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THE TECHNIC

TERMS

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It is a genuine pleasure to receive long and careful letters from those of our Alumni who are in new and interesting fields of work, and very often these letters afford as much interest, in their way, as do the more exact scientific articles which are given more prominence. This month we have a letter from the Canal Zone by Kelso, '08, that should be of unusual interest to all. We like to be able to print letters from Hawaii or some other new field of engineering work, from which Rose men may get new ideas and learn of new methods. It seems odd that a large per cent. of these letters come from late graduates who still have a memory of Rose fresh in mind. Can this mean that the older Alumni have really lost interest? If not, think a minute, Mr. Alumnus, and see if you haven't had some experience that we, your undergraduate brothers, would be glad to read.

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This month THE TECHNIC continues its policy of presenting articles by our Alumni on the various special apprenticeship courses at the large manufacturing concerns of the country.

We publish one this month by Mr. H. L. Watson, of the Class of 1905, on the course at the Allis-Chalmers Company, and another one by Mr. J. B. Shickel, of the Class of 1907, on the course at the General Electric Company.

Both of these articles should be instructive to all students and members of the Senior Class that intend at any time to enter one of these courses.

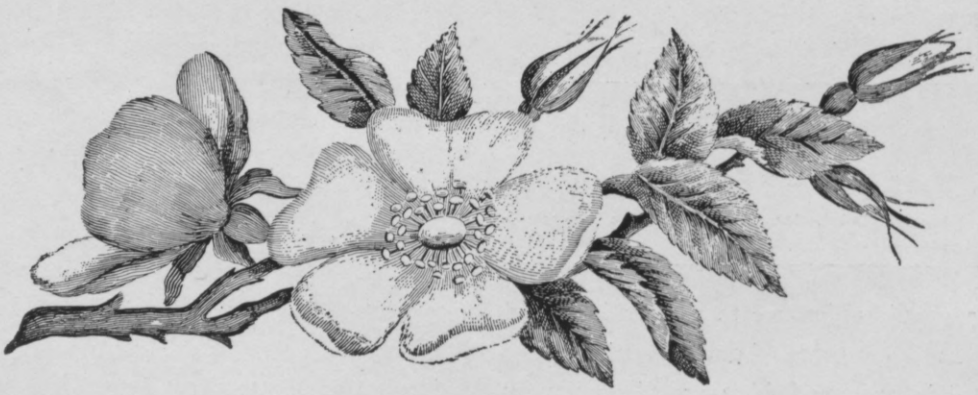
* * * *

The value of a training in Modern Languages to the engineer is often underestimated. As a student in college, he looks with contempt on anything that does not bear directly on the course

that he is pursuing, and imagines that time spent on German and French is practically wasted.

The Faculty, however, have lately raised the requirements in the language department here, so that now at least two years of both German and French are required for graduation. For some years past the chemists have received even further practice than this in language work. Parts of their Junior and Senior years have been spent in journal reviews of chemical literature, which tends to give them a reading knowledge, at least, of current technical literature.

A training of this kind would undoubtedly be of benefit to those in other courses as well, and Professor Peddle has even offered to devote a part of his machine-design time to work of this character. The students, however, do not seem to take up with the idea with any great readiness, and it seems likely that the only way of making the students take interest in this sort of work is to make it required. The time will surely come to every one when they will be glad to be able to read a little German or French, and time spent on it now would certainly we well spent.



THE MANUFACTURE OF PORTLAND CEMENT

By Harry W. Palmer, '03.

The product resulting from the heating to incipient fusion of a mechanical mixture of materials containing silica, lime and alumina, and then grinding to a fine powder the resulting clinker, is called Portland cement. When this powder is mixed with water chemical action takes place, and the mass becomes very hard. In this condition it is gray in color, and is said to resemble the stone from the famous quarries of Portland, England — hence its name.

Chemical analysis of various cements manufactured in both Europe and America, and from a great variety of materials, show the same ingredients in all, but considerable variation in the percentage of each. The following table by Meade shows the analysis of fourteen different brands.

No.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O, K_2O	SO_3	CO_2, H_2O
1.....	23.30	5.85	4.65	60.90	0.90	0.30	2.43	1.40
2.....	22.04	7.35	4.14	61.94	0.91	0.59	1.38	1.65
3.....	19.55	10.65	3.30	59.55	2.41	0.88	2.08	1.40
4.....	27.74	7.74	3.70	56.68	0.57	0.63	1.66	6.28
5.....	27.18	8.85	...	59.50	1.41	...	0.99	...
6.....	25.60	6.13	3.47	60.19	0.70	...	1.13	2.70
7.....	22.20	6.72	2.28	67.31	0.95	...	0.26	0.40
8.....	26.00	6.65	2.75	61.60	1.08	...	0.84	1.10
9.....	22.63	7.06	2.42	60.81	2.89	2.83	0.47	0.33
10.....	22.85	5.31	2.76	65.59	1.24	0.92	1.69	...
11.....	20.80	7.39	2.61	64.00	...	...	...	...
12.....	23.48	9.42		62.92	1.20	0.90	1.25	0.48
13.....	22.89	8.00	2.44	63.38	2.30	...	...	0.99
14.....	23.36	8.07	4.83	58.93	1.00	0.50	0.85	2.46

Numbers 1, 2, 3 and 4 are English cements; 5 and 6 Belgian cements; 7 and 8 French cements; 9 and 10 German cements, and 11, 12, 13 and 14 American cements. A composite cement of equal parts of these fourteen would have the following analysis:

SiO_2	23.54
Al_2O_3	7.19
Fe_2O_3	3.15
CaO	61.66
MgO	1.26
Na_2O and K_2O	0.54
SO_3	1.07
CO_2 and H_2O	1.37

The essential ingredients of Portland cement are lime, silica and alumina. Upon examining thin sections of hardened cement under the microscope, Le Chatelier found that it consisted of hexagonal crystals of calcium hydroxide, $Ca(OH_2)$, bound together by interlaced needlelike

crystals of hydrated monocalcium silicate ($Ca\ Si\ O^3$) $^2 5\ H^2\ O$. His conclusions were, that the important compounds of the cement were tricalcium silicate, $3\ Ca\ O.\ Si\ O^2$ and tricalcium aluminate, $3\ Ca\ O.\ Al^2\ O^3$, which, when mixed with water, reacts as follows:

$2\ Ca^3\ Si\ O^5$ plus $9\ H^2\ O = (Ca\ Si\ O^3)\ ^2 5\ H^2\ O$ plus $4\ Ca\ (O\ H^2)$.

He further concluded that the calcium hydroxide reacts upon the tricalcium aluminate, forming hydrated basic calcium aluminate. Messrs. S. B. and W. B. Newberry, after thorough research, agreed with Le Chatelier that the silica in cement is present as tricalcium silicate, but that the alumina is in combination with the lime as diocalcium aluminate.

They prepared the silicates and aluminates synthetically, using lime and silica in the proportion of 3 molecules to 1 and lime and alumina in the proportions of 2 molecules to 1. This made a sound cement, but it required only a little deviation from these proportions to produce an unsound product.

The formula for tricalcium silicate, $3\ Ca\ O.\ Si\ O^2$, corresponds to 2.8 parts by weight of lime to 1 part of silica, and that of dicalcium aluminate corresponds to 1.1 parts by weight of lime to 1 part of alumina.

Then,

per cent. of lime = per cent. of silica x 2.8 plus per cent. of alumina x 1.1. Materials mixed in accordance with this formula should produce a perfectly balanced Portland cement if the proportion of silica to alumina is within certain limits and other active or adulterating ingredients are not in excess.

Although the essential ingredients of Portland cement are lime, silica and alumina, in the manufacture from natural materials a little of the alumina is always replaced by ferric oxid and some of the lime by magnesia. The alkalies, potash and soda, in the cement were present in the raw materials as silicates, and a trace of carbon dioxid usually remains in the cement, the burning failing to drive it off entirely. The sulphur from the coal, and possibly from the raw material, becomes sulphur dioxid when burned, and forms calcium sulphate.

Cement usually contains from 58 to 67 per cent. of lime. This percentage, of course, depends upon the proportion of silica and alumina. Enough lime should be present to hold in combination all the silica and alumina, or the uncombined silica and alumina act as adulterants and lower the grade of the cement.

If lime is in excess in the raw material, it will be free after burning, and in slaking, when the cement is mixed with water, will expand and cause the hardening product to crack.

It is of the utmost importance that the raw material be an intimate mixture and finely ground, or the burning will fail to cause complete combination of the lime, silica and alumina. Although the heat be sufficient to cause complete combination in well-mixed and finely-ground raw material, if the raw material be poorly prepared, and underburnt cement containing free lime will be the result. Chemical analysis can not be used to detect underburnt cement, for, although the proportions of lime, silica and alumina be correct, the analysis will fail to show whether combination is complete or not; consequently a physical test of mixing the cement with water and watching for cracks, or any indication of unsoundness, must be resorted to.

The time required for the setting of Portland cement depends largely upon the percentage of alumina. This percentage is usually from 5 to 10. If the percentage of alumina be low, the cement will be slow setting. When the percentage of alumina rises above 10 per cent., the cement becomes very quick setting and correspondingly low in tensile strength.

Much of the sulphur found in finished cement may usually be attributed to the gypsum which is ground with the burnt clinker. The action of calcium sulphate upon cement is to delay the set. As much as 2 per cent. calcium sulphate may be added to a cement high in alumina. This increases the time of set, which would otherwise

be too quick, and is not injurious. A greater percentage, 4 or 5, is no doubt detrimental to the quality of the finished product.

The following is chiefly a description of the materials, process and mechanical features in the manufacture of *Speed Portland Cement.* The raw materials are limestone and shale. A good representative sample of the limestone shows the following chemical analysis:

Ca O	51.40
Si O^2	4.00
Al^2 O^3	1.30
Fe^2 O^3	0.20
Mg O	1.50
Loss on ignition	41.00

The analysis of the general run of shale is as follows:

Si O^2	59.08
Al^2 O^3	20.54
Fe^2 O^3	6.38
Ca O	0.50
Mg O	1.50
Loss on ignition	7.00

The problem is to mix the limestone and shale in such a proportion that just enough Ca O will be in the mixture to combine with all the Si O^2 forming the 3 Ca O. Si O^2, all the Al^2 O^3 forming 2 Ca O. Al^2 O^3 and all the Fe^2 O^3 forming 2 Ca O. Fe^2 O^3. The other ingredients are in small quantities and considered as so much foreign matter.

The 4 per cent. Si O^2 in the limestone will combine with 2.8 times its weight of Ca O, the 1.3 per cent. Al^2 O^3 with 1.1 times its weight, and the 0.2 per cent. Fe^2 O^3 with .7 times its weight. Then

$$\begin{aligned} 4 \times 2.8 &= 11.2 \\ 1.3 \times 1.1 &= 1.43 \\ 0.2 \times .7 &= .14 \\ \hline & 12.77 \end{aligned}$$

$51.4 - 12.77 = 38.63$,

that is, 38.63 per cent. of the limestone is Ca O that will be left to combine with the Si O^2, Al^2 O^3 and Fe^2 O^3 of the shale.

The 0.5 per cent. Ca O of the shale will combine with the silica as follows:

$$\frac{0.5}{2.8} = .018$$

$59.08 - .018 = 59.06$

Then in the shale there will be:

Si O^2	59.06
Al^2 O^3	20.54
Fe^2 O^3	6.38

to combine with the 38.63 per cent. Ca O of the limestone.

Take 100 pounds of shale.

59.06 pounds of silica will require
$50.06 \times 2.8 = 165.37$ pounds of Ca O.

$$\frac{165.37}{.3863} = 428 \text{ pounds of limestone.}$$

20.54 pounds of Al^2 O^3 will require
$20.54 \times 1.1 = 22.59$ pounds Ca O.

$$\frac{22.59}{.3863} = 58.5 \text{ pounds of limestone.}$$

6.38 pounds of Fe^2 O^3 will require
$6.38 \times .7 = 4.47$ pounds of Ca O.

$$\frac{4.47}{.3863} = 11.5 \text{ pounds of limestone.}$$

428 plus 58.5 plus 11.5 = 498.
Then the ratio of limestone to shale is 4.98 to 1.

In the materials used the analysis of the shale holds nearly constant, while the lime in the limestone varies considerably with the different strata of rock, so it is customary in practice to run frequent tests on the limestone to determine the percentage of Ca O and govern the mix by the percentage of lime in the whole mix.

In the problem just discussed there are 598 pounds in the mix, 256.47 pounds of which are lime.

$$\frac{256.47}{598} = 42.88 \text{ per cent. Ca O.}$$

The lime is sometimes run a little lower than this, sometimes as low as 42 per cent. It would take complete combination in burning to use 42.88 per cent., and, as this is impossible to accomplish absolutely, it is better to be a little low in lime, for free silica and alumina in the cement are inactive, and in small quantities are practically harmless, while free lime will slake when the cement is mixed with water and cause cracks in the hardening mass.

Chemical and physical tests are made on the finished cement, and by comparing the results of these tests and the per cent. of lime in the raw mixes from which the cement tested was made, the per cent. of lime giving the best results is determined.

At Speed Mills, where the writer is at present employed in engineering work, the limestone is blasted from the ledge and broken up with dynamite. The drilling is done with compressed air from a Laidlaw-Dunn-Gordon two-stage compressor. The rock is loaded into cars with a Marion 80-ton steam shovel and drawn to the mill, 1¾ miles, by a H. K. Porter locomotive.

All the rock first passes through a No. 8 Austin gyratory crusher. The largest pieces from this machine are about four inches in diameter. The crushed rock is elevated by a belt and bucket inclined elevator to a rotary screen, which separates it into four grades. The finest goes directly to a belt conveyor, which takes it to a chain-and-bucket vertical elevator. This elevator will dump it into any one, or distribute it into all, of four large storage tanks. The next finest grade of rock passes through one of two pairs of Sturtevant balanced rolls, where it is reduced to at most five-eighths of an inch diameter, and then is dumped upon the belt conveyor and goes to the storage tanks. The third grade goes to a No. 3 gyratory crusher and the fourth to a No. 5 gyratory crusher. From these the rock is again elevated to the screen by the inclined belt-and-bucket elevator, where it is again graded. The arrangement is such that as soon as the pieces of rock become small enough they are taken by the belt conveyor and elevated into the storage tanks.

The rock is drawn from the bottom of all four storage tanks at once. This process of mixing gives a much more chemically uniform product than the regular run from the quarry. Upon coming from the tanks the rock passes through a Ruggles-Coles drier, where nearly all the moisture is driven off. From the drier it is elevated to a hopper above the scales, where the mix is weighed.

The shale is taken from the pit with a small traction steam shovel, loaded into cars and taken to the mill in the same manner as the rock. Here it first passes through a pan mill, which crushes it fine enough to mix well with the crushed rock. It is then passed through a drier similar to the rock drier and elevated to another hopper over the scales used to weigh the mixes.

Two sets of scales are used, each fitted with a hopper. The ratio of limestone to shale has been determined and the weights set on the scale beams. The limestone and shale are allowed to run from the hoppers above, each into a scale hopper until the beams are raised. After weighing, the two materials are drawn off by feed tables each regulated to give a constant feed that will empty both hoppers at the same time. Both tables feed into an elevator which dumps into a 16-inch screw conveyor. The uniformly mixed raw material is conveyed directly to hoppers over the various machines in the raw grinding room.

The power used in the crusher and drier plant is furnished by a 350 H. P. Hamilton Corliss cross-compound engine. In order to dry and weigh out mixes when the crusher plant is not running, a 100 H. P. Buckeye engine is used as an auxiliary. The drier room can be thrown onto either source of power at will by means of friction clutches.

Two systems of grinding are used, one

through kominuters and tube mills, the other through Fuller-Lehigh mills. Both systems are used simultaneously, each emptying its product into a 12-inch screw conveyor that takes it to the feed hoppers over the rotary kilns.

The kominuters are rotary drums partly filled with steel balls similar to the ordinary 16-pound shot. A system of screens allows the material to be discharged as soon as it is of the desired fineness. The raw material is apparently quite fine as it comes from the kominuters, but these are only preparatory mills. The tube mills do the finishing.

These mills are simply horizontal flint-lined steel cylinders about twenty feet long and five feet in diameter, filled about one-third full of flint pebbles and revolving at the rate of twenty revolutions per minute. The pebbles are nearly round and ranging in size from two to three inches in diameter. The material is fed in at one end and works its way through the tumbling pebbles to the other end, where it is discharged. The tube mill is one of the best mills in use for fine grinding. About 80 H. P. is required to drive it.

The Fuller-Lehigh mill consists of a number of large steel balls in a cup similar to that of a ball bearing. The balls are caused to roll around in this cup, or ring, by pushers at the rate of 160 revolutions per minute. The ring is forty-two inches in diameter and the balls are twelve inches in diameter. A current of air is drawn up through the mill by fans. As soon as the particles become small enough to float upward in this air current, they are driven through a fine screen and discharged.

It is necessary that the raw material be ground to extreme fineness, or complete combination will not take place in the kilns. Samples are tested for fineness at frequent intervals. From 96 to 97 per cent. should pass through a 100-mesh-to-the-inch sieve.

The rotary kilns are boiler-iron tubes, lined with fire brick, mounted at a small angle from the horizontal, and caused to revolve at any desired rate from one revolution per minute to one revolution in three minutes. The raw material is introduced at the upper end and slowly works its way down as the kilns revolve. Two of the kilns of the plant being described are 100 feet long and 7 feet in diameter and two are 125 feet long and 8 feet in diameter. It takes the material about four hours to work through. Fuel is introduced at the lower end in the form of finely-powdered coal sent in with a blast of air. This makes a flame of intense heat. Incipient fusion takes place in the material when it is about twenty feet from the lower end of the kiln. Clinkers are formed and discharged at red heat. These clinkers are black when cool, but when ground into finished cement the color is a greenish gray.

In burning, about 34 per cent., by weight, of the raw material is driven off. This is largely $C O^2$ from the calcium carbonate of the limestone. This, together with the air and gases of combustion, makes necessary a large stack.

It is very important that the burning be sufficient to cause practically complete combination of the lime, silica, iron and alumina, but too much burning makes a clinker extremely hard and difficult to grind. However, overburnt is preferable to underburnt clinker, for the former makes a good quality of cement of high specific gravity, while underburnt cement contains free lime, which, as before stated, is very injurious. The burning is controlled by varying both the speed of the kilns and the feed of the raw material, as well as the air and powdered coal. Cone speed changers are used for this purpose. After the clinkers have cooled, they are carried on a motor-driven belt conveyor to the clinker-grinding room.

The coal used in the rotary kilns is first dried, then put through a Krupp ball mill and finished in Fuller-Lehigh mills. This process is attended by some danger, as an atmosphere laden with fine coal dust is highly inflammable. Coal-grinding plants have been known to explode with great violence; on the other hand, fires have started and gained some headway and then been extin-

guished. It is always well to have the coal-grinding plant isolated and in charge of careful men.

The boiler plant of Speed Mills consists of four vertical Cahall boilers and three Babcock and Wilcox water-tube boilers. These supply steam to engines as follows:

One 350 H. P. Hamilton Corliss cross-compound in the crusher plant, one 100 H. P. Buckeye in the drier room, one 200 H. P. E. P. Allis simple Corliss in the coal plant, one 200 H. P. Chandler & Taylor to drive the kilns, one 100 H. P. Buckeye direct connected to a 220-volt generator, one 100 H. P. Chandler & Taylor direct connected to a 220-volt generator, and two 750 H. P. Hamilton Corliss cross-compound engines. The two 750 H. P. engines drive the raw-grinding and clinker-grinding rooms.

The clinker-grinding room is similar in many respects to the raw-grinding room, kominuters and tube mills as well as Fuller-Lehigh mills being used. After the clinkers pass through the kominuters, the material is about as fine as common black gunpowder, and goes to the tube mills in this condition. Three Fuller-Lehigh mills are used, one preparatory mill and two finishers.

As the clinkers are fed into the preparatory mills, about 2 per cent. of gypsum is added, the purpose, as before stated, being to delay the set of the cement. The dicalcium aluminate part of the cement will set so quickly that unless the calcium sulphate be present to delay the set until the concrete is in place, these bonds will be broken and the tricalcium silicate alone will not be sufficiently strong.

It is absolutely necessary that the finished cement be extremely fine, or complete chemical action, when it is mixed with water, will not take place. Large grains of clinker have no more cementing quality than so many grains of sand. Cement ground fine enough for 97 per cent. to pass through a 100-mesh-to-the-inch sieve is good, but should not fall over 1 or 2 per cent. below that.

It is possible for a cement to be ground to a 97 per cent. fineness and still be faulty in that respect. In fact, all the particles might pass through a 100-mesh-to-the-inch sieve and the material still be far from an impalpable powder. A cement that would pass 97 per cent. on the 100-mesh sieve and only 50 per cent on the 200-mesh sieve would be very poor, while if it pass 85 per cent. on the 200-mesh sieve the probability is that it would be good in respect to fineness. It is believed by many that the tube-mill method will produce a larger per cent. of impalpable powder than any other, although another method might show up as well on the screen test.

It is desirable to age cement at least from thirty to sixty days. This gives the little free lime that may be present an opportunity to become hydrated by moisture from the atmosphere and rendered harmless. Frequent handling, changing from bin to bin and exposing the cement to the air, will have the same effect.

The stock house is a concrete building having twenty-four bins, each 25 feet square and 16 feet deep. The cement is elevated from the clinker-grinding room and conveyed about 100 feet to a cross conveyor that will empty into any bin desired. It is drawn from the bottom of the bins and conveyed through conduits to the packing room at one end of the stock house. Here it is packed in sacks or barrels and loaded for shipment.

As soon as a bin is filled, samples are taken from many different points and analyzed, as well as subjected to thorough physical tests. In the physical laboratory a number of briquettes are made from each sample, and also several pats. Briquettes of different ages are broken and a record of the tensile strength kept. The pats are made about three inches in diameter and one-half inch thick. The time of setting is determined by using Gilmore's needles. One of these has a circular end one-twelfth inch in diameter and a weight upon it of one-fourth pound, while the other has an end one-twenty-fourth inch in

diameter and a weight of one pound. When the cement has sufficiently hardened so that the former weight gently applied to the surface makes no impression, it is said to have its initial set; and when the heavier weight makes no impression, it is said to have its final set.

A reasonably slow-setting cement will take its initial set in from two to five hours and its final set in from six to ten hours. As a rule, slow-setting cements are desired, as they usually develop a higher tensile strength.

Three tests are made on the pats: some are allowed to harden in the air, others in water, and others are steamed. This latter test is the most rigid to which the cement is subjected. The pat is allowed to stand for twelve hours and is then kept for four hours in steam at atmospheric pressure. If the cement is unsound, cracking will surely occur. This test will detect a deficiency in lime, excess of lime, or underburning of the clinker. The most frequent cause of pats failing to stand the steam test is high lime. In cases of this kind the cement is allowed to age, the lime becomes hydrated by absorbing moisture from the atmosphere, and a first-class product is usually the result. No cement is ever shipped until it stands all three pat tests. As a rule, the pats are all sound the first time the test is made, for the great care taken in keeping the raw mix correctly proportioned eliminates nearly all trouble with the finished product. The chief causes of unsoundness may be summed up in the following:

Unsoundness due to —

Excess of lime,
Deficiency of lime,
Imperfect preparation of raw material,
Underburning,
Coarse grinding in both raw material and finished cement.

Further physical tests must show the cement to have high tensile strength and to set within reasonable time limits.

A test sheet from the laboratory records shows the following on a bin of cement made in 1906:

Fineness		.96
Initial Set	6 hrs	20 min.
Pat Test	Steam	O. K.
	Air	O. K.
	Water	O. K.
Tensile Strength	7 days	764 lbs.
	28 days	786 lbs.
	60 days	860 lbs.
	90 days	796 lbs.
	6 months	723 lbs.
	1 year	786 lbs.
	2 years	800 lbs.

Chemical Analysis:

$Si\ O^2$	22.22
$Fe^2\ O^3$ } $Al^2\ O^3$ }	9.92
Ca O	63.10
Mg O	2.61
Gypsum	1.26

MECHANICAL ANALOGUES OF THE ELECTRIC CIRCUIT

Every one who has taught elementary electricity has, doubtless, had difficulty in giving the student a working knowledge of the electric circuit. While analogies, carried too far, are often dangerous and misleading, still it seems that there is no clearer nor more effective means for gaining an insight into the subject than through dynamical or mechanical analogies.

The apparatus, a cut of which is shown, has been used by the writer in illustrating the various properties of simple circuits. A stout cord is passed over the pulleys, C, D, and E. At B is attached a heavy weight, M. At A is hung a smaller weight, m. Friction bands of steel also pass around each pulley, the tensions on which are adjusted by sliding small weights along the levers.

Suppose it is desired to illustrate the problem presented when a motor is driven by a dynamo, which is the same as that when two dissimilar batteries are connected in multiple-arc. Let E be the E.M.F. of the dynamo, or charging battery; e, the counter E.M.F. of the motor or the battery receiving a charge; R, the resistance of the dynamo; r, the resistance of the motor; R^1, the external resistance connected in the circuit.

Let the weights and tensions be so adjusted in the model that the mass, M, moves downward with a uniform speed. We may consider the weight and pulley on the right to represent the dynamo; the pulley at the top, the external resistance; the weight and pulley on the left, the motor.

The following equations may be written down, from which the analogies are at once evident:

In seeking the analogies between the mechanical and electrical quantities the following appear:

(*a*) Mechanical force to electromotive force.

(*b*) Force to overcome mechanical friction to "drop," *i. e.*, IR.

(*c*) Space, equal to velocity into time, to quantity of electricity, equal to current into time.

(*d*) Linear velocity to current of electricity.

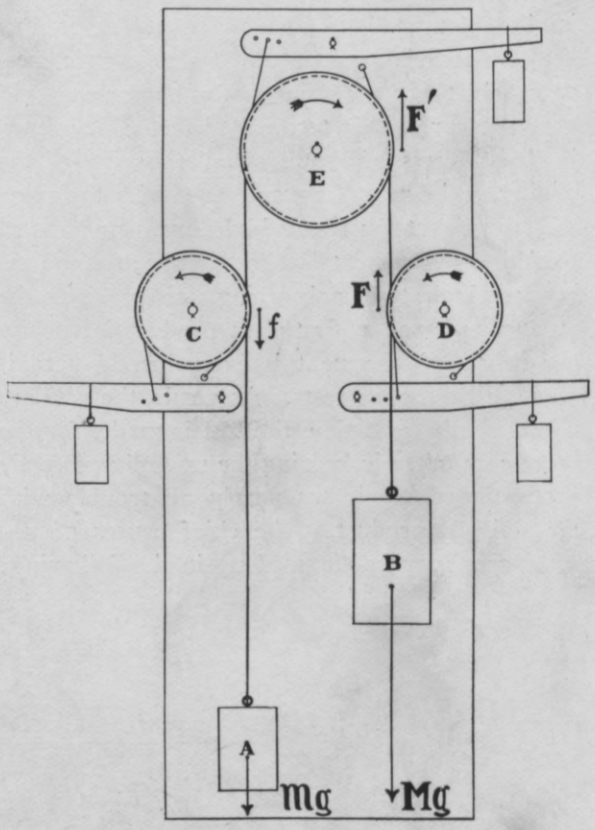


FIG. 1.

Mechanical Model.	Electric Circuit	
$Mgh=mgh+Fh+fh+F^1h$	$EIt=eIt+I^2Rt+I^2rt+I^2R^1t$	Energy
$Mgv=mgv+Fv+fv+F^1v$	$EI=eI+I^2R+I^2r+I^2R^1$	Power
$Mg=mg+F+f+F^1$	$E=e+IR+Ir+IR^1$	Force, E.M.F.

The strict definition of the word analogy should be carefully borne in mind, for it should not be understood that all of the physical properties of the mechanical terms are like those of the corresponding electrical quantities. In fact, no two have the same dimensional formula.

Suppose that it is desired to illustrate what is meant by the Potential Difference between the terminals of the dynamo. Some students have considerable difficulty in understanding that this may be given as

$$V = E - IR \text{ or}$$
$$V = e + Ir + IR^1.$$

However, he ought to have no difficulty in understanding that when the mass, M, falls through units distance, the energy available from the right-hand portion of the string is given by

$Mg - F$, which is the measure of the energy,
$mg + f + F^1$,

which is absorbed elsewhere in the string. A great many other expressions of similar character may be as readily interpreted.

This method gives the student a truer conception of P.D., IR, E.M.F., etc., than the hydrostatic analogues, for it approaches the subject from an energy rather than a pressure point of view.

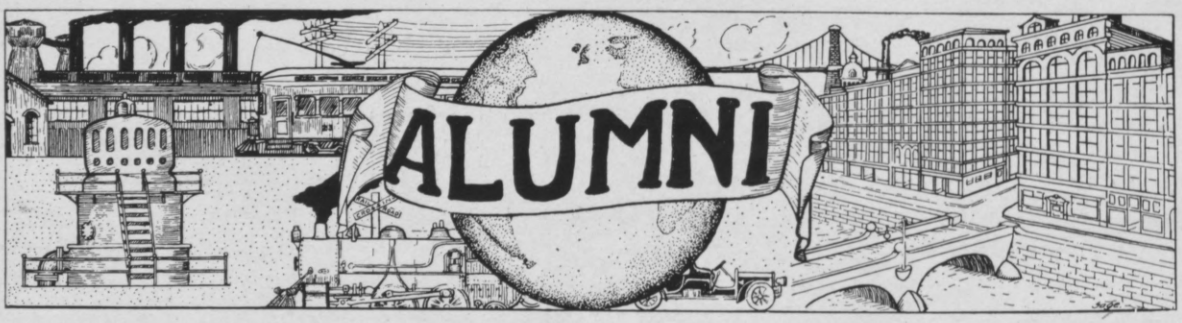
Another source of confusion with the average student is in regard to algebraical signs. Steinmetz, in his book on alternating-current phenomena, devotes considerable space to making clear the difference between various counter electromotive forces and the components of the impressed electromotive forces required to overcome them. With the model these distinctions can be made clear quite readily.

If the student is uncertain in giving the proper sign to the product, IR, in using Kirchhoff's, he is very liable to blunder. He should clearly understand that IR is a vector quantity of the same sense as the current, I. It is not so nearly analogous to force of friction in the model as it is to the component of the actuating force required to overcome the friction.

If it is desired to illustrate the circuit consisting of simply a battery and external resistance, the weight at A and the tension on the pulley at C should both be removed. And if the battery is shortcircuited, the tension at E should be removed. Other circuits where the model might be used as an illustration will readily occur to the reader.

The model in the laboratory was constructed by Messrs. Henry, Stahl, and Kornfeld. The instrument was exhibited at the fourth annual meeting of the Physics teachers of the Indiana colleges.

E. S. Johonnott, Ph.D.
Rose Polytechnic Institute.



GRADUATE STUDENT SYSTEM OF THE ALLIS-CHALMERS COMPANY

By H. L. Watson, '05.

The gradually increasing demand in the large manufacturing concerns in this country for technical men who have had a thorough practical training in addition to the training required in the technical schools have led to the general establishment of graduate apprentice systems, which are nothing more or less than an extension of the college course along purely practical lines.

The Allis-Chalmers Company conducts in its various works a graduate student system to educate young men to fill successfully positions which develop from time to time in its sales, erecting and engineering departments. This system embraces three different courses, namely, mechanical engineering, electrical engineering and mining engineering. Each course covers a period of two years of 2,750 hours of service each, and the students' work is so arranged as to give them the best possible experience and training which the large facilities at hand afford.

To the student who desires to procure the necessary shop training to qualify for the higher positions that are offering in the engineering field, exceptional opportunities are offered by this company, who are builders of a complete line of the most modern machinery, as follows: steam engines, pumping engines, blowing engines, hoisting engines, air compressors, steam turbines, hydraulic turbines, air brakes, electrical machinery of all kinds, flour mill, saw mill and transmission machinery, crushing and cement machinery, mining machinery, etc.

To be eligible to the graduate apprentice course an applicant must be a graduate in mechanical, electrical or mining engineering from a reliable technical institute. The students are required to serve the regular shop time of the company's works where they are employed, which amounts to approximately fifty-five hours a week. The rates of wages paid to the student are 19 cents per hour for the first 2,750 service hours, and 21 cents per hour for the second 2,750 service

hours. All overtime actually worked by the students is counted on the course, and paid for at the same rate proportionately as journeymen employes are paid overtime.

The students are subject at all times to all shop and office rules, and are required to provide themselves with the ordinary tools and instruments which they may find necessary to use in the proper performance of their work either in the shop or drawing rooms. It sometimes happens that a student is not supplied with such instruments, and can not very well afford to purchase them at the time of entering the company's employ. In cases of this sort, if the student so elects, the Allis-Chalmers Company will furnish these necessary tools to them at cost to the company, and deduct such cost from the wages of the students in installments.

For the mechanical engineering students the courses involve work progressing at intervals in the various departments as follows: iron foundry, Corliss engine machine and erecting shop, steam turbine machine and erecting shop, gas engine machine and erecting shop, hydraulic turbine machine and erecting shop, and electrical department (optional). When the opportunity affords toward the end of their course, the mechanical students are sent out in the field with experienced erecting engineers to assist in the erection of machinery, during which time a reasonable allowance is made by the company for traveling and living expenses.

For the electrical engineering student the course involves work progressing through the controller department, transformer department, commutator department, winding department, assembling department, testing department and steam turbine and steam engine department, the latter being optional.

Students on either course engage in the actual work of the various departments mentioned under experienced machinists, and in this way learn to perform the various classes of shop and erecting work in a competent and skillful manner. They have an opportunity at the same time to apply their theoretical knowledge to actual practice and become thoroughly familiar with the lines of machinery on which they work.

The manufacturing facilities of the Allis-Chalmers Company are divided between six large plants, as follows: West Allis and Reliance Works, at Milwaukee; Chicago Works, Nos. 1 and 2; Cincinnati Works, and Scranton Works. In area these works cover near 250 acres, divided between storage yards, trackage, runways and actual inclosed floor space. The total floor space of the various plants is approximately seventy-four acres.

The majority of the students spend their time at the West Allis Works, which are the most modern and largest shops. It is only when one has walked completely through and around the shops at West Allis that a comprehension of their great size may be gained. The following figures may be of interest as indicating their immensity: Total ground area, 110 acres; floor space, 1,438,786 square feet; length of railroad track in yards, 12 miles approximately; capacity of power house, 12,000 H. P.; longest building erection shop, 1,160 feet. In these works 120 cranes are installed, with a lifting capacity of 2,100 tons.

No other large industrial establishment in the country has devoted such an extent of space to the single department of the foundry as may be seen in a visit to these works. The really astonishing scale of operations carried on here daily may be gathered from the fact that single castings weighing over 100 tons each are made into slides and bed-plates of Allis-Chalmers engines without creating the slightest disturbance or involving any disarrangement of other work. The pouring of 400 tons of metal in a single day into gas engine, steam turbine, steam engine or large electric generator and motor castings is no unusual occurrence, while the melting capacity of the foundry is approximately 520 tons daily when running full force. From the foundry the work progresses through the various machine shops to the erecting shop, and from there is shipped to its destination.

The company has established for its employes at West Allis a well-appointed club, occupying quarters in a well-constructed and artistically-designed club-house, situated opposite the entrance to the grounds, where, for a nominal yearly fee, members are given all the benefits usual to such organizations. There are three large dining rooms and a large central reading and lounging room tastily furnished and supplied with the latest papers and magazines, games, etc. Nights are frequently set apart for receptions, parties and entertainments given by members of either sex, the annual dues being devoted to the fund for such purpose. A course of lectures partly popular and partly of a technical nature is also carried on at regular intervals. Those of a scientific and technical nature are regularly attended by the graduate students of engineering, and form one of the most valuable features of their course.

The Allis-Chalmers Company recently organized for its employes, particularly those engaged in engineering work, a society called The Allis-Chalmers Engineering Society, which meets semi-monthly during the winter season and monthly during the summer season, and is conducted for the purpose of bringing the heads of departments and engineers together in a social way as well as encouraging them in the free exchange of ideas through lectures on and in the discussion of subjects pertaining to science of engineering.

The far-reaching benefit of this movement is apparent. While the engineers and others associated with them in the conduct of the company's business become sufficiently acquainted to enjoy the hearty coöperation of each other in the work, their relationship is more of a business character than a social one. During business hours the engineer, in his devotion to the company's interests, can not give much time to social indulgence; he is also too strenuously engaged in working out specific problems to enter into discussions on general engineering matters which do not relate directly to the problems in hand, and this society gives him an opportunity to indulge in these things, which are more or less essential to success in the engineering field.

The society is of especial benefit to the junior engineer. He is thrown into personal contact and association with engineers of wide experience and superior knowledge, and is thereby inspired to greater things. He is not only inspired, but instructed as well through consultation with the senior engineers on points which may not be clearly understood. The successful engineer is not selfish with his knowledge, and is always willing, when the time is afforded, to give sound advice and impart knowledge to the ambitious student.

Since organization, the society has made very satisfactory progress along these lines, and with the facilities at hand its continued success is insured.

The works described above offer great opportunities for engineering students which enable them to obtain the very best shop practice and drafting-room experience as a requisite toward qualifying for the higher position in their chosen professions. The exact direction taken by the students training is, of course, dependent upon their individual qualifications, ambitions and ultimate purpose, but the training obtained, along whatever line it may be, will prove an invaluable asset in later life.

THE GENERAL ELECTRIC STUDENT ENGINEER'S COURSE

By J. B. Shickel, '07.

The question of apprenticeship courses has of late years been one to attract considerable attention from the prospective technical graduate, and more particularly from the electrical man, for it is he who finds himself in need of just such experience as is herein offered. I say of late years, because it has been only within the last two or three that the various electrical companies—for these are the only ones that concern us—have been paying enough for such work to enable the just-out-of-college man to make both ends meet without other source of income. The above statement, however, must not be interpreted as meaning that such employment is even now a financial success—far from it! and he who is contemplating taking up this line of work, expecting to be financially benefited thereby, had better lay aside his pecuniary ambitions at the very beginning.

The main plant of the General Electric Company is located at Schenectady, N. Y. (others at Lynn and Pittsfield, Mass., and Harrison, N. J.), and it is here that the test-man casts his lot. Schenectady is a city of about 75,000 inhabitants, some seventeen miles northwest of Albany and 160 miles, by rail, from New York City. The town is on the Mohawk River and the Erie Canal, the latter running through the business district. Schenectady can not be called an ideal residential location; still, it has the name of being one of the cleanest and healthiest cities in the State. The only factories of importance are the General Electric Company's plant, which, under normal conditions, employs about 15,000, and the American Locomotive Company's plant, which employs, normally, some 6,000 people. A smoky day is unknown in Schenectady, as anthracite is used almost exclusively, except in the two factories mentioned above. The General Electric Company's plant is ten minutes' walk from State Street, the main business thoroughfare. It extends over some 275 acres of ground, on which are fifty large buildings and more than a hundred smaller ones, giving a floor space of about ninety acres.

In giving a few facts concerning the so-called student course at the General Electric Company's plant, for the benefit of the nunc senior, it should be of some interest to him to know something of what will be expected of him and with what sort of machines he will have to deal.

The theory-laden man is started to work directly in the testing department, no breaking in, such as machine-shop practice, or helper's work, being required. There are, however, some men — a few — who have left technical courses before completion, and others — a very few — who have acquired some electrical knowledge, from correspondence schools, or elsewhere, who are placed at shop work until they gain sufficient acquaintance with machines as warrant their being transferred to the testing department.

The testing department, or, as it is familiarly known, "The Test," is divided into some sixteen parts, each subdivision, with a few exceptions, having its own allowance of time. These differ-

ent tests are classified, wherever possible, according to types and sizes of machines. In order to give some idea as to just what will be met with, the following schedule is given, as it is at present, showing also the time each man is supposed to spend on any one test before being transferred to another:

Resistance Measure (2 weeks).

Building No. 23 (1 month). Circuit breakers, fuses, etc.

Train Control (6 weeks). Controllers, multiple unit system of control.

Regulators (for automatic voltage control) (6 weeks).

Induction Motors (2 months). Machines from 5 to 200 H. P.

Railway Motors (2 months). Both A. C. and D. C. motors; includes two weeks on air compressors.

Special (2 months). Tests on machines of special design.

Government (3 months). Small machines, blowers, hoist motors, etc., for the Government.

Industrial Control (3 months). Rheostats, starting compensators, and mine locomotives.

Building No. 60 (3 months). Rotary converters and two-unit sets of capacity greater than 300 Kw.

Building No. 16 (3 months). All single units above 300 Kw. except rotary converters.

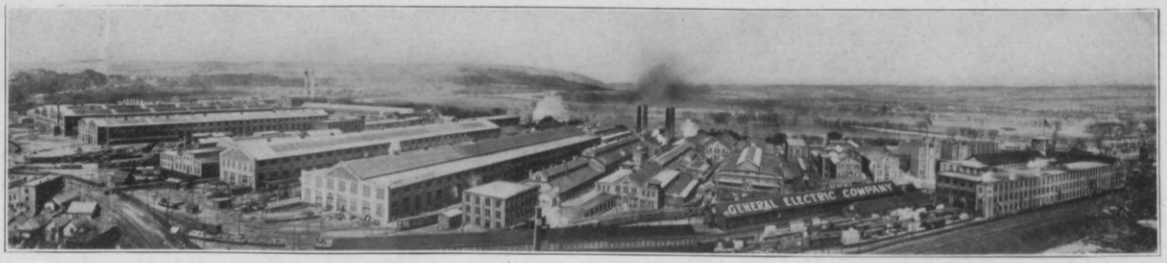
Floor (4 months). Small machines of all types not falling under other classifications.

Commercial Turbine (4 months). Steam turbines exclusively. Horizontal machines range in capacity from 300 to 3,500 Kw. and vertical machines from 500 to 14,000 Kw.

Experimental Turbine (no definite time). Special work on the steam end only.

Transformers (3 months). This test has been located at Pittsfield since November last, and is now known as the De-Centralized Transformer Department of the General Electric Company, being the most modern and completely-equipped plant to be found anywhere.

Berme Bank. This is a test devoted to advanced railway work. A two-mile track on the berme bank of the Erie Canal and a well-equipped car barn furnish opportunity for following up railway work. This test is only for those who intend specializing in this particular line.



GENERAL VIEW OF WORKS.

The working hours on test are from 7 until 12, and from 12:30 until 5:30, for five days a week, and from 7 until 12 on Saturday, thus giving a 55-hour week. For a week of neither tardiness nor absence an extra hour is added by the company, so the day man receives pay for fifty-six hours. Every test-man is expected to work thirteen weeks, nights, if called upon. Night men work sixty hours, from 7 until 7, Monday to Friday, inclusive. A half hour (12 to 12:30) is given for lunch with no time out, which offsets the hour gratis given the day man each week.

The rate at the beginning is at present 20 cents per hour for both day and night work for the first year; 22½ cents the six months follow-

ing, and more later, if the test-man proves himself, to the company's satisfaction, worthy. For overtime (after 5:30) time and a quarter is allowed, except after 4:30 Saturday afternoon and Sunday, when time and a half is given.

One feature found with the General Electric Company, not common with every electrical company, is the giving of machines into the immediate care of the test-man, thereby making him entirely responsible. When a man begins any test he is given the least important work to do, of course, but as fast as new men come on behind him, he moves up in both age and acquaintance until he becomes one of the "old men," running the machines and directing the work as he sees fit.

As soon as a man has completed the assigned time on any test, he may make application to be transferred to his choice of some he has not had. A transfer list is compiled weekly, and in this way a man can very nearly choose his own work.

The time spent on test varies widely, there being no definite agreement entered into with the company. Most every test-man takes at least fifteen months in getting the work he wants — many stay longer. On leaving the test, some leave the company, some enter engineering, some commercial work, and so on. This depends, of course, upon the line of work desired.

For a social side of life there is, among other things, the Edison Club, an organization formed principally from technical men at the G. E. The club has both summer and winter quarters, the summer club house being at the edge of town where there is ample room to enjoy tennis courts, golf grounds and a ball diamond. The downtown property fronts on one of the best streets and backs upon the Mohawk River, giving a fine opportunity for boat enthusiasts.

The Schenectady section of the A. I. E. E. is a wide-awake branch of the national body. Lectures given throughout the winter months have proven both interesting and highly instructive. Dr. C. P. Steinmetz is honorary chairman.

It is only natural for the test-man-to-be to want to know the nature of the work, the company, etc., and even something of his future environments. It was the writer's experience in 1907, when attempts were made to gain a few facts about such things, that they met with very slight success, and what information was received evidently came from a pessimistic source.

The experience gained in the testing department more than fulfills one's expectations, and there are very few, if any, who have regretted choosing this way of obtaining experience.

ALUMNI NOTES.

Mr. W. E. Ford, '98, we are reliably informed, is in the Philippine Islands, and has been for the past two years working for the Philippine Railroad Company. He went under contract with that company to remain two years, but the company has raised his salary and promoted him several times, insisting that he remain there. His work has been varied — locating, constructing and directing, with several thousand men under his control. He will probably remain in the Islands for some time if his health does not break down under the arduous work and trying climatic conditions. Prior to his going to the Islands he was on railroad work in Arkansas, Indian Territory and Oklahoma, and maintained a good standing with and for whom he worked.

THE TECHNIC takes pleasure in announcing what we believe to be something new in the engineering field:

A. EUGENE MICHEL
Advertising Engineer
Specialties — Steam Power Plant
Apparatus and Machine Tools
1572 Hudson Terminal Buildings
50 Church Street, New York

We were in doubt to a certain extent as to what the term "Advertising Engineer" embraced, so, for the benefit of those also in doubt, we give the following:

The title has never been used by more than a

half dozen men in this country, and, so far as known, was originated by Mr. George H. Gibson (former publication manager of the Westinghouse Companies), Mr. Halbert G. Gillette (author of Gillette's Hand Book of Cost Data), and Mr. Michel, when they constituted the first advertising organization composed strictly of technical men. The title was thus chosen to indicate an advertising business, backed by men of engineering experience and offering service exclusively for engineering products. Mr. Michel, of the Class of 1903, expects to have his new office open by March 15th, and will include in his work the planning of advertising campaigns, writing copy for trade-paper advertisements, publicity articles, circulars, catalogues, etc., and general management of the advertising of a limited number of manufacturers of steam power plant apparatus and machine tools.

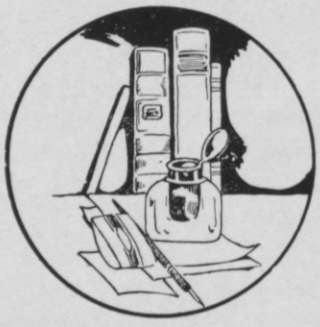
Mr. Henry W. Uhl, '02, we are informed, is also in the same building with Mr. Michel and Mr. Fishback, whom we mentioned in the March issue, and all three are on the same floor. Mr. Uhl is an inspecting engineer with Dr. Charles F. McKenna.

C. W. Post, '07, is Treasurer and General Manager of Delphos Electric Light and Power Company, Delphos, O.

Mr. Graham Davies, '03, has recently been transferred to the Pittsburg office of the Western Electric Company.

Mr. J. Simms Brosius, '03, recently with the Electric Controller and Manufacturing Company, is now with the Westinghouse Electric and Manufacturing Company at Pittsburg.

Word has just come telling of the death of Fred C. Ankeney in Chicago on April 9th. Mr. Ankeney entered Rose with advanced standing in September, 1904, and studied with those taking the electrical course for two years. His home was in Xenia, O.



FOREIGN EXCHANGE

By G. M. Curry, '09.

The term, "Foreign Exchange," is applied to the financial transactions between different countries. It is a system by which commercial nations discharge their debts to each other. These debts represent the difference between the amounts due from one country to another, and must be settled in cash or in something equally satisfactory to creditors. The transmission of gold and currency is risky and expensive. To avoid this risk and expense the system of exchanging debts through the medium of commercial paper is adopted. In other words, exchange is a system by which debts may be paid at a distance without the use of currency.

The necessity and convenience of this method are obvious. Exchange business emanates from various sources, among which are exports and imports, investments of people of one country in the stocks and bonds of another, cost of transportation of goods, commissions for services, expense of travel and remittances to foreign countries. By far the greatest volume of exchange business arises from exports and imports.

Let us take a simple example of direct exchange. A, say of England, has exported English goods to B, of France. In order that B may be saved the expense and risk of sending money to A, the latter draws a bill on B for the sum due and sells it to his neighbor D, in England, who in turn sends it to C, in France, from whom D has imported French goods of exactly equivalent value. C takes the bill to B, in France, and gets his money, while B has in the possession of the bill a discharge of his debt to A. Thus we see that all the debts are paid without the transfer of any money from one country to another. Exchange, then, is merely a system of cancellation of debts. In the example given the exchange is a very simple matter, but when we consider exchange between several different countries, each with a different money system and different standards of value, and consider also that different amounts may be owing from one country to the other, the operation of exchange business becomes complicated.

These cancellations of debt are carried out in large banks called clearing houses. These centers correspond to the inland clearing houses, except that, instead of being adjusted daily, the balances are never brought to a final settlement, but continue from year to year, adjusting themselves as the bills mature. New York is the clearing house of North America, and largely of South and Central America; London is the clearing

house of the British Empire and of the whole world; Paris of Central Europe; the large centers of other districts are the clearing houses of their respective territories.

If the amounts due one country from a second exactly equaled the amounts due the second from the first, exchange between the countries would still be a simple matter, for $100 in one country would buy a bill for $100 payable in the other. But if the two countries were not mutually indebted in equal sums, then the price of a bill would be reduced in the country which had the more owing to it and increased in the country which had the less. This is readily seen. Suppose that American wheat has been shipped to England to the amount of $100,000,000, while English manufacturers have shipped to us articles of the value of $90,000,000; then England would owe America $10,000,000. Thus there would not be enough American exchange in England to discharge the debt, so the English merchants would be forced to ship bullion. Rather than incur this risk and expense, however, the English merchants could afford to discount their bills, thus placing American exchange at a premium. In this manner the indebtedness might be canceled without the transmission of money.

Although the exact balance of trade between two countries is never known, it is reflected in the rate of exchange between the countries, the exchange of the country of less indebtedness being at a premium, and that of the other being at a discount. There is, however, a point above which the rate can not rise. This is called the gold point, and is the rate at which it is cheaper to ship gold than to purchase exchange. When this point is reached, the gold is shipped or the more deeply indebted country exports a large quantity of goods, and thus restores equilibrium. The rate of exchange does not often reach the gold point, and does not long remain there for reasons given.

The rate of exchange between countries fluctuates daily. The difference between the volume of exports and imports is probably the chief cause, but there are also several other causes. When the loaning rate for money here is high, capitalists and bankers will loan their money here instead of investing it in foreign commercial bills, and thus cause a less demand for the bills, and hence a lower rate. If rates for money abroad are high, there will be a greater demand for exchange on foreign countries for the purpose of getting the money to such places in order to take advantage of the high rate, and, therefore, higher rates here for exchange. If the rates for money abroad are lower than here, our capitalists will borrow money in foreign markets for investment here, thus increasing our indebtedness to foreign countries, and, hence, causing higher exchange rates. Investments made by capitalists of one country in the stocks and bonds and financial enterprises of another materially affect the rate of exchange between the countries by increasing or decreasing their mutual indebtedness.

When two countries are indebted to each other in equal sums, exchange is at a par, and all indebtedness can be discharged without the intervention of money. This condition is termed a commercial par of exchange. There is also a par of exchange based upon the monetary standards of two countries, which is called the mint par of exchange. It is the actual value of the pure metal of the standard coin of one country in terms of the coin of another, and is declared by the government of the different countries. The par, for example, between the United States and Great Britain of the pound sterling is $4.8665. This par of exchange is fixed if both countries have a gold standard, but fluctuates, if one country has a silver standard, with the price of silver.

The most intricate and interesting form of exchange is the system by which debts between two countries are adjusted through a third, each having different monetary units. This is called the arbitration of exchange. For example, suppose a New York merchant wished to transmit some money to Paris. He would look up the quotations of exchange, and if he finds that the rate of exchange between New York and Paris is higher than the rate from New York to London plus the

rate from London to Paris (as may be the case), he, of course, transmits his money through London. This method of transferring money from one country to another is common and is done for several reasons. All large banking houses in this country keep accounts in the principal European cities. If, for instance, the concern needed more money in Paris than it had there, it would, if the exchange was favorable, transfer its money from London, say, rather than from here. As an example, suppose a Chicago banker wished to remit to Paris 25,250 francs, and the best rate here was 5.17½ francs per $1.00. This would call for $\frac{25,250}{5.17\frac{1}{2}} = \$4,879.23$. Now, suppose a demand draft on London could be bought at $4.84 per pound sterling, and the exchange at London on Paris was 25.25 francs per pound sterling. A bill for 25,250 francs could then be bought on Paris for £1,000, and this £1,000 would cost $4.84 x 1,000 = $4,840.00. There would, therefore, be a saving of 4,879.23 — 4,840.00 = $39.23 on the transaction. Money is often transmitted from one bank to another in this way solely for the profit gained by the exchange.

Another and more important aspect of arbitration of exchange is as follows: The United States, for example, sells to England much more than England sells to us, and, therefore, as far as these two countries are concerned, there would be a constant stream of money flowing from England to the United States. But the United States buys much more from China, say, than it sells to China, while, on the other hand, England sells more to China than China sells to her. The merchants of America, therefore, pay their debts to China by exchange on London. Having the right to receive large sums in London, they sell this right to Chinese merchants, who are glad to buy it in order to pay the indebtedness of China to England. In this way the operations of exchange are greatly increased in volume, and the amount of bullion sent to one country from another is correspondingly diminished.

This is three-cornered arbitration of exchange, but what China, England and the United States have done in this illustration all nations do, each using every favorable balance with another nation to offset some portion of their indebtedness to still other countries. These operations of exchange are carried on largely through banks, although a special class of brokers in exchange arises in all cities where the business is large in volume. The chief center of exchange operations is in London. To this great clearing house are sent bills of exchange from every quarter of the globe. No matter in what city or upon what continent a man wishes to pay a debt, he can always find some one in London who has credit on that place; that is, who has a right to receive money there. By purchasing this right or credit, and sending it to that city, he can pay a debt there without sending the actual cash. We thus see that exchange greatly facilitates and makes safer the great volume of transactions arising out of international commerce.

The following is an extract from a letter received from Byron Kelso, '08, who has been in the Panama Canal Zone for some time:

When the United States made a treaty with the Republic of Panama, it gained supreme control over a strip of land as long as the isthmus is wide and ten miles broad; five miles on either side of the center line of the canal. This tract of land is known as the Canal Zone.

The present plan of building a lock-type canal calls for what is practically a big lake, to be held in check by the now famous Gatun dam. The water for this lake is supplied by the Chagres River, and in order to know just what can be expected of this most eccentric of all rivers, the I. C. C. (Isthmian Canal Commission) is making extensive surveys of all the tributary drainage basins. So much has been written and is being written about the canal that I think I shall confine myself to my own experiences here, and especially to those on the Chagres River; but first I must explain the general conditions that lead to some phases of the work.

At the expense of a deal of trouble, time and money, the sanitary and municipal departments of the commission have succeeded in stamping out all of the dread tropical diseases within the zone, and we now have really better sanitary conditions than in many of the Southern parts of the States. However, the tributaries of the Chagres extend far beyond the pale of this healthful and carefully patroled zone, and into these remote regions must the new man go, for those already here are too wise to agree to any assignment that will take them into the tropical jungles where the same menaces to health exist now as centuries ago.

So my first assignment was with a corps at work "up the river." I was given a day off, directed to go to the city of Panama and provide myself with a complete tropical surveying outfit. This outfit did not include provisions, tents, cots, revolvers and rifles, these being furnished by the I. C. C. All being in readiness, I proceeded to the end of the railroad, and then traveled in a native dugout canoe for two days and one night. This trip was rather monotonous, the only amusement being target practice at alligators, which we found quite numerous.

Arriving at my destination, I found the party engaged in running a traverse around this section of the watershed. Or, rather, since the jungle was too thick to cut through, we did not run out the actual divides, but each party took a tributary and traversed it till they came to its head, thus establishing a point on the divide. Having a number of such points, a line could be drawn on the map connecting them, which would approximately represent the true drainage boundary. About every five miles we would move camp, this operation necessitating two trips with the canoes. One day, when about fifty miles from the zone, we were in the act of moving camp, out in the water up to our waists, pulling the boats up the rapids, when the worst flood on record came down upon us without an instant's warning. Our boats were swamped, we were swept off our feet, and all our outfit that would float danced off on the crest of the swirling torrent. Somehow we managed to regain the boats, and even saved the instruments and a few stray items on the grub list. Taking inventory, we found we had 128 hard tack and two sides of bacon as supplies to last three white men and seven natives indefinitely. By eating one hard tack and two slices of bacon per man per meal, we estimated that we might get along five days, and thought the flood would surely subside in that time. At the end of five days it had risen fifty-two feet, and was a surging, roaring torrent full of whirlpools. We made a desperate attempt to "ride the tide," but came so nearly being swamped again that we were only too glad to get back to the bank safely. Fortunately, the stream took a new tack the next day, and dropped twenty feet. We then set out on a rather dangerous journey to the place where we had left the other half of our outfit, only to find on our arrival that we were floating some thirty feet above it. The tents were the only part of the outfit that we secured. These had floated down some distance and were lodged in a patch of briars away above the water line as it was then. The only thing to do was to put back to the zone, and this we did in double-quick time on the high water. You may be sure it was a relief to get into a change of clothing; we had spent three weeks in the ones we brought back to civilization on our backs.

Sleeping five nights in a steady downpour of rain was not without its effects on me, and I found myself in the grasp of yellow fever. Reporting promptly to the doctors, I received the best of care, and my case was not so far advanced that it could not be successfully handled.

On my feet again, I was glad to receive an offer of transfer to actual construction, and reported at once to division engineer of Central Division. Here I was put upon the corps of engineers constructing highways through the jungle upon which to haul supplies and produce. This was interesting work indeed, as it is no small engineering problem to get up and around the steep hills — or, rather, mountains — and span

the rivers, keeping all the while within a 5 per cent. grade, which is the maximum allowed on highways here.

After a few weeks of road work, the plans for the big suspension bridge across the canal were ready, and I was appointed assistant to the engineer in charge of construction. We have the excavations for the piers and anchorages completed, and will commence to drive piles for the foundations next week. This bridge has a span of 600 feet, and with the approaches makes quite a long structure.

One thing has impressed me very strongly ever since the first day I set foot here, and that is the enormous, unbelievable waste of machinery by the old French company. Due to graft, poor management or something, numbers of good locomotives and other heavy machinery were dumped overboard in Colon harbor without so much as an attempt at landing them. Scores and hundreds of excavators, dredges and steam shovels were left scattered through the jungle, never being assembled. Graft must have been rife in the high places of the De Lesseps company when one can find a string of thirty or forty old French locomotives lined up in the bush without any sign of ever having been used. These machines are of such good material that, although they have stood for a quarter of a century in the moist tropical jungle, they still are very efficient when overhauled in the shops and put in working order. Several hundred small locomotives have been repaired by the I. C. C. and are now in active service.

Having outlined some of my experiences during working hours, I will attempt a description of some other phases of an engineer's life here. The chief social medium in all the larger towns is the Y. M. C. A. These are operated on a broader and more efficient plan than those we have in the States, and nearly all the fellows spend most of their spare time in them. The reading rooms contain every engineering magazine published, and many other classes; there are billiard and pool rooms, bowling alleys, chess rooms, and they are even provided with confectioneries and cafés. The Government controls these institutions, and they certainly do everything to make the fellows feel at home.

Each good-sized town boasts a league park, where ball games are held frequently throughout the year. Dancing clubs are organized in each town, and altogether, if you could only forget that the United States existed, you would enjoy yourself here as much as at home. However, one is continually thinking that when ten months of service have been completed there will be a six weeks' vacation coming in which to pay the folks at home a much-desired visit.

In the last few years the treatment of employes by the I. C. C. has improved very materially. The strictest sanitary regulations are in force, but the commission service is so efficient that it is not hard to conform to these. Of course, the quarters for all employes are maintained by the commission. When a man reports at the point to which he has been assigned, he is provided with free quarters, which are furnished with electric lights, shower baths, large mosquito nets, and all necessary conveniences. Rigid regulations govern the manner of airing and cleaning these quarters; a negro janitor sweeps out and airs them each day and scrubs everything twice a week. His work is carefully inspected at 4 p. m. daily.

Then, too, the class of men with which one must associate has steadily changed, until now, in place of "the scum of the earth" — as report had it in the first days of operation — practically all the men in the engineering department are college graduates. Although every college, large or small, is represented, the technical graduates have the advantage over the others, and, other things being equal, are given the preference. I was surprised to find some sixteen Purdue men here. The only other Rose man I have found is chief of the electrical and mechanical departments, and I was delighted to learn that he was considered one of the brightest and best-educated men on the zone.

...ATHLETICS...

BASEBALL.

Manager Markley, of the baseball team, has arranged one of the longest and hardest schedules for the team that has been had for several years. Eighteen games will be played in all, nine on the road and nine at home. All of the home games will be played on Saturday afternoons, and another thing that will appeal to the rooters is that every Saturday from now until June will see a game either on the campus or at Parson's Field. Wabash will be taken on for four games and Normal for three. DePauw, Butler, Indiana, Eastern Illinois Normal will be played two each, one here and one there. Purdue, Notre Dame and St. Viatuers will be played one each, all of them on foreign grounds. The latter is a new school to Rose in an athletic way. It is located at Kankakee, Ill., and was scheduled by Markley to come in on the trip to Notre Dame, and thus reduce expenses. In past years they have had good ball teams, and will probably give us a mighty interesting tussle.

Notre Dame and Purdue games will both be of the hardest kind, while with the others we think that we have more than an even show. Last year the rooters will remember that we split even with Wabash on the four games, but we intend doing better than that this year and come off with at least three of them on our side of the ledger. Butler does not look very big, nor does Eastern Illinois Normal, which has lost the Tarbell brothers' battery, which took the game from us alone last spring. DePauw we want to beat badly in both games, as they slipped both of them over on us last year.

The team looks good to the rooters at present. Backman and Frisz in the box are recognized to be two as good flingers as will be seen on any college team in the State this spring. Shook has been putting up an excellent game on short, as has Barrett on third base. Mooney has been shoved over to second, and Hadley is again in his old place on the initial sack. Lawler, a Freshman, will handle the big mitt and mask all season. In the outfield the choice is still in doubt. A number of men have been showing up very good here, but it can not be told just who will play the games all season. The best men on it have been Webster, Nicholson, Ahrens and Wyeth. These men are all good at bringing down the flies, and will probably be given the chances to win their "Rs."

The schedule is as follows:

Apr. 10. Eastern Illinois vs. Rose, at Terre Haute.
Apr. 15. Purdue vs. Rose, at Lafayette.
Apr. 17. Indiana vs. Rose, at Terre Haute.
Apr. 22 Wabash vs. Rose, at Crawfordsville.
Apr. 24. DePauw vs. Rose, at Terre Haute.
Apr. 28. Indiana vs. Rose, at Bloomington.
May 1. Wabash vs. Rose, at Terre Haute.
May 5. Eastern Illinois vs. Rose, at Charleston.
May 8. Normal vs. Rose, at Terre Haute.
May 11. DePauw vs. Rose, at Greencastle.
May 13. Butler vs. Rose, at Indianapolis.
May 15. Normal vs. Rose, at Terre Haute.

May 18. St. Viatuers vs. Rose, at Kankakee, Ill.
May 19. Notre Dame vs. Rose, at South Bend.
May 22. Butler vs. Rose, at Terre Haute.
May 25. Wabash vs. Rose, at Crawfordsville.
May 29. Normal vs. Rose, at Terre Haute.
June 5. Wabash vs. Rose, at Terre Haute.

TRACK.

Track prospects are looking good right now for Rose to regain some of her lost glory on the cinder path. Captain Standau has put in some hard licks with the thinly-clad artists, and really has a very good-looking bunch in the field. Shaw and "Dick" Smith are looking good in the dashes. Smith and Buckley in the high jump and hurdles are showing up very well. Smith also shows class in the broad jump and discus hurl. Standau looks good for the broad jump and shot-put. "Jimmie" Darst is again out with his little hammer, and has been throwing the plaything good distances already this season. He is looked upon to make some good points for us in the meets. Tyler, Devonald, Rasmussen, and Spindle are showing up well in the distance runs, and ought to be able to bring home some trophies.

Manager Tyler has been very busy fixing up the schedule for the men, and has succeeded in arranging five meets for them. Purdue, DePauw, and Normal will be taken on for dual meets. There will be a triangular meet here between Rose, Normal, and Millikin. Then, of course, the State meet at Richmond will be taken in with a vengeance. The schedule is as follows:

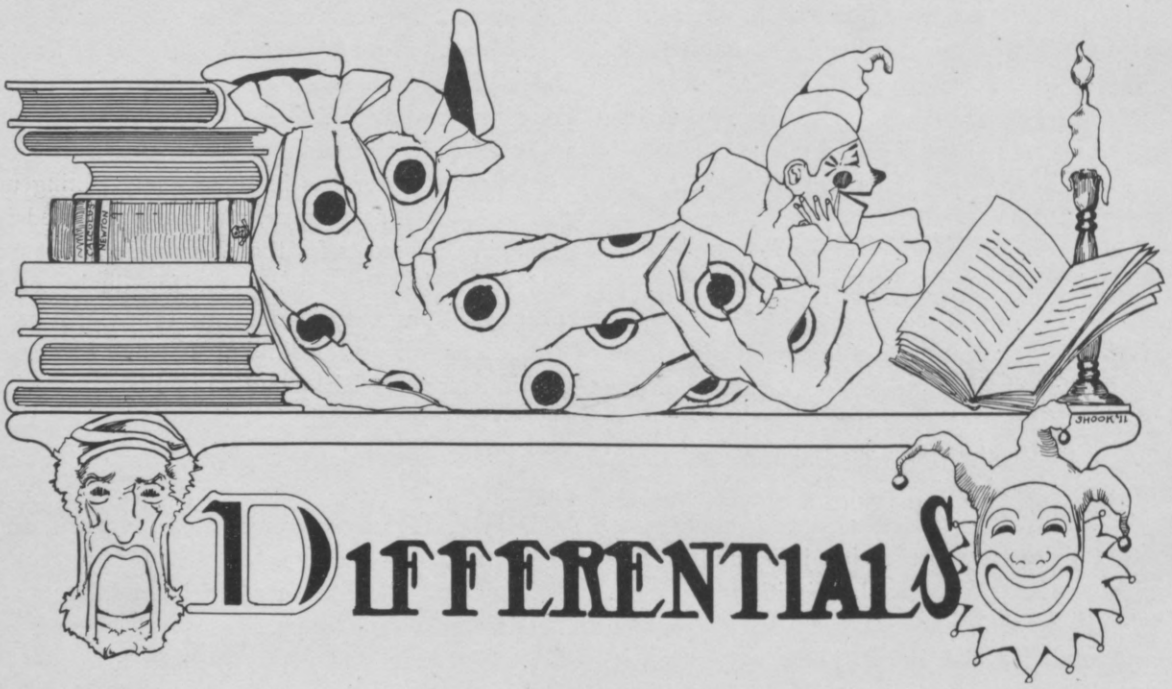
May 1. Dual meet, Rose and Purdue at Lafayette.

May 8. Triangular meet, Rose, Normal, and Millikin at Terre Haute.

May 15. State meet at Richmond.

May 21. Dual meet, Rose and Normal at Terre Haute.

May 29. Dual meet, Rose and DePauw at Greencastle.



"Au reservoir," said the American, who was trying to learn French.

"T'anks," said the polite Frenchman, who was studying English.

HAVE A GUESS.—What did Mac mean when he told Offutt not to display the largest part of himself so frequently?

The coefficient of restitution of a block of wood against adamant where the former applies to the brilliant '11s and the latter to Knippy's Dynamics is, according to the latest experimental tests, somewhere in the neighborhood of minus zero.

Friend: "Don't worry because your sweetheart has turned you down since you lost your money. There are as good fish in the sea as ever were caught."

The one who was stung: "Yes, but I lost my bait."

Washburn: "Some years ago I just had money to burn, and I burnt it, too!"

Smith: "How?"

Washburn: "On an old flame of mine!"

Gilbert, '12: "The dentist told me I had a large cavity that needed filling."

Krieger, '12: "Did he recommend any special course of study?"

Great Tragedy at the Glee Club concert!—The song died on their lips. It had been cruelly murdered.

McKee: "What makes you scratch your head?"

Larsen: "Because I'm the only one that knows it itches."

WANTED.—The name or any information concerning the person or persons who placed that box on my desk. Reward. DADDY LOGAN.

Bennett: "What would be the great difference in expressing this thought in French instead of English?"

Pineda: "It would be a different language."

Considering the unqualified success of the first attempt, it is thought that the Freshman Class will adopt St. Patrick's day as a permanent holiday.

Frisz: "How tall are you, Sproull?"

Sproull: "I can stand about six five in my shoes."

Frisz: "I can stand about six two, myself."

Smith: "I can stand about six, too, if somebody else pays for them."

Those gentlemen (?) who have been nailing overalls and other loose dry goods to the woodshop floor will meet Reddie, '12, behind any convenient barn at the earliest opportunity.

Grosvenor (being caught in the act of taking a nap in lab.): "Well, well; as I live, it's Mr. Barnes!"

It is rumored that the Athletic Association has engaged Bill Royse to coach next year's football team.

A certain Sophomore has discovered that one should never purchase a thermometer in summer; they are much lower in winter.

The dead are soon forgotten — and some people don't have to wait that long.

"Why, my boy, did you fall in that open coal hole?"

"No, course not. I wuz in here, an' they built a pavement over me."—*Ex.*

Judge: "Why did you strike this man?"

Prisoner: "What would you do, judge, if you kept a grocery store, and a man came in and asked if he could take a moving picture of your cheese?"—*Ex.*

Jojo: "Well, I never saw so many entertainers in one class before. We ought to organize a troupe. Give Rush a little colored chalk, station Hickman at the door, and put Shaw—well, Shaw could star in any specialty."

A few extracts from Myer's Treatise on Chemistry:

"There are some substances which can be oxidized, but not combusted."

"Reduction is a slow process of getting rid of a substance due to heat."

"A molecule is a very small particle. They are found in all substances."

"Evaporation is an example of reduction."

Jimmy: "Good old Yost. We'll take you to Milwaukee, and maybe we can trade you in for a sewing machine."

OVERHEARD IN CHEM. LAB.

First Soph (in anger): "Go to h—l."

Second Soph (dramatically): "I'll die first."

Jojo: "I have to laugh at Mr. Shaw. It's really interesting. You never know what he's going to do next."

Blondy, the "honey boy," gave away the fact that he had been boarding for some time by a remark made while dining out on Sunday at a really high-class dinner. He observed a dish of dusky hue at the far end of the table, and unhesitatingly asked the hostess to "Please pass the prunes."

Student (having lost a book): "Seems as though some one is real handy in picking up stuff around here."

Planck: "Yes; he should try out for the ball team."

"Breathes there a man with soul so dead
Who never to himself hath said,
As he stubbed his toe against the bed:
— ? (—) — x—i, Z." —*Ex.*

Back (with a sprained arm): "And the deuce of it all, I have a date to-night." However, his "left" was left, and it was generally supposed to be available in emergencies. And it was.

Back (in Civil, with Howe looking over his shoulder): "Say, fellows, won't we be having a —— of a time this time next year?" Back never did believe in rubber heels, anyway.

Webster (in Light, opening his book to chapter headed "Description of the Eye"): "I'm going to read this. I always did like—um—er—botany."

Logan (to O'Brien, in machine shop): "What has become of Johnston?"

O'Brien (to Frisz): "Where is Jimmie, Fred?"

Frisz: "He's gone to Indianapolis, to the insane asylum. Logan drove him nuts."

"The Man from Home" hit the "Honeymoon Trail" for about "Three Weeks." As he was going "Down the Pike" he met "The Merry Widow." He gave her "The Talk of New York," and told her that he was "The Yankee Prince"; but she thought that he was "The Prince of Pilsen," and told him to go to "The Isle of Spice" and take "A Desperate Chance" with "His Last Dollar." This he refused to do. She then told him to go to "The Devil," but he said, go "Way Down East" to "The Old Homestead" in "East Lynne," get "A Bunch of Keys," unlock "The Mysterious Chamber," and bring forth "The Melting Pot." Then, as it is "Never Too Late to Mend," he will board "The Midnight Express," go "Fifty Miles from Boston," be married in "The Little Church Around the Corner," live like "The Newly-weds," and have "Three Twins."

Centralized Auxiliary Control.

In the design of power plants of importance the modern tendency is toward the use of a system of auxiliary control from the switchboard. In addition to the remote control of oil switches in the main circuits, which has long been practiced, it is now quite feasible to start and stop motors for all purposes from a central point. The old idea that a controlling switch must be located within a few feet of its motor has been modified by the production of remote-control motor starters, the master switches of which are grouped at a central point. It is only a question of a little more wire and a little more elaborate controller, the extra cost of which, in most cases, will be a small price to pay for the greater convenience of operating the various motors for pump service, valve operation, coal and ash handling, fan driving, air compression, and the like, many of which may be located in places inconvenient of access.

Additional switches on the switchboard for the control of lighting circuits in the engine and boiler rooms, coal pockets, oil-storage rooms, pipe tunnels, and of the motor circuits for the traveling crane, constitute an added improvement, which does not interfere in the least with the provisions of parallel switches or controlling apparatus located near the equipment they control; and in the light of the necessity for continuity of service, this duplication of control in many instances would be well worth while.—*Power and the Engineer.*

Gas Equipment for a British Battleship?

According to a brief press cablegram published recently in some of the New York dailies, the British Government has made all the necessary arrangements for the construction of a fighting ship of the "Dreadnought" class to be equipped throughout with gas power. Efforts to get at whatever facts may have given rise to the dispatch have thus far produced no results, nor have any supplementary cablegrams appeared to corroborate the first one or amplify the "information" which it purported to present. It is possible that a new series of experiments with larger equipment than that tested recently on the "Rattler" may form the basis of the cabled report. Certainly it does not seem probable that a government as conservative as that of Great Britain would incur the great risk of flat failure involved in an attempt to construct a 40,000 or 50,000 horse-power producer gas battleship with no precedent beyond the 500 horse-power unit tried out in the "Rattler," or the 1,000 horse-power unit now in process of trial.

When it is considered that the maximum gas-engine output per cylinder thus far secured on land, under the most favorable conditions yet known, is less than 1,500 horse power, rumors as to the equipment of a battleship or other vessel with units which would need to develop at least that much power per cylinder, and probably more, take on the aspect of what the street gamin characterizes as "pipe" dreams. There is no doubt whatever that gas power in large units will be

applied to marine work some day; there is, however, doubt amounting to incredulity on our part that it will happen this year. There exists right now a most promising opportunity for some one to produce a satisfactory marine engine of 1,000 horse power for service on the Great Lakes of this country, but no builder has as yet accumulated the necessary nerve to make the attempt, although a perfectly responsible business concern has signified its readiness to buy and pay for such an engine the moment it is built.—*Power and the Engineer.*

Machinery Building in Japan.

One can not but be surprised at the remarkable progress that is being made in manufacturing industries in Japan. Prior to the Japan-China war of 1894-95, Japan had been an importer of manufactured goods, but subsequently with the rise of manufacturing industries, machinery of various descriptions began to be imported in increasing quantities. Japan has now gone even farther, and the manufacture of light machinery and machine tools has been started and is being briefly carried on.

By some it is claimed that Japan is now quite independent of foreign aid in the manufacture of arms and warships, as this work is being quite satisfactorily accomplished in the various naval and military arsenals of the Government. It must, however, be admitted that as yet Japan has not been able to manufacture all the raw material which enters into the construction of her warships, as heretofore all plates and parts have come, for the most part, from Scotland and north of England. But the Government foundries at Wakamatsu are now about ready to supply material for all ship-building purposes.

On a recent trip through the habutai silk district, it was found that machinery had been introduced for the production of habutai, and to such an extent that it is likely in a very short time they will do away with the hand method heretofore generally used throughout the country. * * *

There is beginning to be an extensive demand in this country for electrical machinery, though at present there are only a few manufacturers of electric machines and supplies in Japan. Perhaps the most important of these are the Shibaura Engineering Company and the Tokio Electric Company, Ltd., which is a joint enterprise of the General Electric Company, of Schenectady, N. Y., and a body of Japanese. * * * —*American Machinist.*

A New Steel.

The suggestion made by Professor Arnold at the recent meeting of the Royal Institution of Great Britain has attained actuality sooner than was anticipated. The professor stated that, speaking on specific facts within his knowledge, he was strongly of opinion that the best high-speed steel of to-day was destined to be superseded, and that he thought it probable a year hence there would be on the market a British steel with quadruple the cutting power of any now known to metallurgy. This naturally caused intense excitement among steel manufacturers, and in Sheffield created a feeling little short of consternation. Inquiries among the four or five present makers showed that the announcement was received with a considerable amount of incredulity. On Wednesday, however, the secret was out, and it was announced that Messrs. Jonas & Clover, of the Continental Steel Works, had discovered a new steel, which, in the opinion of experts, fully justified the encomiums of the professor.

Messrs. Jonas & Clover state that the steel, as a matter of fact, is already on the market, and that samples have been in the hands of travelers of the firm since the beginning of the year. Rigorous tests have been made, and the steel has undoubtedly more than quadrupled the efficiency of any existing steel of a similar type. * * *

This new steel has been named "Novo Superior."—*American Machinist.*