing the general cross-section of the Hodenpyl Development.

EDITOR'S NOTE

Mr. Ackermann was assistant engineer on the Hodenpyl Development. This article was written by him with the permission of Mr. William W. Tefft, Chief Engineer of the Commonwealth Power Corporation.

The Conduit Spillway is particularly adapted to developments where earth or rock-fill dams are most economical, and where the rivers have a comparatively low ratio of flood flow to normal flow, as occur in the lower peninsula of Michigan. The two developments previously mentioned occur on rivers where the entire flood flow is easily handled.

In general a conduit spillway under the full cross-stream width of the power house may be assumed to replace a tainter-gate spillway of equal width for low heads, and more than equal it for higher heads. For flashy rivers the application of a combination of the two types of spillway proves economical and desirable from both a construction and operating standpoint.

It is particularly noteworthy that the new spillway in its practical applications has made possible two engineering achievements of no little importance.

The Alcona development was built on unprecedented foundation conditions which were studied by a number of the country's foremost construction engineers before a satisfactory solution of the problem was found. The Conduit spillway provided for a single cubical structure and economies of construction which greatly simplified the problem. (A meager description is given in Power, Vol. 59, 1924, p. 212.)

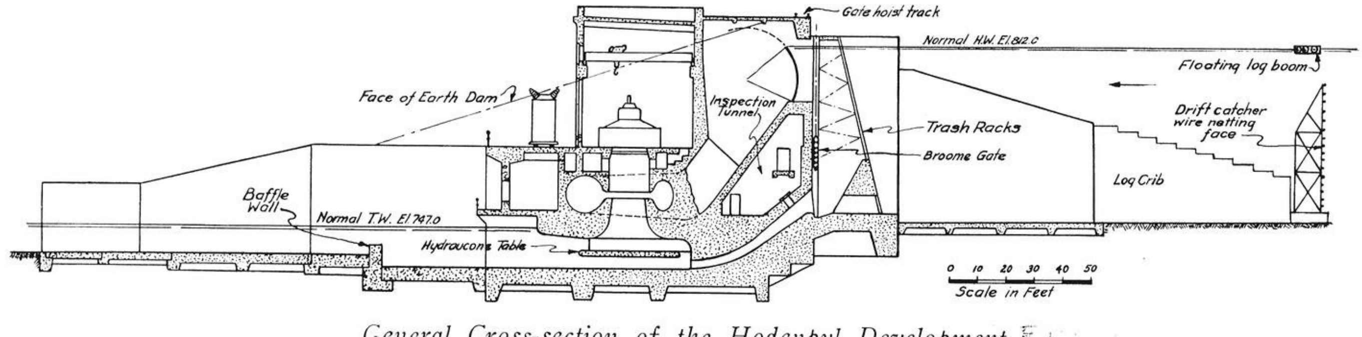
The same type of construction made feasible the construction of the Hodenpyl development as the highest head dam in the world on soil foundation. as far as is known, and with a spillway through it. The normal head is 65 feet and the dam is provided with additional 10 feet freeboard, which would have required a tainter-gate spillway of excessive cost.

Advantages of Conduit Spillway

In considering the desirability of the new type of spillway, many advantages can be listed in its favor over the ordinary type of tainter-gate spillway, among which the principal one is the great saving effected in the cost of the development.

Besides saving the cost of a separate spillway structure, opportunities are made possible for simplified construction methods on the power house, and the total time required for the construction of the entire development can be reduced considerably. A careful estimate indicated a net saving of over $260,000 on a $2,000,000 development originally designed with outside spillway. Under certain foundation conditions this amounts to as much as 43 per cent of the total construction cost.

Tests on one of the plants have indicated that the Conduit Spillway gives a decided head-increaser effect of about 4 per cent of additional K. W. hours generated during the spilling season over the energy delivered when the excess water is discharged

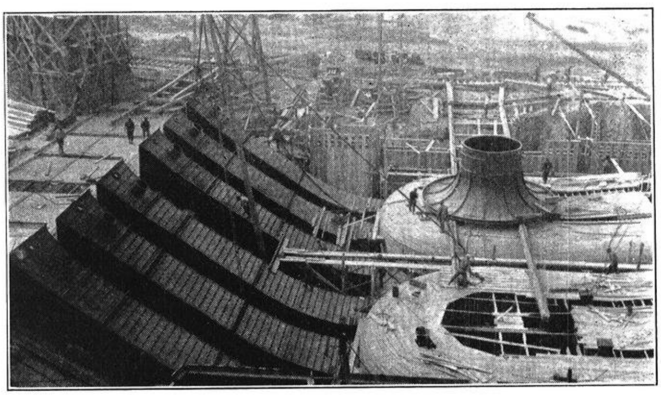


General Cross-section of the Hodenpyl Development over an outside spillway. By altering the design somewhat, a head-increaser effect up to 17 per cent efficiency of spilled water can be obtained.

Since the water is drawn from the pond at a considerable distance below its surface all of the winter troubles with spillways are eliminated. There are no gates to freeze shut or to be damaged by ice, and the customary steam heating of one of the spillway gates throughout the winter is avoided. Furthermore, in case of necessity practically the entire pond may be readily emptied.

From an operating standpoint the principal advantage is offered in the ability of the operator to control the spillway valves without leaving the generator room. Since the Conduit Spillway requires a slightly deeper tailrace, improvement in the hydraulic conditions there during normal operation when no water is spilling also tends to increase the efficiency of the plant.

The spillway tubes may be supplied with emergency gates at the entrance which may be lowered and thus permit inspection and repairs to the control valves without loss of water from the pond.

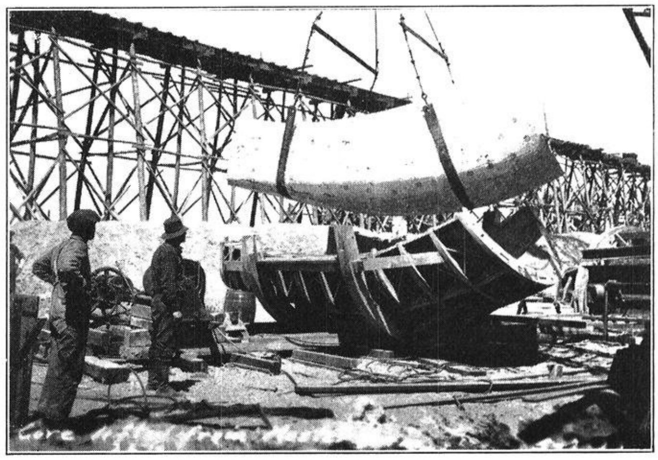


General Arrangement of Spillway Tubes and Draft Tubes at Hodenpyl Development

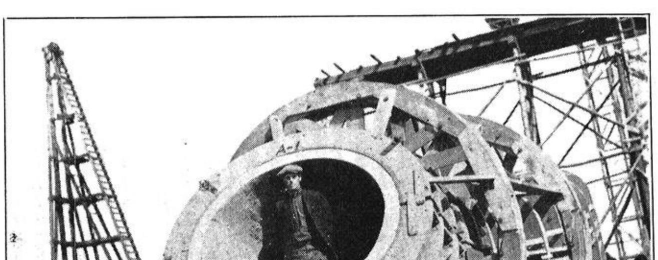
Disadvantages of Conduit Spillway

Only one real disadvantage presents itself in the use of the Conduit Spillway: All water neccesarily passes through the power house structure and thus deposits greater quantities of trash, submerged debris or possibly slush ice on the trash racks which, therefore, require more attention.

The possibilities of trouble from debris have been considerably reduced by the construction of a submerged drift catcher in front of the power house, which is merely a high fence of submerged wire netting extending over a reasonable distance immediately in front of the power house at a point where the velocities are quite low. This drift catcher prevents submerged drift such as stumps and dead heads from ever reaching the trash racks; the usual log boom acts similarly for the debris floating on the surface, so that in cleaning the racks the amount of large trash to be handled is very limited.



Removing Plaster Cast from Master Pattern



Plaster Cast of Spillway Tube in Master Pattern

Most earth dams of whatever spillway design should be provided with an emergency spillway, a very simple expedient. In the low section of the earth dam which usually occurs at one end of the embankment and some distance from the power house, the freeboard is left from 3 to 5 feet lower for a distance of several hundred feet and corewall and sheet piling in this section are omitted. In case of an excessive rise in the elevation of the pond this low section is overtopped and eroded, thus causing a minimum amount of damage. A suitable crossdyke extends from the end of the emergency spillway nearest the power house in such a direction as to retain the flood waters and prevent them from reaching the power house or any part of the remaining dam before entering the tailrace. Such an emergency spillway has ample capacity to not only carry the maximum natural flood, but also the sudden flood which may occur from the failure of a dam located farther upstream.

Fundamental Theory Involved

One of the essential features of the new spillway is a satisfactory means of arresting the destructive velocities of the discharge water before it leaves the downstream apron, and at the same time preventing disturbances which would affect the operation of the turbines. This offered the chief problem of the design, and required considerable investigation and experimental work, all of which confirmed the original tentative design.

The best practical means of dissipating the energy in the spilling waters for the usual overflow spillway consists of dropping the discharge into a shallow so-called tumble bay where the water churns to foam, thereby dissipating the energy into heat by friction, so that the efflux will leave the apron in a quiet stream.

The turbulence in the tumble bay is evidently dependent on the amount discharged per second and the head, or, in other words, the momentum of the discharge water. It is also dependent on the amount of water in the tumble bay. The greatest turbulence in the water will occur if the tumble bay contents are entirely swept out by the rush of water. and its energy is lost by churning on itself and against the structure. For tainter gate spillways this is of secondary importance so long as the turbulence is properly confined between retaining walls and cannot damage the base or adjoining earth slopes or foundation.

For undersluices, however, the turbulence is minimized which prevents its reacting on the turbines in an unfavorable manner. First consideration was therefore given to this factor in the development of the Tefft Tube Spillway. Since the disturbances are a function of the tumble bay contents, a comparision was readily made between the expected turbulence from undersluices of a proposed plant, and the observed turbulence from a tainter gate spillway, (which was not regarded as excessive) by determining the amount of momentum (mass x velocity) added per second to each cubic foot of tumble bay contents during spilling. The results of this theoretical consideration provided a satisfactory basis to warrant further small and large scale experiments.

Experimental Results

The principal object of these tests was to confirm the theory as to the most economical means of obtaining a satisfactory dampening effect. Some of the principles and conclusions obtained are given below:

I. The dampening effect of the quiet water surrounding a stream discharging into and underneath the surface at high velocity is proportional to:

1. Velocity of the discharging stream
2. Periphery of the discharging stream as related to its cross-sectional area
3. Mass of impounded water in the tailrace and the amount of energy it can absorb.

II. By making the discharge end of the spillway conduit rectangular, the area of contact with the surrounding body of water is increased, and the dampening effect is thus increased.

III. Pointing the stream slightly downward at an angle at the discharge end of the conduit, flattens out the stream and thus increases the dampening effect from above and below, and at the same time reduces any disturbances in the tailwater.

IV. The shape of the conduit is important in order to avoid noise, cavitation and erosion at the high velocities that obtain.

V. The head of water over the discharging jet proved to be an important factor. With an insufficient depth in the tailrace and tumble bay, the quiet water would be pushed downstream, entirely exposing the jet, but when the high velocity stream discharged into a quiet body of water of sufficient depth, it did not affect the quiet body for a considerable distance from the end of the nozzle, until it reached a "point of dispersion or mushrooming."

Under such conditions it was evident that the turbine discharge would not be affected by the spillway waters until both had reached the "point of dispersion", which was far enough downstream from the mouth of the draft tube to have no effect on the operation of the units.

VI. It was found that the most satisfactory means of destroying the remaining energy of the jets was obtained by their impinging on a vertical wall (baffle wall) on the far side of the tumble bay. After passing through the tailrace water any remaining horizontal velocity is checked at this submerged weir, and the water is discharged over the baffle wall and down the tailrace as a quiet stream.

VII. The minimum elevation of the wall below the surface of the tailwater is mainly limited by the cross-sectional area required for discharge of the turbines during normal operation. The best location of the baffle wall apparently is just beyond the "point of dispersion" of the jet, and only sufficient additional apron is required in the tailrace beyond the baffle wall to obtain the flare necessary to give a velocity off the end of the apron that is slow enough to avoid erosion. This condition is not materially different than for the tailrace without the spillway.

It is quite evident that a most satisfactory means of determining a suitable tailrace design is by means of experiments on models built to scale for each proposed development; but in general the dimensions of a tailrace determined by the requirements obtaining for the draft tubes, provide a tailrace in which satisfactory operating conditions may be expected for the Conduit Spillway.

Predetermination of Operating Conditions

A careful study of the probable operating requirements of the conduit spillway was made possible by the provision for a single spillway tube in the Mio Development in 1917. This is one of the typical plants with outside tainter gate spillway located on the Au Sable River. The object of the design at this plant was primarily to provide a more economical means of spilling smaller quantities of water, particularly in the winter time when frost and ice conditions made the operation of the tainter gates rather costly, but it also made possible direct experiments and tests on the relative power

(*Continued on page* 250)

THE ENGINEER AND STEAM POLLUTION

By C. M. Baker, *State Sanitary Engineer*

ENGINEERING may be said to consist of the control and application of the laws and materials of nature to the uses of man. The engineer builds great dams across the streams and forces the waters back in reserve power to be utilized over dry periods. He harnesses the stream and in the form of electricity distributes its power many miles to centers of municipal and industrial development. He builds great industries on the banks of streams, the wheels of which are turned by their power. Through chemical processes he takes materials produced by nature and changes their character to best meet his needs but in this process he frequently discharges into the streams materials so changed in character that they unbalance the natural elements to such an extent that objectionable conditions are created. He pumps water from the streams and wells through pipes to supply cities and industries and constructs sewers which allow this water to flow back into the streams carrying with it the municipal and industrial wastes of the community. This adds to the burden of the stream itself to such an extent in many instances that not only are the public health and comfort affected, but the water becomes so polluted that it cannot be used below for similar industrial purposes, and in fact in some instances the pollution becomes so great as to deteriorate the structures that the engineer builds in his control of the stream. Finally he is confronted with the problem of correcting a situation, caused by his own developments, that man may utilize the valuable assets of nature and yet enjoy her pristine beauties and elements unimpaired. Oh man! you would kill the goose that lays the golden egg, then cry for the plumage of the goose, more geese and more eggs. To meet your demands and whims the engineer must take from nature that which you want for your comfort, convenience and pleasure and yet leave nature in her original condition that you may still enjoy her beauty, profit by her treasures and participate in her pristine advantages.

Pollution Defined

Technically, any substance other than natural runoff entering a stream may be considered pollution. In a broader sense, however, only those substances that deleteriously affect the public health or comfort, fish life, or other aquatic animal or plant life of the stream may be considered pollution. Even this definition, however, may need modification in its application to local conditions since the significance or importance of the pollution depends upon many factors, such as the volume of the wastes in relation to the stream flow, character and concentration of the wastes, type of fish present and normal uses of the stream.

Primarily, however, interest may be centered upon what might be termed objectionable pollution, that is, pollution that will cause objectionable conditions in the stream itself either by its effect upon the public health, comfort or aquatic life and other natural or normal uses of the stream. Obviously, what may be considered objectionable pollution in one case may be entirely permissible in another or vice-versa.

The Problem

It is apparent from the above that the problem of stream pollution consists of so treating or controlling pollution from domestic sewage and industrial wastes that objectionable conditions are not created. A number of methods have been developed for the practical treatment of domestic sewage but the wastes from industries constitute a more difficult problem. A method applicable to the treatment of domestic sewage cannot in all cases be applied to the disposal of industrial wastes and if applicable, modifications are usually necessary. In fact, the problem of industrial waste disposal consists of a series of problems even more numerous than the different classes of industries which include the following: beet surgar plants; canneries; chemical, coal tar, gas, corn, metal and milk products plants; mining wastes; oil and refinery wastes; packing and rendering plants, paper and pulp mills and textile industries. Various types of treatment are frequently necessary for different plants of the same industry. For instance, in the canning industry, different methods of treatment are required for the canning of different vegetables and fruits. Likewise the various chemical plants require the application of different methods. Each and every question of industrial waste disposal, therefore, constitutes a separate and individual problem requiring a careful study of the industry itself, local conditions, the character and uses to be made of the stream, etc.

Uses of Streams

In considering the effect of pollution upon streams, consideration must be given to their normal uses which may be classified as follows:

(1) Human consumption as for drinking water.

(2) Production of food as for watering stock, irrigation and propogation of fish.

(3) Disposal of wastes such as industrial wastes and domestic and municipal sewage.

(4) Production of power.

(5) Transportation.

(6) Recreational, including fishing particularly for game fish.

Generally speaking, public rights in the stream are paramount to private rights. The most important use is probably for human consumption since this more directly affects the public health although in some instances navigation is considered paramount. Opinions differ as to the relative importance of the various uses. The discharge of wastes into a stream is, however, often the only practical method of disposal and constitutes a necessary and proper use provided the dilution is so great or the preliminary treatment such as not to materially affect the public health, comfort or normal aquatic life of the stream. The amount of pollution permissible, therefore, depends to a considerable extent upon the other normal uses of a stream and involves an economic utilization of its resources. With this in view, the State of Pennsylvania, has adopted a policy of classifying its streams into three groups: (A) Streams practically unpolluted, (B) Streams somewhat polluted and where the extent of regulation or control involves a consideration of their present and probably future uses, also practical remedial measures for abatement of pollution, and (C) Streams so polluted that they can be used only for the disposal of sewage and wastes and therefore, the only treatment of wastes required is such as will prevent local nuisance. It it believed, however, that it is unnecessary at the present time to place any of Wisconsin's streams in the last classification.

Effect of Pollution

Pollution may directly affect the public health, fish life, plant or other aquatic life of a stream or indirectly the effect upon any one of these conditions may influence the other. For instance, plant life has a very material bearing upon fish life. Pollution may, however, be present to such an extent as to affect fish life and have very little influence upon the public health. In fact, some, such as acid wastes, may act as germicides and thereby minimize the danger to public health.

The most important consideration, of course, is whether the pollution affects the public health, as in the contamination of drinking water supplies. In general, pollution from domestic sewage is the greatest factor in this respect because of the disease germs that it is apt to carry. Tannery wastes carrying anthrax, however, is an exception to this statement. It is, however, impractical if not impossible to prevent or control stream pollution that water may be used directly from the stream for potable public supplies without treatment. The practical application, therefore, consists in removal of the grosser pollution by sewage or waste treatment and finally by complete filtration and purification of public water supplies. This applies alike to streams and lakes although the latter usually furnish more satisfactory supplies because of the more efficient sedimentation and natural purification.

Pollution may effect fish life in any or all of three ways:

(1) Direct killing of the fish.
(2) Changes of natural conditions so that fish seek other habitat either because of the condition of the water or the affect the wastes have upon plant or lower animal life constituting fish food.
(3) Influence upon fish larvae and young fish; that is, upon the reproduction of the species.

Wastes may be either directly poisonous or toxic to fish or their oxygen demand may be such that the dissolved oxygen normally present in the stream necessary to sustain fish life, is so depleted that the fish suffocate or seek other habitat.

If the dissolved oxygen becomes less than 2 parts per million, the affect upon fish is apt to be deleterious. Certain wastes such as fiber from the paper industry may also form sludge or deposits in the beds of streams and thus interfere with the spawn or spawning of fish. Industrial wastes as a rule have a greater oxygen demand than domestic sewage.

If the pollution is such that the dissolved oxygen is practically depleted, the plant and aquatic life of the stream is entirely changed, green plant and aerobic organisms disappear and lower forms of anaerobic animal life, such as worms and other similar organisms predominate. Gradually, however, through natural processes of purification,—to be discussed more in detail later,—the stream may recover from this "sick" condition so that plant and aquatic life returns to practically its normal state.

Natural Purification

In the natural process of decomposition or breaking down of organic matter, the animal or vegetable organic material is first changed into certain unstable nitrogenous compounds by the action of certain classes of bacteria that operate in the absence of air. The material is then changed by another class of bacteria which operate effectively only in the presence of air to the nitrate form, this latter process being one of oxidation. The nitrate material then becomes plant food which is again taken up by plants and may be consumed by animals thus completing the cycle. A similar natural process of purification takes place in a stream when it is polluted with organic wastes.

The capacity of a stream to receive and oxidize sewage and other organic wastes depends upon its oxygen resources which consist of the dissolved oxygen normally present in the water, that which may be supplied by growing plants and the oxygen supplied by aeration in passing over ripples and falls or due to wave action. If the oxygen demand of the wastes becomes greater than that supplied by plants and aeration, there is a gradual depletion of the dissolved oxygen of the water, although as the depletion increases the tendency to take more oxygen from the atmos-

(*Continued on page* 258)

AN ENGINEER'S OPPORTUNITY IN A PAPER MILL

By GEORGE F. HRUBESKY, *Senior Chemical*

ABOUT this time of year, senior engineers who contemplate entering some industrial field are trying to decide which industry will give them the greatest opportunity for advancement and to use their technical training. This is a particularly difficult question for a chemical engineer to decide because of the large number of industries in which his services can be used. The path of least resistance is always the easiest one to follow, but it usually ends disappointingly. It is comparatively easy for a chemical engineer to obtain work in some chemical industry that is under complete technical control; it is also easy for him to "sell his ideas" and obtain co-operation in such an organization; but, unless he is unusually brilliant, his progress there is likely to be slow. It is more difficult to obtain a job and to secure co-operation in some industry that has had little or no experience with technical men, but it is this type of work that affords an engineer the greatest opportunities even though his path is not strewn with flowers. Between these extremes may be found various degrees of difficulties for the engineer, and to illustrate these situations I shall speak of some personal experience in a paper mill.

Papermaking is an ancient art. It was known long before any chemists or chemical engineers were in existence. It is difficult to convince a practical papermaker that a chemical engineer can be of any aid whatever in solving the numerous problems which constantly confront him. If an engineer does succeed in getting a position in a papermill, he will usually encounter difficulty in convincing the practical man that his ideas are of value. This is a discouraging prospect to an engineer who contemplates entering this field. But every cloud has a silver lining, and an engineer will find that once he convinces the practical man that his ideas are worth while, a papermill will afford him some of the greatest opportunities for the use of his technical training that can be found in any industry. Furthermore, his work will be so interesting that he will spend the largest portion of the twenty-four hours at the mill.

The cost of transportation of raw materials for the manufacture of pulp and paper has brought about many radical changes in the paper industry that will give the technical man more chances to obtain employment. The papermills in Wisconsin in the last ten years have been forced to change the type of paper manufacture due to the depletion of the supply of pulp or pulpwood near the mills. Before this supply was depleted, these mills could manufacture common paper, such as newsprint and wrapping paper, on a competitive basis with mills in other sections of the country. In the course of the past ten years the timber supply of many mills has been exhausted; they have been forced to buy their pulp or pulpwood from Canada or other distant places and they have been unable to compete successfully with papermills located near the timber supply. It seems odd that papermills located far north in Canada can manufacture paper and send it to a jobber in Chicago at a lower cost than can mills in Wisconsin that obtains pulp from Canada, and makes the paper in this state. When pulpwood is sawed into lengths, chipped and finally cooked to produce pulp, the yield is less than fifty per cent of the weight of the pulpwood. The pulp is washed with water and, when ready for shipment contains only about one-third pulp and two-thirds water. If the pulp is dried, a large amount of steam is required and this increases its cost. Thus due to the greater amount of weight that must be transported by mills buying pulp from Canada, they cannot compete with the mills that manufacture common paper at the source of supply.

This does not leave the manufacturer many choices. He will either have to close his mill or manufacture some grade of paper requiring special skill or paper that can be made from materials close at hand. The opening of several large papermills in the South for the manufacture of kraft wrapping paper from the waste cuttings in the southern pine lumber industry has made the situation more acute for kraft paper manufacturers in this state.

A special papermill, or one about to change to the manufacture of specialties, is greatly in need of the services of a chemical engineer, and he will find enough opportunities in this work to satisfy his greatest ambition. It is difficult to classify and to specify what types of paper should be listed as specialty papers. They can generally be classed as papers made to meet the particular requirements of some customers, and usually require a greater amount of skill in manufacture than ordinary grades of paper. It would be more difficult to say what kind of problems would confront the technical man in these mills. The only indication that I could give of the type of work and problems encountered would be to relate some experience encountered in a mill that manufactured, printed, and waxed paper for breadwrappers.

I had the good fortune, two months after the mill was started, to obtain employment in the laboratory; I worked there a year before entering college. I also obtained employment in this laboratory during each summer vacation and also for a year while not attending college.

When I started, the paper mills were enjoying the wonderful prosperity common to all industries during the post-war period of inflation. Practically any quality of paper could be sold at a handsome profit. In a few months this was all changed, and it was impossible to sell paper even at a loss. The problem before this company, as the manager stated, was to make the best quality breadwrapper on the market at the lowest possible price. This gave the laboratory an opportunity to show its usefulness. Prior to the period of deflation, the company had built a new beater room and bleaching plant where they could bleach the pulp purchased from outside. A new type of beater was installed and an attempt was made to bleach, wash, and beat the pulp in one machine. Previously much trouble has been encountered in making paper that was strong enough for use, and after this change, much trouble was encountered in making paper that would stay on the machine. This gave the laboratory an opportunity to aid in the solution of these difficulties and, after it was shown that the technical man did have ideas that were of practical value in improving the quality of the paper, it was possible to make much more rapid progress in technical work. An idea of the change in this mill after about four years of work is given by the following incident.

One day the general superintendent came into the laboratory and said to the chief chemist, "Do you know, that if we could cut the number of breaks in the paper down to four in each roll, we would save $50,000 per year." He elaborated upon this idea and, becoming enthusiastic, went to the papermill superintendent and told him that he would have to cut his breaks down to four in each roll. The papermill superintendent decided that the general superintendent had had some poor coffee for breakfast and said to me that they would soon expect him to make paper out of nothing but water. About four years later I recalled this incident to a young fellow who had run a machine at that time and is now superintendent and he said, "Why, do you know, George, that if we had four breaks in a roll now, I would think that something was radically wrong; I would chase up to the lab to find out how they ever allowed such poor pulp to get into the mill; and I would look all over the machine to find out what was wrong." At the time he said this they had just established a new record in running one of the paper machines for four weeks without a break during the running time. This shows that the superintendent's idea about eliminating breaks was more than surpassed, although the saving probably did not amount to $50,000 a year, this being figured on paper prices in the days of prosperity. Only a portion of the credit for this improvement in manufacturing conditions should go to the technical man. A large portion of the credit is due to the practical papermaker who realized the value of technical tests and co-operated with the technical man. A large portion of the credit is due to the general superintendent who gave the technical man every opportunity to make improvements and who supported and improved upon his suggestions.

Needless to say, these results were not accomplished overnight nor without encountering opposition nor without expense and the making of mistakes. Every change made or suggested had to be proven in black and white to the practical man before he would consent to it.

The first problem confronting the laboratory was to make stronger paper. First we found that the lack of strength in the paper was due to lack of strength in the pulp, and after developing the testing methods suitable for our particular requirements, we proceeded to become "hard boiled" in regard to the quality of pulp shipped us. A buyer's market existed at the time and the pulp mills were willing to go to almost any trouble to satisfy our requirements, and under these circumstances three different companies decided that they would never be able to make pulp that would satisfy us. We obtained the desired quality of pulp, however, and the changes in conditions on the paper machine were very pleasing. The machine tenders no longer hated to come to work because they no longer had the prospect before them of running or hustling around every minute of their eight hours trying to keep the paper on the machine. There is an old tradition in the paper mill to the effect that "when a machine tender is working the company is losing money."

After we had obtained a satisfactory pulp supply we decided that the only way to determine the desirable qualities of the paper was to test paper of various qualities by actually wrapping loaves of bread on the various types of breadwrapping machines in use. When we had determined to our own satisfaction the special requirements of this paper, we tried to improve condition in the manufacture of the paper to meet these requirements. Most of these changes were made by the practical man who was able by the results of the laboratory tests to determine when a change was beneficial. Changes suggested by the technical man usually encountered real opposition from the practical man unless they could be proven beneficial before the change was made. After a period of about two years, and after much work, many arguments, and many trials, we finally had a fairly complete system of checking and controlling the quality of the paper produced in every way necessary, and this mill has the unique distinction that these tests are made by the machine tenders who formerly cussed them as "a bunch of darn foolishness", but who now explain to every machine tender they meet the absolute necessity and value of these tests.

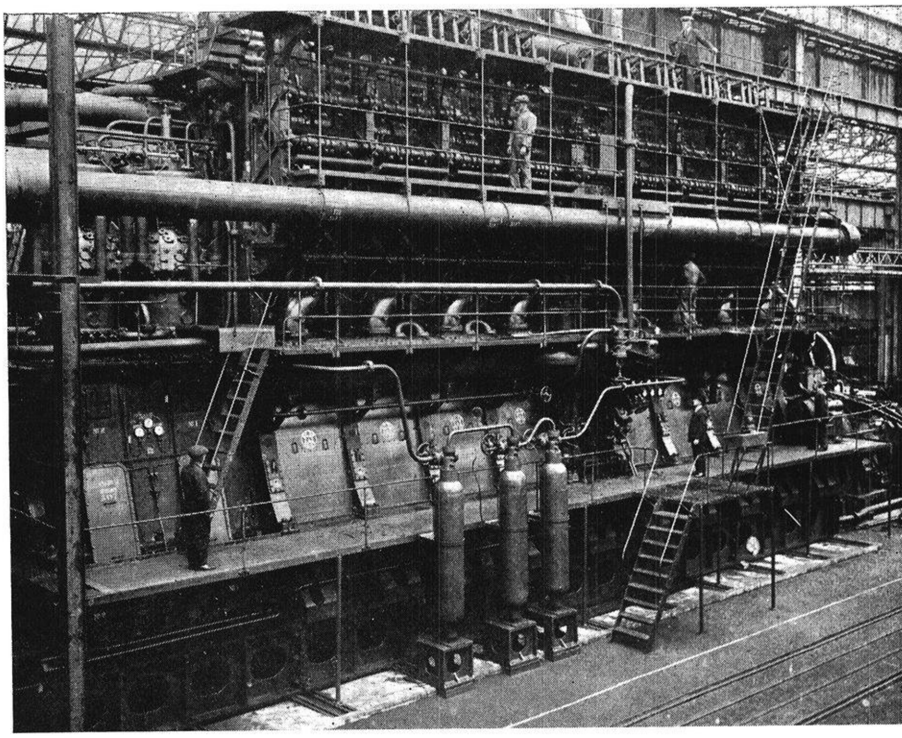
"What an individual makes of himself, determines the success or failure of his life." — *Chrisman.*

Engineering Review

WORLD'S LARGEST MOTOR SHIP

Undoubtedly the outstanding fact in the development of the world's merchant marine is the rapidity with which the Diesel marine motor is replacing the steam engine as the main drive for power-driven shipping.

The latest and largest passenger motor ship, the Asturias, built by Harland & Wolff, for service between New York and South America, is a 22,500 ton ship and her dimensions place her well up among the large steam-driven passenger ships of today. She measures 655 feet over all; her breadth is 78 feet and her depth is 45 feet.



One the twin Diesel marine engines used in the "Asturias"
Courtesy Scientific American

It takes but a glance at our illustration of one of the twin motors to show to what mammoth proportions the marine motor engine has grown. This view shows a complete unit as erected on the floor of the shop and a striking impression of its size is afforded by the men who are standing on the four successive platforms that occupy the full height of the motor.

Each of the twin-screw main engines is designed to give a normal output of 7,500 h. p. Each unit consists of eight cylinders, 33 and 1-15 inches in diameter, the common stroke being 59 and 1-16 inches. The engines are designed to run at a service speed of 115 r. p. m.

Scientific American Magazine

ITALY TO DRAW MORE POWER FROM THE ALPS

Alpine glaciers and the heavy coverings of snow cloaking parts of these towering mountains will furnish motive power for two new hydro-electric plants having a combined capacity of 88,300 h. p. The falling waters emanating from the glaciers and snow will drive the turbo-generators to be installed at Pallenzeno and Rovesca.

According to report, it will not be necessary to erect dams to impound the flow inasmuch as the melting goes on continually and at a rate which will insure at all times an ample supply of water to drive the turbo-generators. Even though the minimum flow may not seem large, still the head available will always be a high one and will provide sufficient energy to insure the steady development of more than 88,000 h. p.

The two new plants will be in the neighborhood of Lake Maggiore; and most of the work in connection with their development has been centered in driving a 17 mile tunnel through solid rock. The Pallenzeno and Rovesca power-houses will be linked with the well-known Italian Edison superpower system which, with the new stations, will have a total generating capacity of 1,060,000 h. p.

The Compressed Air Magazine

MAGNET ON TRUCK PICKS SCRAPS FROM WESTERN GRAVEL ROAD

As a result of the success a mining company in Idaho had in ridding a gravel road of pieces of old metal by the use of a heavy magnet, the Idaho State Highway Department secured use of the equipment to "clean" part of the Yellowstone Trail that had been causing motorists a great amount of trouble. The road was cleaned by a heavy lifting magnet suspended from the rear of a 5-ton truck with a clearance above the road surface of about four inches. Electric current

(Continued on page 242)

Editorials

TIME SPENT IN COLLEGE Occasionally someone endeavors to insert into the minds of us student engineers the rather chilling thought that all the while we are here spending efforts on books and laboratory work, the practical person of our age is out in the world gleaning valuable experience and earning money; furthermore, when we do get out, our book learning will be of no value, and being softened mentally by four years of books, we will have a stiff time catching up and may always be at somewhat of a disadvantage.

One must remember that the engineer is a professional man, and that his ultimate attainments are limited by his ambition. The non-college man learns a certain amount which takes him a limited distance toward success, and beyond this distance he cannot go. It is assumed that the man who has been through an engineering college has learned to think and how to find out things for himself; such ability penetrates all limitations except the limitations of the man's own initiative.

The value of the college education in business is another matter. Roger W. Babson thinks that "men training for the professions should go to college for four years, but it is debatable whether most men training for business should do so". Likewise, James B. Duke, the tobacco man, says, "I don't believe a college education does a man much good in business, except for the personal satisfaction it gives him". Mr. Duke goes on to name five kinds of leaders he believes necessary in a community, to wit, preachers, teachers, engineers, doctors, and lawyers. He thinks that these leaders should be college trained.

Like anything else, an engineering education may be a detriment; its value depends on the man. It may curb his initiative and make him dependent upon books and fixed precedure. But if he acquires the main ideas, which is learning to think, and can find out things, there is no height to which his energy cannot take him.

HOW TO CO-OPERATE Industry and the technical colleges are seeking ways and means of co-operating with each other, but have not, as yet, worked out a smooth channel of communication between each other. A little trail-blazing is being done by the American Bridge Co., which evidently believes that the way to co-operate is to co-operate. The company recently investigated the possibility of speeding the preparation of plans through the use of pencil drawings. Having worked out satisfactory methods, it took another step: It prepared an explanation of its method and sent it to various engineering schools, thus putting the schools in touch with this new practice in the shortest possible time. The incident is one that needs to broadcasted as a suggestion to others. If industry will keep the colleges informed of changes and developments in practice, the training of students will benefit thereby. This is a modest suggestion, but it is a practical one.

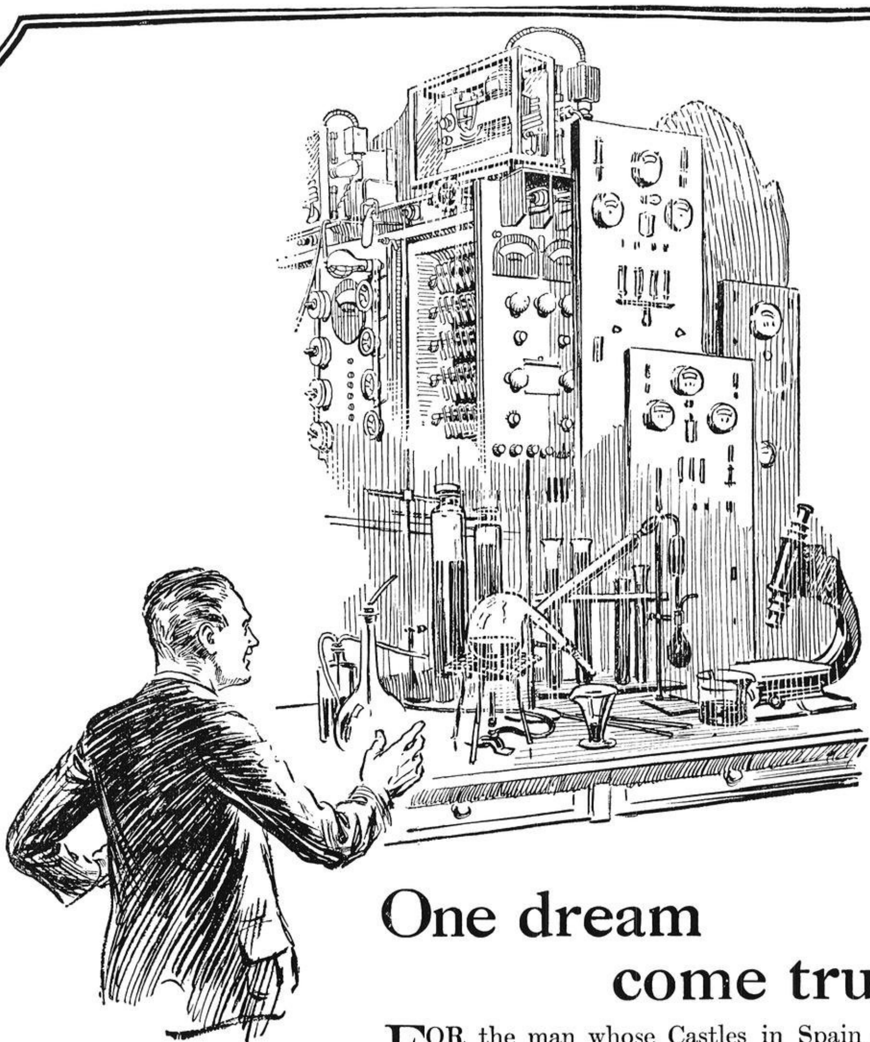
CONSERVATIVE AND INTOLERANT YOUTH "Neither Edison nor Steinmetz", remarked an observing faculty member in commenting upon recent elections to so-called honorary fraternities, "could be elected today to an honorary engineering fraternity; race, physical deformity, or a tendency to be reserved would bar them. Youth, which boasts so loudly of having thrown off the shackles of convention and tradition,—even educated youth, seems unable to throw off the conservatism and intolerance which the strange and the new seem always to arouse in man".

There are on our campus, men and women, who are different from the great majority of their fellows, and who suffer polite ostracism on that account. Most of these strange people, though strongly individualistic, are highly intellectual and have fine ideals. They are most interesting companions, once a person can overcome the prejudices their strangeness creates and learn to know them. Some of them are certain to become people of note in after years. But they cannot make an honorary fraternity. It seems a pity.

The present practice of honorary societies is to base elections partly upon scholastic achievement and partly upon personal qualities. The idea behind this practice has a certain appeal, but its practical appliction results in the rejection of some first-class men who do not happen to be good fellows and the election of some good fellows who are only second-class men.

AN OPPORTUNITY FOR THE DULL AND UNAMBITIOUS A letter that has recently come to this college contains a view-point that is so surprising in its naivete that it is worth printing here.

"We are looking for a young man of rather definite type. The work we want done is the preparation and microscopic examination of metallographic specimens. We want a man with the patience and determination to ultimately become highly expert in this work and we believe that the type best suited is one who is neither



brilliant nor ambitious to become a general manager, but one who will take pride in establishing a reputation for himself as an expert microscopist, as one or two other metallographic investigators of this country have done. Neither a full college course nor special training in metallography is essential in our opinion. We have had experience in placing young technical graduates on this work and the difficulty has been that about the time they become reasonably proficient and of real value they become restless and anxious to progress to some other work."

The merits of the expert microscopist are neither here nor there. The thing that grinds is the assumption that engineering colleges are developing human worms for industry. The men who go out from Wisconsin vary widely in capacity for service, but without exception, they are ambitious. Without ambition they would never have made the sacrifices and undergone the self-discipline necessary to acquire technical training. They set no limits upon their ambitions because they cannot tell until they have struggled, how far they can go or how high they can rise. They may not achieve their ambitions, but the struggle to do so will make their lives worth living. The question occurs: Why doesn't the writer of the letter put his own son into the job?

AN ELASTIC WORK-DAY It would appear that the Delaware and Hudson Company, in devising an elastic work-day for the purpose of eliminating unemployment caused by fluctuations in business conditions, has hit upon a solution of one of industries' most pressing problems. Briefly, the scheme is this: The railroad's forces are based upon "minimum employment under normal condition". The agreement with the shopmen provides that men will not be laid off until the whole force is on an eight-hour day, nor will additional men be employed until all are working ten hours, "penalty overtime being paid only after the expiration of the work day of the period as posted on the bulletin board." The anthracite coal strike put the scheme to a real test, with the management bearing the strain; the results so far have been satisfactory. The plan has not been tested under conditions that require the ten-hour day. The scheme may have something to offer to industry in Wisconsin, which faces legislation aimed at making it carry its employees over periods of depression.

ENGINEERING REVIEW

(Continued from page 239)

was supplied to the magnet by 72 cells of regular locomotive type storage batteries.

In sweeping back and forth across five miles of road in its first trial, the magnet picked up 150 pounds of nails, bolts, wire and scrap iron, all of which constituted a severe menace to motorists. In cleaning one portion of the Yellowstone Trail, three trips were made during which time 603 pounds of nails and scrap iron were extracted from the road surface, much of this material was invisible to the naked eye. The magnet used in the experiment was made by the Electric Controller and Manufacturing Company.

Engineering News-Record.

COLORADO RIVER DEVELOPMENT

The Colorado River is one of the great natural resources of the United States. It is 1700 miles long, rises in the state of Colorado, flows through Colorado, Utah, Arizona and continues through the Republic of Mexico, emptying into the Gulf of California.

Four important developments present themselves in connection with the development of the river. They comprise the prevention of floods, utilization of the waters for irrigation purposes, production of electric energy and water for domestic use in southwestern municipalities.

The Colorado River basin has been under observation, study, and survey since the close of the Civil War. More than a million dollars has been expended in its investigation by various departments of the Government. No less than 55 measures have been introduced in Congress providing for various phases of its development. It has been under consideration by practically every Congress for the past six decades.

Among the suggestions for the river's development is the plan for the construction of an immense dam at Boulder Canyon. It combines in its purposes control of the floods, irrigation, and power production. The project is a challenge to the country's ablest engineers and should be the subject of the most deliberate review as to its physical feasibility.

The proposed Boulder Dam will be the largest engineering structure of its kind ever attempted, the maximum development being planned to raise the water surface 605 feet, a height greater than that of the Washington Monument and more than two and one-fourth times that of the Don Pedro Dam in California, which has the greatest lift of any in this country and probably in the world. The dam will contain over 3,375,000 cubic yards of concrete, which is more than three time as much as the Assuan Dam in Egypt, which containes the greatest amount of masonry of any dam previously built. The reservoir formed by the dam will be 120 miles long and will have an area of 157,000 acres, which is one and one-half times as much as that of Gatun Lake on the Panama Canal. Included in this enterprise is the irrigation of what is known as the Imperial Valley in California. At present this land is watered by a canal running through Mexico. The people of Imperial Valley have a feeling of insecurity and restiveness, however, due to the excessive cost of repairs, and because the canal, being beyond the control of our laws and customs, is subject to tampering and is a possible source of international dispute. To correct this situation it is proposed to build a canal running from the Colorado river to the Imperial Valley, entirely on the American side of the

(Continued on page 255)

Campus Notes

A NEW WISCONSIN TEXT

AMONG recent publications of the McGraw-Hill Book Company, *Introductory Electrodynamics for Engineers* is of particular interest to Wisconsin engineers because it is a Wisconsin product. Professor Edward Bennet, chairman of the department of electrical engineering, is co-author with H. M. Grothers, formerly associate professor of electrical engineering here, and now dean of engineering at South Dakota State College.

Although the authors deviate markedly from the orthodox treatment of introductory electrical theory, the workability of the book has been demonstrated over a period of several years with the material in mimeographed form. The inclusion of much material that would ordinarily be omitted in an introductory course, particularly the concluding chapters "*Ferromagnetic* Materials" and "Propogation of Electric Effects", makes the text a reference work of considerable value.

Chief among the features distinguishing the book from typical presentations of the subject is the manner in which interpretative discussions are carried on in terms of merchanical force on the electric charge. This policy, which is followed consistently throughout the book, should establish with the student an appreciation that seemingly diverse effects are related through the fundamental expressions for force on electrons.

The use, throughout the entire treatment of electric and magnetic theory, of a single system of units, appears to a logically minded person a real improvement over the prevalent usuage of a mixture of three systems. This system, a rationalized Practical System, has been freed of the numerous conversion factors incident to combination of Electrostatic, Electromagnetic, and so called Practical Systems.

THEY CALL 'EM CHRYSLERS NOW

Buck, junior mechanical: "I see that they'll have to change the unit of magnetic flux."

His Civil friend: "How come?"

Buck: "They aren't making *maxwells* any more."

REGIONAL MEETING OF AIEE TO BE HELD HERE

Electrical engineers from five states will attend the annual regional meeting of the Great Lakes district of the American Institute of Electrical Engineers, to be held in Madison on May 6 and 7. Nearly 200 engineers from Indiana, Illinois, Michigan, Minnesota, and Wisconsin will attend this gathering.

Professor Edward Bennett, of the department of electrical engineering, who is vice-president of the A. I. E. E., will discuss co-operation between the colleges and industries in research. L. J. Peters, assistant professor of electrical engineering will present a paper entitled *The Behavior of Radio Receiving Systems to Signals and to Interferences.* Other electrical engineers, well known in their particular fields, will discuss problems of rural electrification, cooperation between the colleges and industries in research, and development in power transmission and distribution.

CHI EPSILON INITIATES

Eight junior Civils were initiated into Chi Epsilon, honorary civil engineering fraternity, on the evening of March 16. The initiation ceremony and banquet was held at the Loraine Hotel. Those initiated were Edward Birkenwald, Dave L. Harker, Robert T. Homewood, Edgar A. Landwehr, Carl B. Ledin, Arnold G. Oettmeir, Arthur W. Piltz, and Orland K. Zeugener.

The banquet was presided over by Prof. W. S. Kinne. Prof. C. I. Corp spoke to the initiates on behalf of the faculty. The fraternity weclome was extended by R. A. Nelson, to which R. T. Homewood responded for the initiates.

The engagement of Miss Martha Elliott Ashbrook ex '28 to Frank Hobbins Woy e '26 was announced the latter part of last month. The marriage will take place late in June.

NEW DIESEL ENGINE BEING INSTALLED IN STEAM AND GAS LAB

A new 40-horsepower Diesel is being installed in the steam and gas laboratory to replace the old Weston engine which has occupied a prominent place in the lab for many years. It will be fully installed and ready for use the latter part of April.

The new engine, which weighs 13,000 pounds and requires a 33-ton foundation to support it, is of the single cylinder type, with a 12-inch cylinder and a 15-inch stroke, and will attain 1300 r. p. m.

Have you seen "Chris" Wiepking sweeping the mechanics lab of late? Or perhaps you've noticed those tiny beads of sweat rolling down poor Chris's countenance as he demonstrates the proper method of mixing concrete? All of this hardship has been occasioned by the resignation of Walter La Flash, who has been the attendant in the mechanics laboratory for the past 10 years. Walter is now working in the Highway Commission's Testing Laboratory which is situated behind the Engineering Building. His place in the "busting lab" has been filled by Moulton Basford.

(*Continued on page 248*)

Alumni Notes

CHEMICAL ENGINEERING

Arthur B. Chadwick, ch'10, has changed his address to 119 Fellows Ave., Syracuse, New York.

John P. Gerhauser, ch'22, was married to Miss Yvonne Washburn on March 4. They will make their home in Green Bay where Mr. Gerhauser is an industrial engineer with the Wisconsin Public Service Corporation.

Donald S. Grenfell, ch'14, is now manager of the Oakland Plant of the Oakland Chemical and Pigment Company. His address is 766 — 50th Ave., Oakland, California.

Merril E. Hansen, ch'29, who is with Illinois Power and Light Company of Decatur, Illinois, is now the father of Helen Virginia, who is six weeks old.

CIVIL ENGINEERING

William H. Bradley. c'78, has changed his address to 960 S. Oxford Ave., Los Angeles, California.

C. B. Christianson, c'22, has been with the Engstrom and Company, General Contractors of Wheeling, West Virginia, since the first of the year. Also working in the office there is C. F. Sloan, former instructor in Structural Engineering, Ernest Barnes, c'22, and G. R. Schneider, c'22. Mr. Christianson's present address is at 206 S. Front St., Wheeling, W. Va.

Robert C. Nethercut, c'25, who is with the Barber-Coleman Company of Rockford, Ill., was in Madison the week-end of March 20th and states that he is very busy with his work in the experimental department, and also the studying which is necessary. This company manufactures machinery for many different industries, and is prominent for its experimental work.

Irving Saltzstein, c'26 (Feb.), who is now with the Standard Fruit and Steamship Company R. R. at La Ceiba, Honduras, writes as follows: "I am just about settled in the Tropics by now since I found a fine bunch of Americans here, living in quarters similar to the average college dormitory. This town of La Ceiba has a population of about six thousand. My work, at present, consists in revaluing company buildings for purposes of insurance. I have to go out and measure the buildings, then draw a plan of them, then a bill of materials and lastly, make an estimate of replacement costs. The company has two hundred miles of narrow-gauge line connecting their farms with La Ceiba, which is their port. After the buildings are finished, I will be working on the line."

Lawrence L. Stebbins, c'24, who was with the New York Telephone Company after graduation until March, 1925, is now with the Ferber Construction Company of Hackensack, New Jersey. Mr. Stebbins says most of the work is in estimating, drawing, designing, and the letting of subcontracts. Since this Company does over 700,000 dollars worth of business a year there is plenty of work for all of the engineers. Mr. Stebbins also states that he has plenty of school work besides his duties in the factory. His address is 136 Weaver Ave., Bloomfield, New Jersey.

ELECTRICAL ENGINEERING

Casey V. Loomis, e'22, has changed his address to 416 Kenilworth Place, Milwaukee, Wisconsin.

F. E. Stewart, e'24, is now living at 2827 Rio Grande St., Austin, Texas.

MECHANICAL ENGINEERING

Wenzel Fabera, m'25, since starting work for the Combustion Engineering Corporation of New York has been very busy. He is in the erection department and states that he has made many interesting trips to different parts of the locality to install new stokers. Mr. Fabera gives one instance in particular in Raleigh where there was no white labor. Because the negroes employed were ignorant as regards to mechanical work, it was necessary for Mr. Fabera to do most of the actual installation himself, as he was afraid that even nuts would not be properly tightened. His address is Combustion Engineering Corporation, Bankers' Trust Bldg., Philadelphia, Pa.

S. G. Hillard, m'26, (Feb.), is now with the Public Service Company of Northern Illinois and is located at Joliet where he has been employed for several weeks. The plant is rated at 50,000 kw. and is located four miles from town.

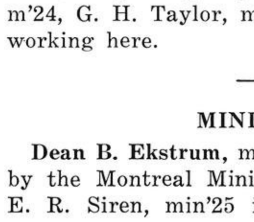
Norman W. Mitchell, m'23, has accepted a position on the Industrial Engineering Staff of Edward Schuster and Company of Milwaukee, Wisconsin.

C. H. Pan, m'25, since leaving school has been at the Michigan State Auto School, but states that it is not for engineers but for mechanics. Mr. Pan is thinking of taking charge of a bus line in China.

D. E. Stuart, m'26 (Feb.), is now with the Daty Engineering Company of Dayton, Ohio. His address is c/o of W. R. Knopp, Dayton, Ohio.

Frank T. Wolfe, m'23, has changed his address to 681 Summit Ave., Westfield, New Jersey.

J. Park Woods, m'22, Research Director for L. S. Ayres and Company, Indianapolis, Ind., in a letter to Professor Larson states that there is a position open here. However, the work technically speaking, is not along engineering lines but requires a man with some accounting, natural maturity, ability to deal with people, and an analytical mind.



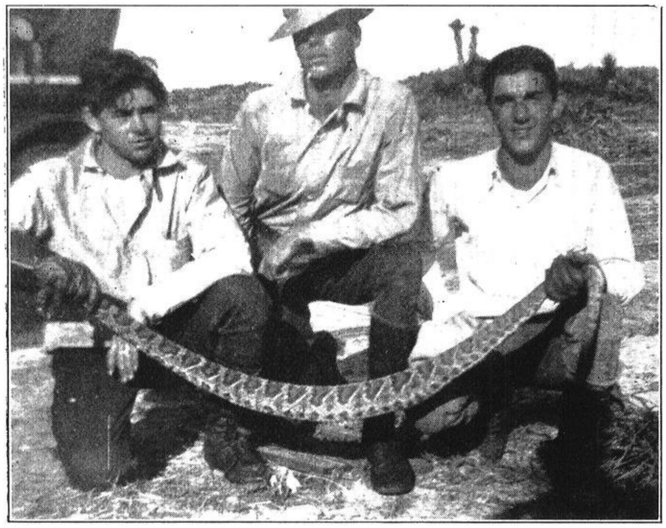
B. K. Breed, m'24, who is with the Underwriters Laboratories of Chicago, gives much information concerning oil burners in a letter to Professor Larson. He states that the chief objection to them is the noise, however this depends greatly upon the installation and type of heating plant in which the burner operates. Insulated pipes and floor stands usually result in quieting any burner considerably. C. J. Koskinan, m'24, G. H. Taylor, m'15, and H. A. Lange, m'20, are also working here.

MINING ENGINEERING

Dean B. Ekstrum, min'26, is employed as Mining Engineer by the Montreal Mining Company at Montreal, Wisconsin. E. R. Siren, min'25 is now also employed here.

J. V. Mangold, min'24, is Mining Engineer with the Simon Silver and Lead Mining Company at Simon, Nevada.

Henry A. Lynch, min'24, has left the Mexican Great Western Smelting Company and has gone into the interior of Columbia, South America on a prospecting trip.



A fine specimen of the famous Diamond-back rattlesnake, captured by the fellows in the crew near Miami. We carry $KMnO_4$ and a quart of (?) as a cure in case of a bite.

CAMPUS NOTES

(Continued from page 244)

RESEARCH FELLOWSHIPS ESTABLISHED IN COLLEGE OF ENGINEERING

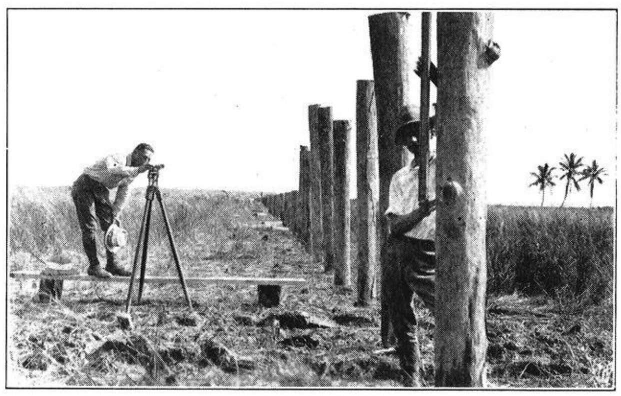
For the purpose of promoting engineering research and the development of qualified research men, three graduate fellowships have been established in the College of Engineering, each tenable for a period of two years.

The salary for the first year will be $900 and $1100 for the second year. The fellow will be required to devote not less than half his time to assigned research work in the College of Engineering, but will in any case be given opportunity to complete his work for the M. S. degree within the two-year period. Candidates must be graduates of engineering schools of recognized standing, and should preferably have had one or two years of graduate study or teaching or engineering experience.

Applications for these fellowships for the year 1926-27 are now invited. For further information and application blanks address F. E. Turneaure, Dean, College of Mechanics and Engineering, University of Wisconsin, Madison, Wis.

Kappa Eta Kappa, professional electrical fraternity, announces the formal initiation of B. R. Teare, '27, Menominee; N. B. Thayer '27, Antigo; F. R. Collbohm '28, Madison; W. H. Glister '27, La Crosse; H. J. Felber '28, Chippeway Falls; L. A. Wollaeger '28, Milwaukee; and D. H. Zillman '28, Colby.

Wm. G. Beatty, min'24, is in Miama, Florida. He writes to Professor Millar, "From school I went directly to Camp Knox, Ky., for a training course made necessary by my having taken the advanced military course in the university. After camp was over, my next move was to Indianapolis, where I worked at photography and the selling of public Utility Stock for the Utility Securities Company. The photographic work was not so successful as I had thought it would be. After several months in Indianapolis I left for Butte, Montana. to go into mining. "Starting at the bottom", as is proverbial with college men, I went from mucker to miner, timberman, then to sampler for the Anaconda Copper Company.



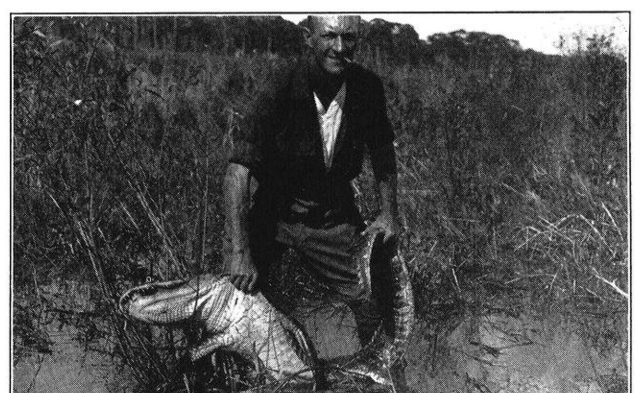
Valuable bay-front property is made by clearing salt water mangrove swamps, and then pumping in sand and rock from the bay bottom. Bulk-heads are constructed on the property lines where necessary.

"After about three months in Butte, I received a wire from my cousin in Miami, advising me to come to Florida. Later communications urging me to come to Miami finally prevailed and I arrived in Miami on August 10, 1925.

"My work here was not to be mining or real estate salesman — but Chief of Party in land surveying. Can you imagine that? My only preparation was T. E. 108. For the first few weeks. I believe I studied more about T. E. than I ever did at school. — The work is such as running boundaries on property; staking out lots, streets, sidewalk grades; giving line for bulkhead work, cut off on piling; estimates of amounts of earth needed to fill a piece of property; cut estimate for payment of dredge man, etc. My party is the last one to be retained by the company. This week will see the end for us, I expect. —

"From there I expect to go to Brittingham for a short stay and from there to General Electric or Allis Chalmers — where I can find work with a future."

"The making of a man is life work."



"A'gator with every lot" might well be the slogan with several realty companies down there. There will be many a'gator covered when this land is filled.

A NEW TYPE OF SPILLWAY

(Continued from page 234)

output obtained with the operation of either type of spillway.

Design and Operation of Conduit Spillway

In designing the spillway tubes it is evident that the principal considerations should be given to the hydraulic losses and to the most suitable type of control and operation. The curvature should be gradual, and sudden changes in the cross-section must be avoided. The losses due to entrance, friction, gradual contraction, curvature, and discharge should be kept at a minimum by proper and economical design.

The most suitable and economical type of control mechanism will differ for each development, depending on a variety of factors. In the Alcona plant the flow is controlled by butterfly valves operated by oil pressure. An operating tunnel which contains the cylinders and oil pumps is located in the structure immediately above the tubes. The butterfly valves are opened by the force of the oil pressure acting against a piston connected to the valve lever. The control valves for the oil pressure are located on the generator room floor, and suitable provisions are made for direct emergency hand control of the butterfly valves.

Since the completion of this dam several valve manufacturers have placed an electrical control and motor drive for butterfly valves on the market, which seems to have several advantages over the oil pressure system.

The Hodenpyl spillway is controlled by means of sliding caterpillar gates, operated by a hoist from the penstock deck, the same hoist that was installed for the penstock gates. This plant is also provided with an operating tunnel from which access may be gained to the interior of the spillway tubes through manholes.

Immediately behind the sliding gate, the mouth of the tube is connected to the atmosphere by means of an 18 inch air pipe which prevents the formation of a vacuum behind the gate at partial opening. Although these air pipes draw considerable air at part headgate opening, they do not destroy the vacuum on the draft tubes even at part gate on the turbines.

Some of the photographs presented herewith indicate the condition of the tailrace during spilling. It is to be noted that no vibrations have been experienced at any time nor does the spilling have any effect on the turbine operation except to increase their power.

Construction and Cost of Conduits

A few remarks on the construction of the conduits may be of interest.

The six Alcona conduits, designed for 1,000 c. f. s. per tube, were of unusually complicated design but gave good hydraulic conditions. The tube changed from a circular section of 6.5 feet diameter at its upper end to a rectagular section 9 feet wide and about 3.5 feet high at the lower end. In elevation the centerline of the tube was a parabola and in plan a compound curve of 3 foot offset, 15 feet long.

Only one master form was constructed of wood and inside of this six shells were cast of gypsum plaster to a thickness of 5 inches, reinforced by a layer of wire mesh. The outside of these shells was of the required dimensions and was painted with asphalt. The shells were then placed in position and concrete poured around them. Later they were chipped away, leaving the desired passage in the concrete structure. The total cost of this system of forming did not exceed $2,000.

The Hodenpyl Spillway has a capacity of 1650 c. f. s. per tube, and because of the higher velocities is lined with steel plate. Each tube was fabricated in four sections, for shipping, out of steel plate and angles welded together. The tubes were thickly studded with welded Z-bars which anchor into the concrete to prevent collapse of the tube in case of vacuum. Each tube is about 45 feet long, weighs 15 tons and was fabricated at a cost of $3,000.

Patents

The Conduit Spillway was developed by Wm. W. Tefft, Chief Engineer of the Commonwealth Power Corporation, whose applications for Canadian and U. S. patents, filed in 1915, were granted under Canadian No. 188,695, and U. S. No. 1,281,706 of Oct. 15, 1918.

Although actual experience may lead to modification and refinements in the design of the Conduit Spillway, the pioneering activities made thus far must be regarded as highly successful. Its possibilities are evident.

Athletics

HOCKEY

The final games of the season were played with Minnesota at Minneapolis and both were real battles, since they decided the championship in both the conference and the hockey league. Handicapped by the loss of two of the best men, Wisconsin dropped both games, 3 to 2, and 2 to 1, after furious battles. In the first game, Lidicker, junior civil, shared the honor of scoring with Captain Gross, and kept up heavy driving all the time. Spike Carlson, senior chemical, did especially fine work in the second game. Harold Ruf, sophomore civil, played his usual strong defense game as goal guard, making it very difficult for the Gophers to add tallies to their score. The men were given fine support too by Whiteside, senior civil, and Carrier, soph mechanical. The outcome of the games left Wisconsin tied with Minnesota in the Northern Intercollegiate Hockey Association and second to Minnesota in the conference.

Just before the last game a captain for next year was selected by the team and this honor fell to an engineer, William Lidicker. His fast offensive work and accurate shots have been outstanding features of the team's play this year, and he surely deserves the captaincy. There need be no fear either as to his eligibility for Lidicker was awarded sophomore high honors. Only a few of the regulars are lost from the team, and with likely new men out plus a greater interest than ever, due to Coach Iverson's work, next year's team should also be a menace to championship contenders.

ENGINEER'S PLACE IN CONFERENCE WRESTLING MEET

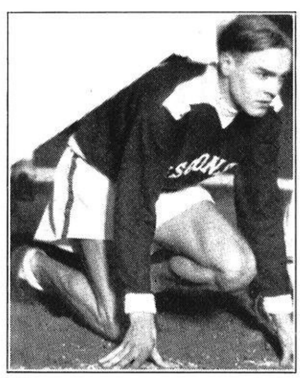
Of the five medals brought home from the conference individual wrestling tourney held at Purdue, three were won by engineers. Cole and O'Laughlin both won seconds in the 175 and 135 pound classes respectively and Splees, who has been a dependable point winner all season placed fourth in the 158 pound class, after drawing for his first match one of the strongest men in his class. In reaching the semi-finals in his weight, Cole defeated two former conference champions. Captain Lyle Zodtner was very unfortunate in the meet for in the first match he had three ribs cracked, and was thus prevented from placing. This meet concluded a most successful year for Wisconsin, in which the Badgers downed the strong Illinois team, the first defeat it had suffered in five years.

Following the close of the season, no captain was elected, as no doubt all the men will strive hard for the position and the best eligible wrestler may be chosen. Prospects for next year look pretty good just now, for only two men are lost, including Captain Zodtner, senior chemical. He has done very well this year, and his loss would be serious were it not that there is other promising material on hand. Strong engineering wrestlers to form the neucleus of next year's team are Splees, Cole, O'Laughlin, Brackett, and Chao, all of whom have shown up well during the past season. With an earlier start next year as Coach Hitchcock plans, and perhaps better luck in the matter of injuries, the team should be even stronger in 1927 than in 1926.

Much of the credit for the fine wrestling team and the building up of the sport at Wisconsin goes to Coach George Hitchcock. He is an adept at the sport himself and has many times received offers to become a professional. He devotes all of his time, however, outside of his instructional work in the College of Engineering, to the coaching of new men and making wrestling at Wisconsin a better sport, and with marked success.

TRACK

The coming of spring has recalled to life the interest in track. Indoor work has been carried on for some time, but with the arrival of more kindly weather, activities will be pushed harder than ever. It would seem that track should be no more interesting than other sports to engineering students, but it does offer a better opportunity for practice. Other sports, such as football demand the practice of all the participants together, and with a heavy all-day schedule the engineer is not easily able to carry them. Track, however, does not require the presence of the entire squad at all times, and individual practice is effective; hence it is somewhat more suitable for the engineer.

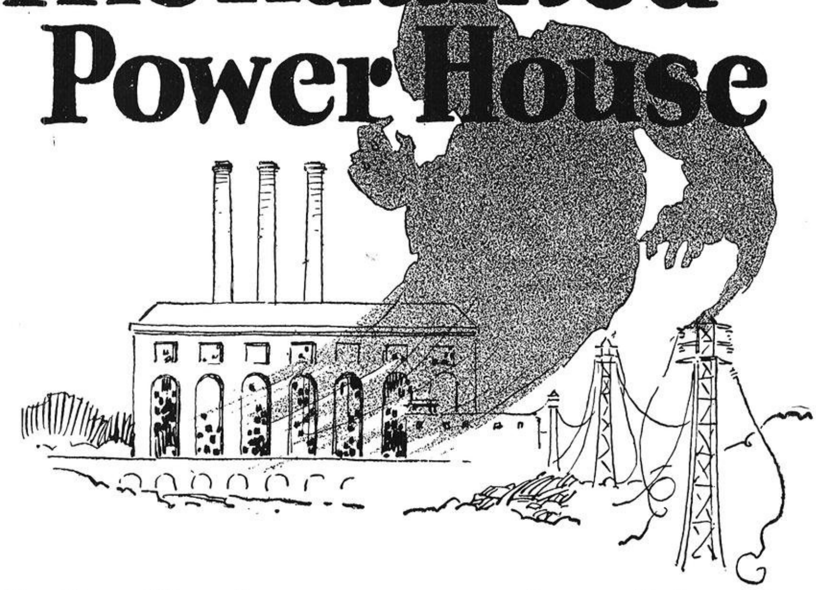


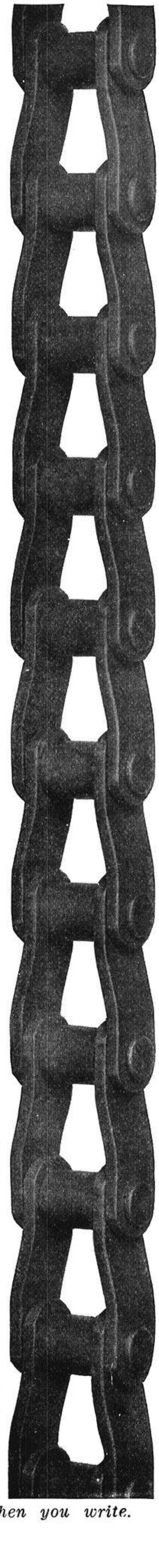
Bemis
Sophomore Miner

Incidentally, there are many engineers that serve to support this conclusion and most of them are highly praised by Coach Jones. Ray Erickson, a junior electrical, is a shining example of a good student and a very good half-miler besides. Rex Bemis, a soph miner, also runs a nice half mile. Murphy, a very excellent student, and a sophomore chemical by the way, is a

(Continued on page 256)

The Haunted Power House





The Grey Ghost haunts every power house, little or big. He lurks menacingly in every boiler room. Workmen despise him. Getting rid of him is a dead expense.

The Grey Ghost rides in with the jolly old Coal. You don't see him tumbling out of the car, or in the track hoppers. You can't locate him in the conveyors, the bins or the weigh larries. For the Grey Ghost is a spawn of the devil and is only waiting to be born in the fire and get into the ash pit. The Grey Ghost is the ashes that come from merry Old King Coal.

When you think you have him trapped in the ash pit the trouble commences. Try to get him out of there without his whirling all over the plant choking the working men, getting into the machinery and stinking the whole place up with brimstone.

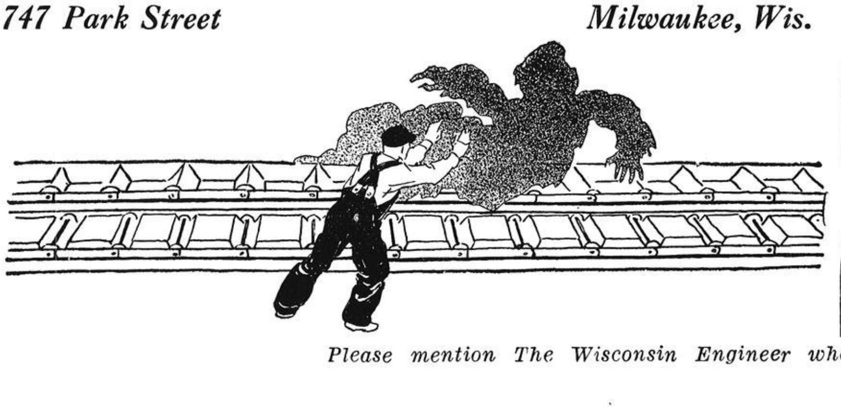
Getting the hot wet Grey Ghost, with his corrosive sulphur content and abrasive ash out of the plant at the least expense is a job for experts.

The Rex Engineers are regular Ghost-Breakers and have the bag of tricks that are needed to lay the Grey Ghost. A letter will set them at him in your plant.

REX CONVEYORS

CHAIN BELT COMPANY

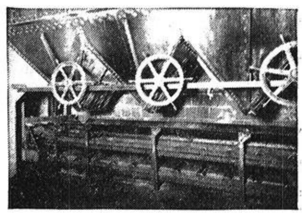
747 Park Street *Milwaukee, Wis.*



Serving All Other Industries

Almost any method of mechanical handling of coal and ashes ought to show a distinct cost advantage over handling the same materials by hand.

This back-breaking job is one that machinery can do better and cheaper than men. Buckets and weight larries beat scoops and wheelbarrows.



Rex Cast Iron Pan Conveyors in the Plant of the Indiana-Michigan Electric Co., South Bend, Ind.

Our engineering and field forces have been trained to work out the coal and ash handling systems that are best for a particular job.

Material handling, in itself a great industry, serves practically all other industries in the mechanical handling of raw, semi-finished and finished products such as: Coal, coke, ashes, sand, gravel, warehouse freight, cement, gypsum, glass, pottery, canning and packing produce, lumber, fertilizer, foundry sand, boxes, barrels and progressive assemblies. Its use is almost as limitless as the use of power.

Whether you are a student, a graduate engineer or a manufacturer it might be well to inquire what mechanical handling may hold for you.

We will gladly furnish additional information to anyone interested.

Among the Products Manufactured by the

Chain Belt Company

are:

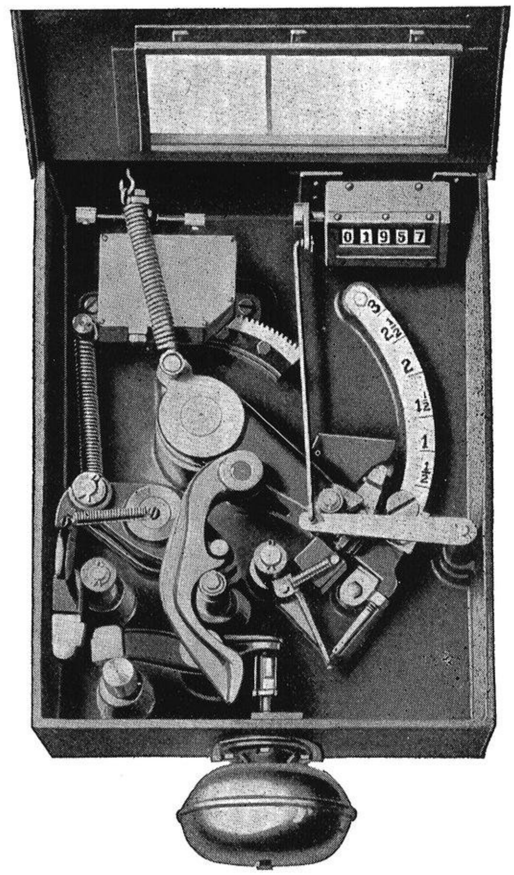
Rex Conveyor Machinery for handling materials of all kinds.
Rex Chain for power transmission or conveying materials.
Rex Concrete Mixers for construction work.
Rex Concrete Pavers for streets and highways.
Rex Power Transmission Equipment.
Rex Traveling Water Screens.

The Chain Belt Company and its affiliated organizations employ approximately 2,000 men.

Standardized Concrete

This illustration of the Koehring escapement type batch meter shows the method by which the discharge chute is automatically locked as soon as the charge enters the drum. The discharge chute cannot be moved until the regulated mixing time has elapsed, when it automatically releases the discharge lever and signals the fact with a bell. The meter also registers each batch that enters the drum.

Patent Nos.
1,321,460; 1,282,558, 1,338,761.



THE Koehring Company long ago foresaw the *value* of standardizing concrete,—foresaw and provided for it before the tremendous volume used in constructing roads and permanent structures made standardized concrete a vital *necessity.*

One of the most important means of insuring a uniform strength and quality of concrete is the Koehring Batch Meter,—a positive means for timing each batch and measuring the thoroughness of mix. This device, upon being set for the specified mixing period, automatically locks the discharge chute as soon as the drum receives the materials; the discharge chute cannot then be operated until the full specified mixing time has elapsed.

Every state highway department requires, in its specifications for concrete highway construction, the use of batch meters. This Koehring development is an integral unit on practically every paving mixer today,—a Koehring contribution to the industry.

The Koehring mixer, with the Koehring batch meter, Koehring five action re-mixing principle, and the Koehring automatic water measuring tank, provides the most positive mechanical means yet developed for producing standardized concrete of unvarying uniformity.

KOEHRING COMPANY
PAVERS, MIXERS—GASOLINE SHOVELS, CRANES, DRAGLINES
MILWAUKEE, WISCONSIN

KOEHRING

ENGINEERING REVIEW

(Continued from page 242)

border, and irrigating a total of 700,000 acres instead of the 400,000 acres now under irrigation.

The necessity for flood control is obvious. To those familiar with the behavior of the Colorado River it is believed that the Pescadoro Cut Off, an artificial deflection of the river completed two years ago and now a security against floods, may not serve its purpose for more than a total of 15 years. At the end of that period the basin may become silted and filled, the amount of silt being deposited in it annually amounting to 100,000 acre feet. The river will then return to its old channel, again threatening life and destroying property.

The total cost of the proposed Boulder Canyon project, including the building of the dam, erection of power plant, extension of transmission lines and construction of the All-American canal, is estimated at $200,000,000. The actual expenditure necessary to complete the works may run as high as one-half the cost of the Panama Canal. Whether or not it is practical, at any cost, to divert through tunnels in the Boulder Canyon walls, such a body of water as flows down the Colorado River long enough to build this huge structure, whether a mass of masonry unapproached in the history of engineering is practical, whether it is possible to give more than an intelligent guess at the cost, are problems that must be definitely settled in order to justify the Government in assuming such a heavy financial obligation.

—*Engineering Age.*

DEFLECTION OF 40 INCH WALL UNDER PRESSURE OF FINGER CAN BE MEASURED BY NEW DEVICE

The amount of deflection of a masonry wall 40 inches thick under the pressure of one finger can be measured by an instrument recently constructed by C. G. Peters of the bureau of Standards. If one looks into the eye piece while some one else walks across the floor, the deflection is apparently so great that one would suppose the whole building to be swaying back and forth as though made of cardboard.

The instrument makes use of the interference of light waves and is very simple in construction. A glass plate is fastened to the wall of the building. Another plate is mounted close to this first plate in the tube of the instrument. Part of the light from a helium tube passes through the plate in the instrument. The interference of these two sets of light rays causes light and dark bands to appear in the field of the eye piece. When the distance between the two plates is changed the bands move across the field. Motion equal to the distance between two dark bands represents a deflection of about one hundred thousandth of an inch.

You will get an uncommon reward for an uncommon effort, but only the effort will get you anything.

HOW COME MATHEMATCS

(Continued from page 230)

In optics, Newton solved the problem of the rainbow. After sixteen years, Newton returned to his attempts to explain the moon's motion by means of assumed influence of gravitation. In 1687 he published his monumental *Principia Philosophæ Naturalis Mathematica,* which gives his famous laws of motion. Newton's greatest mathematical achievement was the invention of the infinitesimal calculus. Newton was mild mannered, always shrinking from publicity and controversy.

The argument which arose between the friends of Newton and his great contemporary G. G. Leibnitz as to the priority in the invention of the calculus caused the greatest mathematicians of the age to take the field. Statesmen and kings contributed an auxiliary force to settle the argument, but after two hundred years have elapsed, a verdict has not yet been pronounced. In studying the controversy after nearly 150 years have extinguished personal feelings and allayed national jealousies, the following results have been obtained: First, that Newton first invented the method of fluxions, that the method was incomplete in its notation, and that the fundamental principle of it was not published until 1687, nearly twenty years after he had invented it; second, that Leibnitz communicated to Newton in 1677 his differential calculus, with a complete system of notation, and that he published it in 1684, three years before the publication of Newton's *Method.*

Leibnitz was born in Leipsic in 1646, taking his doctor's degree at 20, and was immediately offered a professorship. He founded the Academy of Science at Berlin, and was an organizer of similar bodies at St. Petersburg (Pertograd), Dresden, and Vienna. But for the overshadowing genius of Newton, Leibnitz' contribution to science might have been greater than it was; it was Leibnitz who gave to the differential calculus the form and notation out of which our own has grown.

ATHLETICS

(Continued from page 252)

promising hurdler. There is little Zola, junior chemical, who is an earnest worker and has performed remarkably well in the cross country and one mile events, and has also aided materially to the success of his relay team. Stowe, another sophomore chemical, competes in the quarter mile, and Zilisch, junior civil, is a fair hurdler.

Our track team is not very evenly balanced this year, thanks to the scythe of ineligibility. Although we are woefully weak in the pole vault, we still have the versatile McGinnis, who can be and generally is pressed into service in this event. Captain Kennedy and Vic Chapman need little introduction, but certainly deserve all the praise that can be given to any two such dependable point-getters. In spite of all this adversity, Coach Jones has more than succeeded in

(Continued on page 260)

THE ENGINEER AND STREAM POLLUTION

(Continued from page 236)

phere increases due to what may be termed a difference in potential. If depletion proceeds to such an extent, however, that the oxygen is entirely used up, septic or putrefactive conditions prevail, green plants die, and fish life becomes extinct and anaerobic organisms predominate. Later, however, due to aeration and other sources of oxygen, the stream may recover from this condition, a surplus of oxygen may be available and due to the fertilizing value of the nitrates formed by oxidation or nitrification of the wastes, plant life may return to normal or become even more luxuriant than formerly. With the more abundant plant life, fish may be as abundant or more abundant than formerly. due to the additional food supply and gradually the stream may return to practically its normal condition.

The normal change or natural purification outlined above, however, may be interfered with if the stream receives additional pollution. Plant "A" may discharge a certain amount of wastes into a stream with only partial reduction of the dissolved oxygen of the water so that objectionable conditions are not created. If the distance or time of flow between is such that the stream recovers from the effect of pollution from "A" before it reaches "B", plant "B" may discharge a like amount of waste without causing objectionable pollution, but if "C" should later install a similar plant between "A" and "B" so that the stream does not recover from the effects of pollution from "A" before the discharge of wastes from "C" the combined effect may be detrimental and when, to this combined effect the wastes from "B" below are added, the pollution will become even more objectionable. Under such conditions the people are apt to attribute the whole cause of the objectionable conditions to plant "C" because such conditions did not exist till it was placed in operation. In reality, however, each plant may be contributing an equal amount of pollution.

Experiments and studies by the United States Public Health Service on the Ohio River indicate a gradual reduction in the bacteriological pollution of a stream from domestic sewage or other sources, so that approximately 90% of the bacteria are removed in about 100 hours flow, the reduction being more a factor of time than distance.

The phenomena of natural purification of streams must be taken into consideration in the practical and economical disposal of wastes. If the volume of flow is adequate and the distance so great that the effect of one source of pollution is eliminated before additional pollution is added to the stream, less complete treatment may be required. A careful study of stream flow and local conditions are, therefore, necessary.

Climatic Conditions

Climatic conditions have a very material influence upon stream pollution. The amount of oxygen that water will actually retain in solution is less in warm than in cold weather being about 14 parts per million at O°C. and 9 at 20°C. On the other hand biological oxidation or decomposition of organic wastes is more rapid in warm weather so that the oxygen demand for this purpose is greater. Furthermore, the tolerance of fish is greater in cold than in warm weather and greater amounts of oxygen are required by the fish when the water is warm.

Solving the Problem

In attacking the problem of stream pollution and industrial waste disposal, consideration should be given to, and a study made of the following subjects:

(1) Sources of pollution—both municipal and industrial.

(2) Classification and analyses of the different wastes; also the feasibility of separating them into their respective classes.

(3) Careful measurements of the volume and flow of the various classes of wastes.

(4) Local conditions with reference to treatment, including topography, soil conditions, character of built up area and other factors that might have an influence upon any treatment plant installed.

(5) Stream flow particularly during dry periods, although consideration may also be given to impounding projects for storage of flood water for utilization during low normal flow.

(6) The character of the stream above and below the outlet, falls, rapids, ponding and other data that may have any effect upon its purifying power.

(7) Available literature to determine previous work done in treatment of the various contributing wastes under consideration.

(8) Industrial processes contributing wastes to determine whether practical processes have been developed for the recovery of valuable by-products that would minimize the pollution and produce a revenue to the industry that would wholly or partly cover the expenses of treatment.

(9) Treatment processes that may be applicable and unless definite data are available from other installations, an experimental plant should be installed and operated to determine the practicability of various methods before the installation or development of any final plant.

(10) Finally, a complete and final solution of the problem of stream pollution can be reached only by close co-operation on the part of engineers, state and federal officials and industries, since all are concerned not only in the question of waste disposal but in the practical and economical development and utilization of natural resources.

"To select well among old things is almost equal to inventing new ones." —*Trublet.*

INDUSTRIAL LIGHTING CODES.

In order to protect workers from accidents and eye sight damage, no less than five states, New York, New Jersey, Pennsylvania, Wisconsin and Oregon have now in force lighting codes for industrial establishments. Other states are now considering the adoption of an industrial lighting code, and it seems only a question of time when all the states will adopt such a code.

Proper lighting of work places is not only of great importance to the operators working therein, directly affecting their safety and eyesight, but it is a factor of equal importance to the employer, as quality and quantity of output are deciding factors of profit or loss in the operation of the plant.

The introduction to the Wisconsin code reads as follows: "Insufficient and improperly applied illumination is a prolific cause of industrial accidents. In the past few years numerous investigators, studying the cause of accidents, have found that the accident rate in plants with poor lighting is higher than similar plants which are well illuminated. Factories which have installed approved lighting have experienced reductions in their accidents which are very gratifying.

"Of even greater importance, poor lighting impairs vision. Because diminution of eyesight from this cause is gradual, it may take the individual years to become aware of it.

"This makes it all the more important to guard against the insidious effects of dim illumination, of glaring light sources shining in the eyes, of flickering light, of sharp shadows, of glare reflected from polished parts of work. To conserve the eyesight of the working class is a distinct economic gain to the state, but regardless of that, humanitarian considerations demand it.

"Finally, inadequate illumination decreases the production of the industries of the state, and to that extent, the wealth of its people. Factory managers who have installed improved illumination, are unanimous in the conviction that better lighting increases production and decreases spoilage."

The Wisconsin Commission has adopted a rule to the effect that, "diffusive or refractive window glass shall be used for the purpose of improving day light conditions or for the avoidance of eye strain, wherever the location of the work is such that the worker must face large window areas, through which excessively bright light may at times enter the building."

A glass is now available which meets the above requirements. It properly diffuses the light and prevents sun glare passing into the building and is known as Factrolite.

Engineers of to-day are making a thorough study of illumination, so that they may be able to plan and lay out industrial plants, to scientifically increase their efficiency to as near the maximum as possible. This accomplished the engineer is not only doing something worth while for his employer, but is doing quite as much for himself by coming into prominence with modern ideas.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,

220 Fifth Avenue,

St. Louis. New York. Chicago

No. 8.

SUGGESTIONS FOR MAKING GRAPHS

(*Continued from page 231*)

contrasting weights or types of lines serve well for identification. Too light a line should not be used, however, as it may be lost in the scale lines, especially where they coincide or are parallel. If several curves start from the zero point a solid black mass at their convergence may be avoided by stopping all but the outer ones a short distance away, or by tapering the lines to obscure white spaces between them. The use of various types of points to identify curves of equal weight does not seem to be so satisfactory as varied types of lines with small open circles of equal size. Crosses, squares, triangles and what-not waste time and are hard to make uniform in size and shape.

The designation of each curve should preferably be lettered along the curve itself, even twice if the curves are long and intertwined. Another method is to draw a sample of each line with the designation following, in orderly arrangement in the most vacant corner. Numbers may be used in a similar manner. Scale lines should not be drawn thru lettering or open circles. This is easily avoided by drawing the scale lines last, and stopping them close to and at an equal distance from all lines of lettering. Soft pencil stop lines will insure uniformity.

The types of letters used should be few, and these of simple form but carefully executed. The main title and figure number are usually set up in type, either above or below the chart, in inverted pyramid form. If, on account of blueprinting it is desired to have the title on the tracing, vertical capitals seem most appropriate. The various lines should be carefully centered. A box may be ruled about the title as illustrated. Care should be taken not to have the lines of the box coincide with or too close to the scale lines. An easy method is to letter up the title sketchily in pencil on a separate sheet, and then center each line separately on the tracing in the exact location desired.

For the curve captions, or the legend, if the former are not used, vertical small letters or lower case are peculiarly fitted. The scale designations and numerals look well in slant, tho they too may be vertical. Guide lines should be used in both rows and columns to insure accurate alignment in every respect. Even the digits of the scale numerals should be in exact columnar order. These should be outside the border, unless a double scale is needed, in which case one column can be inside, or preferably, on the right side if space permits. All figures and letters should be open in form or they will close up when reduced.

For best results the reduction should be not less than two thirds the original, and better only one-half size. Skill and experience are required to make an original for large reduction, as some lettering is apt to be too small to be readily legible, and light line and small circles may fade out entirely.

An analysis of first class examples of lettering in publications indicates that the printed height of lower case letter such as "n" or "o" should be between 1/20 and 1/16 inch in height. Smaller letters are difficult to read, and larger look coarse. Good results are secured by making them 3/32 inches high on original drawings for one-half reduction, and in the same proportion for larger or smaller reductions. Capitals and figures should be 5/32 inches high for one-half reduction. Lettering for titles may be larger and in bold face.

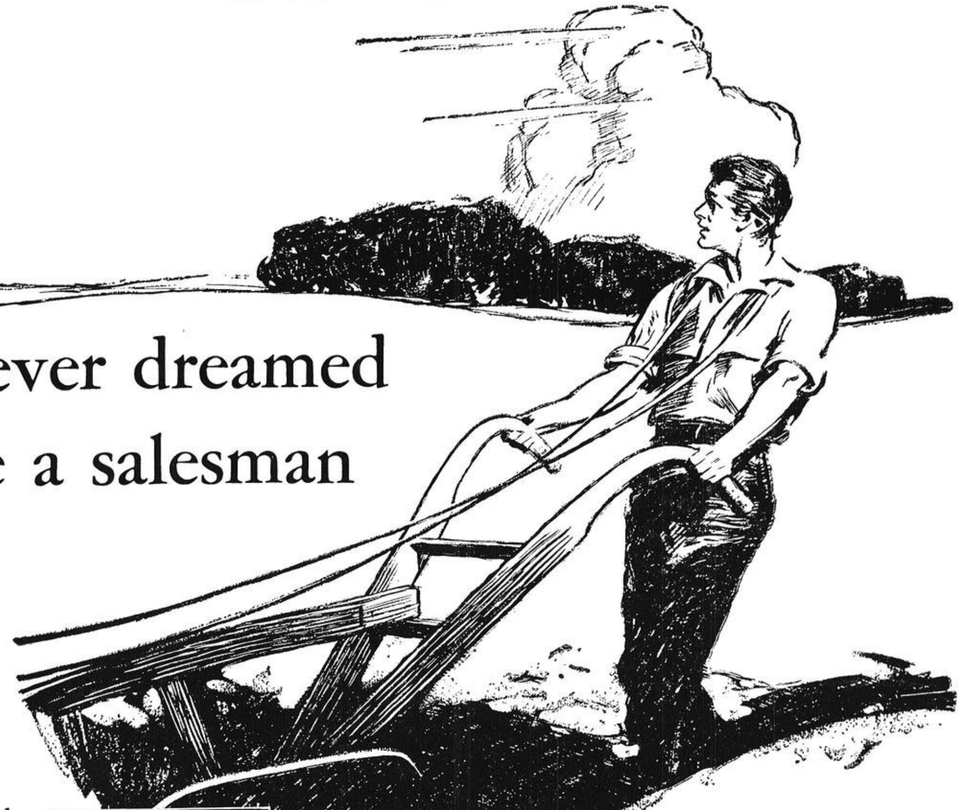
A common belief is that rough lines and lettering will smooth out when reduced. Though this is true to a limited extent, especially with large reductions, a rough line will still be rough, and may even appear more so if great care is not taken in the etching. Only the best work will insure uniformly fine results.

ATHLETICS

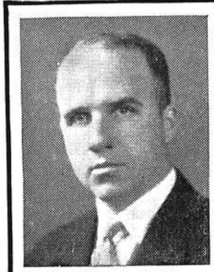
(*Continued from page 256*)

his develoment of the team, as may well be evidenced by our victories in the quadrangular meet at Evanston and over the strong Notre Dame aggregation. And so we may certainly look forward to further conquests in the slowly approaching Spring season.

It's not the work of one man that brings us to the goal, it's the everlasting team work of every bloomin' soul!—Kipling.



Loomis never dreamed he'd make a salesman



E. W LOOMIS

The question is sometimes asked: Where do young men get when they enter a large industrial organization? Have they opportunity to exercise creative talents? Or are they forced into narrow grooves? This series of advertisements throws light on these questions. Each advertisement takes up the record of a college man who came with the Westinghouse Company within the last ten years or so, after graduation.

E. W. Loomis started life as a farmer boy—a real "dirt" farmer—as did his parents and grandparents before him.

Across the corn furrows, however, he would catch sight on the road of the only kind of engineer a farmer boy of that day saw—a civil engineer—and a civil engineer Loomis determined he would be.

At Delaware University, however, he got a job in the electrical laboratory—he also waited table, played football, wrestled, was commissary of the Commons, ran the battalion and did a number of other things, besides studying electrical engineering. One day a kindly professor said to him—"You understand men even better than you do electricity and engineering, why not go in for the sale of electrical apparatus?" Loomis liked the idea—came to Westinghouse—took the student course—then off to the New York Office as a "cub" salesman.

He worked—he always had—both on the farm and in college. In three years he was head of a section of the industrial sales department. By 1922 he was manager of the Industrial Division of the New York Office—charged with responsibility for the sale of Westinghouse apparatus to all industrial customers in New York State and in the northern half of New Jersey.

Loomis has fifty-two men working under his direction. It is barely eleven years since the wise old professor remarked to him—"Consider selling; it's a promising field."

Westinghouse

WESTINGHOUSE ELECTRIC