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IN recording the death of the Rev. Konrad Mees, which occurred at his home in Columbus, O., on March 27, THE TECHNIC desires to express its sorrow and its sympathy with our President in his bereavement.

THE Faculty has been good enough to allow members of THE TECHNIC Board several unexcused absences during the present term to give to TECHNIC work. The editors appreciate very much this favor granted, and desire here to express their thanks.

THE TECHNIC would like to see the library open between the hours of one and five-thirty in the afternoon. The student complains that at the time he wishes most to use the library the doors are closed. From two o'clock until five he is generally at recitations and has time only between times to drop in and glance over the periodicals. A change in the hours would be appreciated.

A MEETING of the Board of Managers was held on April 5th to transact business pertaining to the welfare of the Institute.

THE new catalogue which is now being distributed, differs in a few particulars from that of 1901–02. A comparison of the calendars shows that 1902–03 has four working days less. The Spring vacation will be shortened to three days. Senior Civils and Chemists are to have six hours a week of machine design—which, however, are to be taken from the thirty-six hours of Civil Engineering and Chemistry, so the total number of hours will not be increased. No mention is made of a lecture course, but it is presumed that there will be lectures on engineering subjects from time to time during the Spring term as heretofore.

OUR editor of Reviews gives in this number an extract from the *American Machinist*, which favors the adoption of the metric system in this country. We note that a resolution in regard to the metric system was adopted by the National Manufacturers' Association, at their seventh annual meeting, held at Indianapolis, April 15–17, and reads as follows:

Resolved, That it appears to this Association that the compulsory adoption of the metric system would probably affect the manufacturing interests of the United States as follows: One-third who are exporters to European countries and their dependencies would be benefitted, one-third who do business in this country and all other countries would neither be benefitted nor greatly injured, one-third who do business in this country and in England and dependencies would be seriously injured. For all this the expense and inconvenience would be very great. In view of these conditions and the further fact that the metric system is already legalized for those who find it profitable, this association recommends that no further action be taken on the matter at this time by Congress.

By F. C. WAGNER.

IN spite of their very extended use in the arts, the information required for an intelligent design of electro-magnets is sadly wanting. This is doubtless partly due to the fact that in many cases it is easier to construct the magnet and try it than it is to attempt to calculate its action in advance. It is also true, however, that except for traction magnets, i. e., magnets working with their armatures always in contact with the pole faces, the data for an exact calculation are not obtainable. It is the purpose of this paper to analyze some recent experiments for the purpose of providing a part of this necessary data.

The law of attraction between two so-called magnet poles has long been known, and is properly expressed by the statement that the mechanical force exerted between them is proportional to the product of their pole strengths and inversely proportional to the square of the distance between them. But ideal magnet poles do not exist, and although approximate counterparts may be obtained by the use of long bar magnets and the law above stated may thus be verified, still the results are of theoretical interest only. Many attempts have been made to discover the laws governing the attraction of shorter bar magnets, extended accounts of which will be found in treatises upon magnetism. The general result has been that a multitude of different formulae have been derived, each applicable to certain special cases, but none of them throwing any light upon the problem of the practical design of commercial forms of electro-magnets.

The law of attraction, when the armature is in contact with the pole faces, has also been accurately stated, and is commonly used in the design of lifting magnets. This law is that the force with which the armature is pulled toward each pole face is proportional to the square of the intensity of induction across the contact surface, multiplied by the area of the contact surface. Numerically, the force in pounds equals the square of the intensity of induction expressed in lines per square centimeter, multiplied by the contact area in square centimeters, and divided by 11,183,600.

When it is required to design an electro-magnet for commercial use, it is quickly seen that the most economical form is one in which the magnetic induction passes entirely through iron, except for that portion of the magnetic circuit where it is desired to produce motion. Hence the movable portion, which is usually the armature, is placed at a certain distance from the pole faces so that when attracted to them the required movement will be produced. What is the force acting upon the armature at the beginning of its movement?

In the first place, it would seem that the law of attraction should depend upon the relative dimensions of the iron parts and not upon their absolute size. So that if, for example, the laws governing the attraction of a common horseshoe electro-magnet with a bar armature be determined for various air gaps and intensities of induction, the attraction of any other similar electro-magnet of different dimensions but of the same form and quality of iron can be calculated therefrom.

The experimental results given below are taken from two different sets of experiments made upon two different electro-magnets.

The first set of experiments was made by Mr. Geo. A. Damon at the University of Michigan in 1895, and forms the subject of Mr. Damon's thesis for the degree of B. S. in electrical engineering. The second set of experiments was made by Messrs. H. S. Richardson and T. D. Witherspoon at the Rose Polytechnic Institute in 1900, and likewise forms the subject of theses for the degree of B. S. in electrical engineering.

The magnet used by Mr. Damon was of the horse shoe type, made of a single piece of round soft iron 1½ inches in diameter. The mean length of the magnetic circuit through this part of the magnet was 25.2 inches, and the distance between the axes of the poles was 6 inches. The armature was of square section, having an area of 2.0 square inches. The mean length of the magnetic circuit through the armature was 7.5 inches. The magnetizing coils contained 3164 turns of No. 18 B. & S. gauge copper wire, divided equally between the two legs of the magnet. The armature and pole faces were carefully surfaced.

In conducting the experiments distance pieces of hard wood were placed between the armature and the pole faces, and the force required to pull the armature away from the pole faces was measured by suitable apparatus. Exploring coils were used at different places surrounding the iron, and the induction passing through them was measured by reversing the current in the magnetizing coils and noting the throw of a ballistic galvanometer.

For the purpose of utilizing the results of the experiments in the practical design of electro-magnets the writer has calculated what would have been the intensity of induction in the air gaps upon the assumption that the induction passes directly across from the pole face to the armature without spreading. The pull due to such calculated value of the induction in the air gap has also been calculated and compared with the measured pull. The values of the permeability corresponding to various values of the intensity of induction B are given by Mr. Damon, as are also the values of B at several points in the magnetic circuit. The value of the permeability corresponding to the average value of B was found, and from this, together with the known length of the magnetic circuit, the ampere turns required to force the average induction through the iron parts of the circuit was determined. The balance of the magnetizing force was divided equally between the two air gaps and the strength of field, H, thereby produced under the assumed condition was calculated.

Tables I to IV contain the values obtained and calculated from Mr. Damon's experiments:

TABLE I.

AIR GAP=⅛ INCH=1-12 DIAM. OF POLE FACE.

	1732 Ampere turns.	3812 Ampere turns.	7277 Ampere turns.
Maximum B in magnet	6600	12000	16500
B at pole face	3300	6800	10100
Calculated H in air gap	2460	5240	8280
Pull per pole due to calculated H in air gap, pounds	6.19	28.0	70.3
Measured pull per pole, pounds	8.12	28.7	59.25
Ratio of measured pull to calculated pull	1.31	1.02	0.84

TABLE II.

AIR GAP=¼ INCH=1-6 DIAM. OF POLE FACE.

	1732 Ampere turns.	3812 Ampere turns.	7277 Ampere turns.
Maximum B in magnet	5300	10100	15200
B at pole face	2300	4600	7300
Calculated H in air gap	1270	2770	5090
Pull per pole due to calculated H in air gap, pounds	1.66	7.83	26.5
Measured pull per pole, pounds	3.00	11.00	26.7
Ratio of measured pull to calculated pull	1.81	1.40	1.01

TABLE III.

AIR GAP=½ INCH=⅓ DIAM. OF POLE FACE.

	1732 Ampere turns.	3812 Ampere turns.	7277 Ampere turns.
Maximum B in Magnet	4800	9700	14500
B at pole face	1410	2730	4000
Calculated H in air gap	664	971	2733
Pull per pole due to calculated H in air gap, pounds	0.45	2.2	7.63
Measured pull per pole, pounds	1.00	3.62	9.5
Ratio of measured pull to calculated pull	2.22	1.64	1.25

TABLE IV.

AIR GAP=1 INCH=⅔ DIAM. OF POLE FACE.

	1732 Ampere turns.	3812 Ampere turns.	7277 Ampere turns.
Maximum B in magnet	4000	8500	13900
B at pole face	710	1720	2900
Calculated H in air gap	344	792	1460
Pull per pole due to calculated H in air gap, pounds	0.12	0.64	2.17
Measured pull per pole, pounds	0.375	1.12	2.87
Ratio of measured pull to calculated pull	3.12	1.75	1.32

The magnet used by Messrs. Richardson and Witherspoon was of the horseshoe type, with round cores and rectangular shaped yoke. The cores were 1½ inches in diameter, turned down to ⅞ inch where they entered the yoke. At the pole face end the cores were turned down to 1 inch for a distance of ½ inch, and collars were used to bring the diameter of the pole face back to 1½ inches. The object of this was to permit of the use of collars of various external diameters. The cores were forced into tight-fitting holes in the yoke with a pressure of from 1½ to 2 tons. The yoke was 12¼ inches long, and had a cross section of 1½ inches by 1$\frac{3}{16}$ inches. The distance between the axes of the cores was 10¾ inches. The armature was 12⅜ inches long, and had a cross section of 1½ inches by 1$\frac{3}{16}$ inches. The mean length of the magnetic circuit through the iron was 43.5 inches. The magnetizing coils were wound in eight sections, four being placed on each leg of the magnet. In order to reduce the time constant of the magnet to a minimum, the maximum current of 20 amperes was always used, and the magnetizing force was varied using successively two, four, six and eight sections.

The experiments were conducted in substantially the same manner as were Mr. Damon's, although with different apparatus. In addition to the exploring coils encircling the iron at various places a supplementary exploring coil was made having an internal diameter equal to 1½ inches. This coil was placed against the surface of the armature concentric with and opposite to one of the pole faces, so as to measure the induction entering the armature at that place. The writer has calculated the values of H in the air gap and the pull corresponding exactly as for Mr. Damon's experiments.

Tables V to XII exhibit the results obtained and calculated from Messrs. Richardson and Witherspoon's experiments:

TABLE V.

AIR GAP=⅛ INCH=1-12 DIAM. OF POLE FACE.

	3240 Ampere turns.	6480 Ampere turns.
Maximum B in magnet	9000.	14450.
B at pole face	5950.	8720.
Calculated H in air gap	4765.	8840.
Pull per pole due to calculated H in air gap, lbs.	23.2	79.8
Measured pull per pole, pounds	24.6	47.8
Ratio of measured pull to calculated pull	1.06	0.60

TABLE VI.

AIR GAP=¼ INCH=⅙ DIAM. OF POLE FACE.

	3240 Ampere turns.	6480 Ampere turns.	9700 Ampere turns.
Maximum B in magnet	6900.	13100.	15200.
B at pole face	3850.	6400.	7150.
H at armature surface, measured	2300.	3870.	4370.
Calculated H in air gap	2590	4340.	6820.
Pull per pole due to calculated H in air gap, pounds	6.85	19.2	47.5
Measured pull per pole, pounds	[6.42]	17.52	26.4
Ratio of measured pull to calculated pull	[0.94]	0.91	0.55

TABLE VII.

AIR GAP=⅜ INCH=¼ DIAM. OF POLE FACE.

	3240 Ampere turns.	6480 Ampere turns.	9700 Ampere turns.	12560 Ampere turns.
Maximum B in magnet	5900.	13300.	14300.	16500.
B at pole face	2750.	5400.	5650.	6250.
H at armature surface, measured	1590.	2840.	3210.	3400.
Calculated H in air gap	1780.	3245.	4770.	5460.
Pull per pole due to calculated H in air gap, pounds	3.23	10.75	23.25	30.5
Measured pull per pole, lbs.	4.52	[14.27]	17.78	19.38
Ratio of measured pull to calculated pull	1.40	[1.33]	0.76	0.63

TABLE VIII.

AIR GAP=½ INCH=⅓ DIAM. OF POLE FACE.

	3240 Ampere turns.	6480 Ampere turns.	9700 Ampere turns.	12560 Ampere turns.
Maximum B in magnet	5600.	11600.	14200.	16400.
B at pole face	2300.	3900.	4800.	5650.
H at armature surface, measured	1170.	2030.	2440.	2700.
Calculated H in air gap	1350.	2700.	3800.	4620.
Pull per pole due to calculated H in air gap, pounds	1.87	7.43	14.77	21.8
Measured pull per pole, lbs.	2.62	7.58	11.72	13.52
Ratio of measured pull to calculated pull	1.40	1.02	0.80	0.62

TABLE IX.

AIR GAP=5/8 INCH=5-12 DIAM. OF POLE FACE.

	3240 Ampere turns.	6480 Ampere turns.	9700 Ampere turns.	12560 Ampere turns.
Maximum B in magnet . . .	5400.	11300.	13900.	16200.
B at pole face	2050.	3550.	4750.	5100.
H at armature surface, measured	920.	1590.	1870.	2200.
Calculated H in air gap . . .	1082.	2160.	3040.	3480.
Pull per pole due to calculated H in air gap, pounds	1.20	4.76	9.45	12.37
Measured pull per pole, lbs. .	1.87	5.52	8.52	10.12
Ratio of measured pull to calalated pull	1.56	1.16	0.90	0.82

TABLE X.

AIR GAP=3/4 INCH=1/2 DIAM. OF POLE FACE.

	3240 Ampere turns.	6480 Ampere turns.	9700 Ampere turns.	12560 Ampere turns.
Maximum B in magnet . . .	5100.	11100.	13900.	16000.
B at pole face	1910.	3075.	3980.	4650.
H at armature surface, measured	760.	1400.	1600.	1830.
Calculated H in air gap . . .	894.	1740.	2530.	3080.
Pull per pole due to calculated H in air gap, pounds	0.82	3.1	6.57	9.67
Measured pull per pole, lbs. .	1.48	4.12	6.48	7.82
Ratio of measured pull to calculated pull	1.80	1.33	0.98	0.81

TABLE XI.

AIR GAP=7/8 INCH=7-12 DIAM. OF POLE FACE.

	3240 Ampere turns.	6480 Ampere turns.	9700 Ampere turns.	12560 Ampere turns.
Maximum B in magnet . . .	5100.	11100.	13900.	16200.
B at pole face	1850.	3100.	3800.	4550.
H at armature surface, measured	560.	1270.	1500.	1590.
Calculated H in air gap . . .	779.	1550.	2170.	2480.
Pull per pole due to calculated H in air gap, pounds	0.62	2.46	4.82	6.31.
Measured pull per pole, lbs. .	1.17	3.32	5.07	6.12
Ratio of measured pull to calculated pull	1.89	1.35	1.04	0.97

TABLE XII.

AIR GAP=1 INCH=2/3 DIAM. POLE FACE.

	3240 Ampere turns.	6480 Ampere turns.	9700 Ampere turns.	12560 Ampere turns.
Maximum B in magnet	4900.	10600.	13700.	16000.
B at pole face	1750.	2850.	3500.	4200.
H at armature surface, measured	510.	1020.	1210.	1380.
Calculated H in air gap . . .	684.	1370.	1900.	2310.
Pull per pole due to calculated H in air gap, pounds	0.48	1.93	3.69	5.45
Measured pull per pole, lbs. .	0.97	2.62	3.67	5.12
Ratio of measured pull to calculated pull	2.02	1.36	.99	0.94

The numbers bracketed in the tables appear to involve experimental errors.

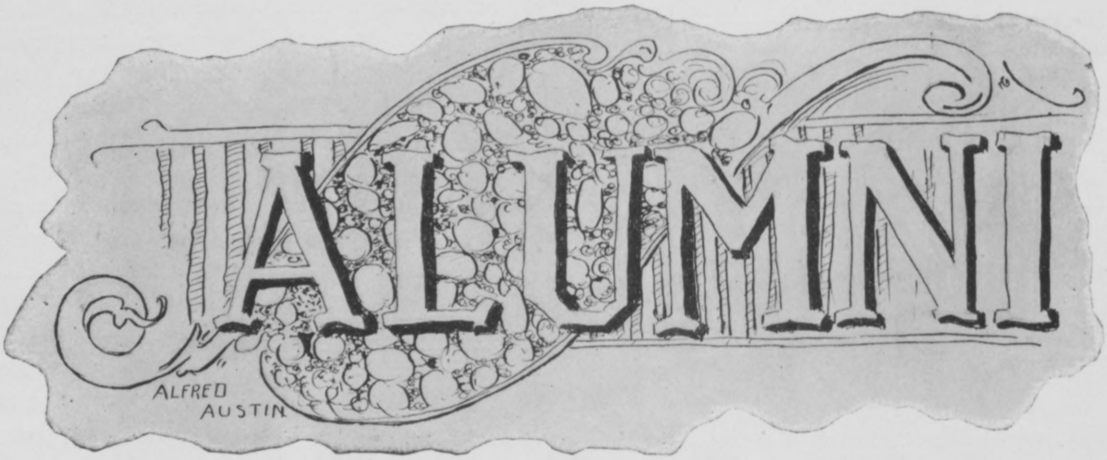
From an inspection of the tables it is seen that the calculated value of H in the air gap is in all cases *less* than the measured intensity of induction in the pole tips. Also the calculated value of H is *greater* than the measured value of H close to the armature surface. Both of these results might have been anticipated from the known spreading of the lines of induction as they leave the pole face and approach the armature.

The ratio of the measured pull to the calculated decreases as the magnetizing force increases, being greater than unity for small magnetizing forces, and in most cases less than unity for large magnetizing forces. This seems to indicate that the distribution of the induction varies as the permeability of the iron changes.

For the same magnetizing force the ratio of the measured to the calculated pull increases with increasing air gap.

Both sets of experiments exhibit these relations. Upon comparing the numerical results, however, a number of discrepancies are found. How far these may be due to experimental errors it is, of course, impossible to determine. The difference in the magnets themselves will doubtless account for some of the discrepancies In Mr. Damon's magnet the length of the magnetic circuit was smaller than in the other magnet, and in addition there were no joints. Also the quality of the iron may have been different, and this would have exerted a very considerable influence, especially at high intensities of induction.

Again, in Mr. Damon's magnet the distance from center to center of the pole faces was 6 inches, while in the other magnet it was 10¾ inches. It seems probable that this would also influence the results, especially for the larger air gaps. There is evidently room for further experiment along these same lines to determine the effect of varying the distance between the pole faces, and to investigate the use of extended pole pieces, different sizes of armature, etc.



Disappearing Gun Carriages.

By HARRY STEELE RICHARDSON, '00.

THE disappearing idea in the construction of gun carriages is not a new one, but it is only within the last few years that the problem has received a satisfactory solution. It has been the subject of study in other countries as well as our own for many years, and the most satisfactory result has been that obtained in this country. But it has not received as close attention abroad probably for the reason that the question of coast defense, on account of the military conditions there, is a secondary one. England relies on her navy, France on her navy and army, while in Russia and Germany the coast to be defended is not extensive, and in Turkey most of the coast fortifications occupy high sites. The alternative of the disappearing carriage is the barbette carriage, which, before the advent of the former, was the mount almost universally used for sea coast guns and which still is considered the one to be used in high fortifications. The barbette carriage may be described roughly as being similar to the disappearing carriage without the feature of disappearing. That is, the top carriage recoils upon rollers on the chassis rails but the gun does not descend behind the parapet.

Many features go to make the study of disappearing carriages one of the most interesting in engineering development. Ordnance construction in its entirety is a peculiar branch of engineering, one where the materials and parts are subjected to severe shocks and strains and have to be prepared to meet many unforseen and yet very possible conditions, for although the conditions of firing in any case are very thoroughly determined, yet it is never known just what may happen. This can scarcely be said of any other branch of engineering. With the increase in the power of guns and the development of powder the carriage problem has become more difficult, and it was not until recently that the carriage has caught up with the gun in the matter of progress, and that is true only in permanent emplacements.

In brief the objects of the disappearing carriage are to give increased protection to the men and guns and to reduce to a minimum the possibility of the guns or the battery as a whole being used as a target for the enemy's fire.

The three most important questions that were presented for solution with the disappearing carriage were the cost, the means of maneuvering, and the rapidity of fire. By the development of the iron and steel industry and the improvements in construction, the first has been brought within reasonable limits.

The question of armament of a fortification is a separate one for each case, and must be answered by considering the fortification and its environment. There are several other items which cannot be taken up here, but which nevertheless must be considered with the disappearing carriage, such as range-finding, skill in manipulation, the care and preservation of the carriage, but there seems to be no doubt as to the merits of the disappearing principle; the mechanical accomplishment of it, however, is another matter.

In regard to the means of maneuvering, that was a subject of vital importance, and in many cases the devices that were employed for this feature of the work caused the carriages to be rejected. Various devices and systems have been suggested and tried, including those operated by hydraulic, pneumatic, steam, hydro-pneumatic, electric and hand power. It was definitely decided that whatever mechanical means was employed it should be simple and easy working and permit operating by hand power.

In the disappearing carriage of today, with its electric manipulation and facilities for loading, which was previously done by means of various kinds of cranes and hoists, a satisfactory rapidity of fire has been attained.

As early as 1873 carriages were proposed in this country with a disappearing principle in view, known as counterpoise and depressing carriages, and embracing all sorts of methods for absorbing the recoil and maneuvering as has been mentioned. Most of these disappeared by receding down an incline behind the parapet or moving in the arc of a circle. With either of these motions it is evident that the parapet had to be low or else the recoiled position of the gun be a considerable distance behind the parapet. In either case the prime object of the principle was lost, that of protection to the men and carriage. What was desired was a high parapet and a construction that would permit the gun being directly behind it when in the recoiled position.

From time to time plans for disappearing carriages were proposed, but it was not until 1886, however, and after much study and discussion, that the principle was approved and adopted in this country, and it was not until 1894 that the condition mentioned above was obtained. The carriage of that year is known as the Buffington-Crozier carriage, and was applied to the 8-inch and 10-inch guns, and since then it has been improved on in several models of different years and extended to use with the 6-inch and 12-inch guns. Although many improvements and additions and changes in details have been made, the principle has remained unaltered, and therefore a description of the present carriage will give an idea of the present construction and leave out nothing important from the earlier carriages.

It is not wrong to assume, I think, that the subject of ordnance, on account of its exclusiveness and limited application, is not generally familiar to those not in direct contact with it, and it is therefore regretted that the general drawings of the carriage could not be reproduced here to supplement a detailed description which might furnish an interesting study. I have taken for the direct part of the subject the 12-inch disappearing carraige, model of 1901, which is the latest design and is now in course of construction, and it is hoped that a general description may be understood without the aid of a drawing.

The principal parts of the carriage are the gun levers of cast steel No. 1, the gun lever axle of forged steel No. 3, the elevating arm of cast steel No. 1, the top carriage of cast steel No. 2, the recoil rollers of forged steel No. 3, the chassis rails of cast iron No. 2, the racer of cast steel No. 1, the working platform of steel plate, the traversing rollers of forged steel No. 3, the base ring of cast iron No. 2, the counterweight of lead, the gearing for elevating, retracting and traversing, the electric motors and controllers, the sight standard, the sighting platforms, and the amunition truck. The following table gives the physical properties of the various metals employed, bronze being used principally in bearings, bushings and in some of the pinions and gears:

METAL	Elastic limit	Tensile strength	Elongation after rupture	Contract'n of area
	Lbs. per sq. in.	Lbs. per sq. in.	Per cent.	Per cent.
Cast steel No. 1 . . .	25,000	60,000	18.0	27.0
either	28,000	65,000	16.0	24.0
Cast steel No. 2 . . .	35,000	75,000	13.0	20.0
Forged steel No. 1 .	27,000	60,000	28.0	40.0
Forged steel No. 2 .	35,000	75,000	20.0	30.0
Forged steel No. 3 .	42,000	90,000	16.0	24.0
Wrought iron . . .	22,500	50,000	25.0	35.0
Cast iron No. 1 . . .	. . .	22,000	. .	. .
Cast iron No. 2 . . .	. . .	*28,000	0.25	. .
Bronze No. 1	. . .	28,000	. .	. .
Bronze No. 2	. . .	35,000	. .	. .
Bronze No. 3	. . .	45,000	. .	. .
Bronze No. 4	30,000	60,000	20.	. .
Copper	. . .	32,000	22.	. .

*Cast iron No. 2 must not show a tensile strength of more than 39,000 pounds per square inch.

The gun is supported by its trunnions in bearings at the upper ends of the gun levers, which are thus tied together at that point and also at about the center of the gun lever axle and at the bottom by attachment to the counterweight, the distance between the two extreme bearings being 15.5 feet. The gun is also attached near the breech to the carriage by the elevating arm, which acts as a tie, as there is an upper pull of about 3,500 pounds due to the muzzle preponderance of the gun. The gun levers are pivoted near the center by the axle, which has bearings in the top carriage, which is made up of two hydraulic cylinders of one piece of cast-steel with roller surfaces formed on the under side. Inside each cylinder are two forged steel throttling bars bolted to the cylinder walls from the outside. These bars pass through notches in the pistons, and being of constant width, but of variable depth, they regulate the size of the orifices through which the liquid flows past the piston. The curve of the throttling bars is such as to cause a constant resistance to be offered to the force of recoil. The cylinders have an inside diameter of 13 inches, and the liquid used is neutral oil having a specific gravity of about 0.85. The service pressure is 1,400 pounds per square inch, which gives a stress of 150,000 pounds on each piston rod. The pressures in the cylinders are equalized during the recoil by having the front ends of the cylinders connected by a copper pipe. The front and rear ends are also connected by copper pipes through an adjustable throttling valve, and there is an expansion chamber placed above each cylinder and connected to the rear of it. When recoil takes place, the cylinders move and the pistons remain stationary. The piston rods, 4.75 inches in diameter, with the pistons and counter-recoil buffers forged on them, pass through both ends of the cylinders and are secured to the chassis. The top carriage recoils upon two sets of live recoil rollers running on top of the chassis rails which are inclined 1°20′ with the horizontal.

The chassis are massive iron castings which might be commonly termed upright pieces. Their general section is that of an I beam, and when assembled, their center lines are 82.25 inches apart, being placed parallel to the direction of the gun and secured together by transoms at the front and rear, the compound piece thus formed being bolted down to the racer.

The general shape of the racer is that of a ring of 17 feet 10 inches outside and 12 feet 11.5 inches inside diameter, the under surface resting and revolving on twenty-four conical traversing rollers which have bearings in distance rings.

The base ring is of the same general shape as the racer, its upper surface having a path on which the traversing rollers run. In the drawing the base ring is shown in section with the outline of the traversing rollers in dot-and-dash lines. The base ring, then, supports the entire weight of the carriage and gun, and is bolted firmly to the concrete foundation. It has a flange projecting up and fitting inside a corresponding one on the racer, thus forming the pintle or pivot which serves to keep the carriage central. Both the racer and base ring are made in halves and bolted and tongued together.

The working platform is a steel plate ring made in sections and fastened to the racer by brackets; its outside diameter is 24 feet, 11 inches, which may be regarded as the external dimensions of the carriage, to get a general idea of the size of it. Those operating the carriage are either on the sighting or working platforms, and so revolve with the carriage.

The counterweight is of lead and weighs about 160,000 pounds. It is made of layers varying in thickness and consisting of two or more pieces. These layers rest upon a steel bottom which is suspended from the crosshead by four keyed rods. The lower ends of the gun levers are attached to the crosshead by two pins. Formed in one piece with the crosshead are clips lined with bronze, which bear on crosshead guides formed on the inner faces of the chassis rails, thus constraining the crosshead and counterweight and lower ends of the gun levers to move in a vertical direction.

The elevating arm is of one piece of steel, its general shape being that of a V, the wide end spreading around the gun and attached on each side to the elevating band on the gun. The lower end of the arm is attached to a slide which moves in guides on the rear of the rear transom. The slide is moved up and down by a screw, inclined at an angle of 25° 42′ 21″ with the vertical, which is actuated through spur and bevel gears by hand wheels on the outside of the chassis, being mounted on a through shaft. The inclined screw is fitted with a retaining device and the nut acts as a buffer. The elevating gear can also be operated by an electric motor which is placed just inside the left chassis, and by means of a lever and rocking pinion the work of this motor can be transferred to the retracting gear and used to retract the gun. For measuring the elevation, a bronze scale is fitted to the slide and a pointer to the transom.

The traversing gear has a crank on each side of the carriage, they being mounted on a through shaft, and by means of two sets of bevel gears the power is transmitted to a vertical shaft near the rear of the carriage; this shaft has a bearing in and extends through the racer, and on the end of it is a pinion which engages in the traversing rack which is made in sections and screwed to the inside of the base ring. The traversing can also be accomplished by electric power, the pinion of the motor engaging in a gear which is also carried by the shaft on which are the cranks and bevel gears.

The retracting gear, for retracting the gun without firing, consists of a train of spur gearing operating two drums, the ropes passing over pulleys at the rear end of the chassis and hooked to the upper ends of the gun levers.

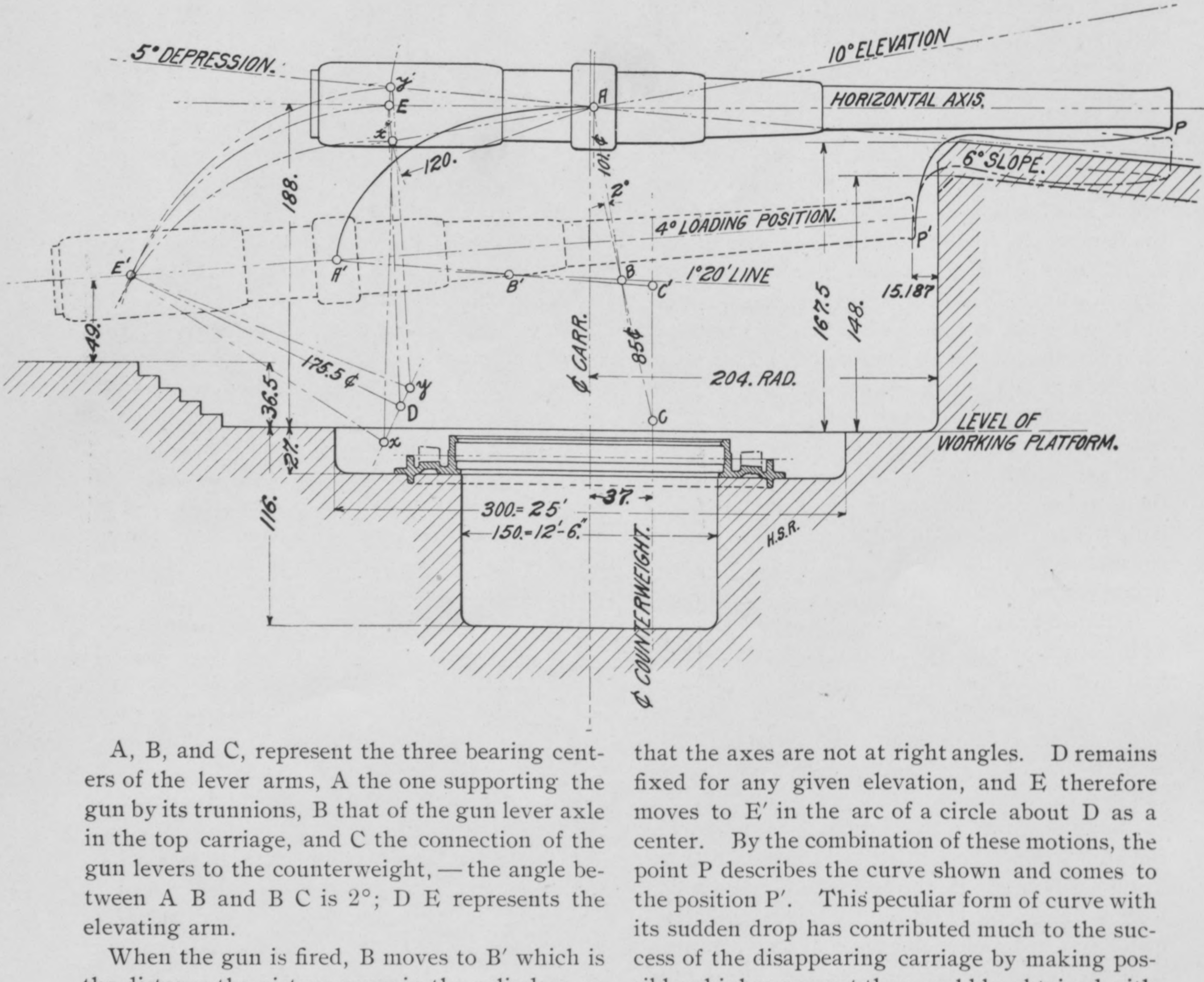
On each side of the carriage is a sighting platform 10 feet 10.75 inches above the working platform and fitted with ladders at each end and railings. They are supported by standards at the rear and brackets fastened to the cross-head guide at the front. The left standard extends up through the platform and receives the sight standard. This is fitted with a sight parallel mechanism which is attached to the elevating gear by bevel gears and rods extending up through the standard, and thereby automatically maintains the sight parallel bar parallel to the axis of the gun. The sighting arrangement includes a set of miniature electric lights for night use.

In addition to the ordinary method of firing, the carriage is arranged to permit electric firing by means of a magneto box which is automatically cocked when the gun goes into battery.

The electric motors for maneuvering are 4 H. P., one having 540 R.P.M. and the other 600 R. P.M. The controllers are placed on the left side of the working platform near the rear and can be operated there or on the left sighting platform, and in addition, the one for the traversing motor can be operated near the front of the carriage by the man who reads the azimuth circle. This circle, graduated to degrees for measuring the traverse of the carriage, is a brass ring two inches wide and is screwed to the top of the base ring, being covered by the racer except at the opening in the latter for reading it, the pointer being attached to the racer.

The maximum time required to traverse the carriage 360° is one minute and thirty seconds; that for elevating through 12 degrees is thirty nine seconds; that for retracting the gun from the firing to the loading position is two minutes and forty-five seconds.

The action of the carriage may be best understood by reference to the drawing, which is a section through the center of the carriage showing the parapet and foundation and the well for the counterweight. The gun in solid lines represents the horizontal firing position, the axis being 188 inches, or 15 feet 8 inches, above the working platform; that in dotted lines is the recoiled position which makes an angle of four degrees with the horizontal. In making the drawing for this Article, I have indicated on the center lines, in some cases, the distance between centers and have given a few other general dimensions, all in inches.



A, B, and C, represent the three bearing centers of the lever arms, A the one supporting the gun by its trunnions, B that of the gun lever axle in the top carriage, and C the connection of the gun levers to the counterweight, — the angle between A B and B C is 2°; D E represents the elevating arm.

When the gun is fired, B moves to B′ which is the distance the pistons move in the cylinders, or the recoil, which is 66.9712 inches in this case, and C moves vertically to C′, the result being that A moves in the arc of an ellipse to A′. The ellipse, of which A A′ is a part, is distorted in the sense that the axes are not at right angles. D remains fixed for any given elevation, and E therefore moves to E′ in the arc of a circle about D as a center. By the combination of these motions, the point P describes the curve shown and comes to the position P′. This peculiar form of curve with its sudden drop has contributed much to the success of the disappearing carriage by making possible a higher parapet than could be obtained with any former construction and permitting the gun, when in the recoiled position, to be within a few inches of the parapet. The maximum angles of elevation and depression are 10° and 5° respectively, the corresponding positions of the elevating arm being shown by yy′ and xx′. The inclination of the elevating slide with the vertical, 25° 42′ 21″, shown by the line xy, is such that no matter what the elevation may be, that is, what position DE may occupy between the limits xx′ and yy′, the point E comes to E′, with a very small error as indicated by the discrepancy of the arcs not intersecting at that point. It is evident there would be no error if the line xy was made the arc of a circle about E′ as a center, the error therefore being due to the approximation of the arc to the chord. The muzzle of the gun is also shown for 5° depression, and the corresponding path of P in dot-and-dash lines. In emplacements where this depression is to be used the height of the parapet must be that of the lower one shown. As has been stated, the recoiled position shown is that in which the axis of the gun makes an angle of 4° with the horizontal. There is permitted however, in cases of extreme recoil, a position of the elevating arm and gun levers about two inches lower which makes the above angle about 1°45′ but which, as has been shown, alters the position of E′ very little. When this position is reached, the upper ends of the gun levers strike on buffers bolted to the rear of the chassis. These buffers consist of alternate layers of wrought-iron and balata capped with steel.

As the gun can be trained in the recoiled as well as in the firing position, it would appear at first glance that the work required to elevate or depress the gun would be less in the former than in the latter position because of the smaller distance the breech of the gun has to be moved. But the vertical component of the force along the elevating arm, which is the effective force in moving the gun, is much less than when the gun is in the firing position and therefore the total force would have to be greater; also the friction of the slide, being proportional to the normal pressure upon it, is greater in the recoiled position on account of both the increase in the component of the force which is normal to the slide and also the increase in the force itself due to that position of the elevating arm. So as a matter of fact, although the gun moves through a smaller distance, the work required to do it is as great, and may be some greater, in the recoiled position.

The energy of recoil is absorbed partly by raising the counter-weight, but principally by the resistance of the hydraulic cylinders.

The gun is caught and held in the recoil position by pawls on the front of the chassis engaging in rachets on the crosshead and holding the counterweight up.

To load the gun, a four wheel steel truck, which can be adjusted in height, is run up to the gun, the tray holding the projectile extending into the breech. After loading the pawls are tripped and the greater moment of the counterweight raises the gun to the firing position, the time required being 10 seconds. A shock as the gun comes into this position is avoided by counter-recoil buffers arranged in the cylinders.

These buffers consist of enlargements on the piston rods and as the cylinders come forward these enlargements enter bronze buffer-liners secured to the inside of the cylinders. The length of the liners is 13.5 inches and the difference between their inside diameter and the diameter of the buffers varies from .025 inches at one end to .005 inches at the other, and the liquid forced through this clearance acts as a cushion and causes the carriage to reach its final position gradually.

A description of the carriage could scarcely be considered complete without giving some general idea of the gun for which it is designed. It is a breech loading steel rifle of 12 inches caliber, the total length being 42 feet 0.35 inches. The outside diameter at the breech is 48.5 inches and that at the muzzle, 24 inches. The total weight is 59.1 tons or 132,380 pounds. The projectile has a length of 3.5 or 4 calibers, weighing 1000 pounds. Approximately, the smokeless powder charge is 375 pounds, giving a muzzle velocity of 2650 feet per second and therefore a muzzle energy of 48, 680 foot-tons.

Both the disappearing principal and the present construction have received some criticism recently, especially in regard to the intricacy, care and cost of the carriage. From year to year additions have been made in the way of appliances to expedite the various operations, which may give the present carriage a complicated appearance, yet the principle of the carriage is much simpler than any of the former ones that have given any kind of satisfaction.

As to the care of it, any machine from which is expected fine adjustments and accurate results requires constant attention and practice in its use.

The cost of the gun and carriage of the type I have described is about $80,000 and though it may seem excessive to some, yet it is a question of relative cost.

The disappearing carriage has had about as thorough and exhaustive tests as could be possible in times of peace, and it seems to fulfil the purpose for which it is designed. But as it has been some time since we have had to actively defend our coasts, it has not been subjected to actual warfare and what must be the decisive test, therefore it's merits are still a subject for discussion and conjecture.

ALUMNI NOTES.

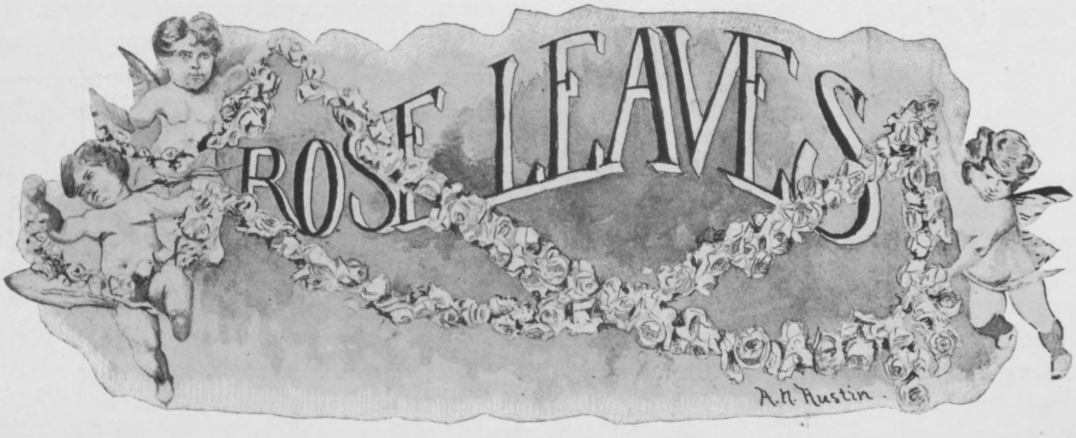
C. A. Howell is doing some experimental work for the Texas Midland Railroad, and is located at Terrell, Texas.

Announcement has been received of the marriage of Mr. Frederick W. Schneider, '98, and Miss Gertrude J. Gotthold, at New York City, on April 3rd. Also of Mr. Walter L. Decker, '96, and Miss Lillie Morton, at Brooklyn, N. Y., on April 3rd.

At a meeting of the Engineers' Club of St. Louis, held April 2nd, the application of Mr. J. J. Kessler for membership was received.

Announcement has been received of the marriage of Max B. Fitch to Miss Estelle Lewis, at Los Angeles, Cal., on April the fifteenth.

Arthur and Ned Kidder spent a few days in the city recently visiting their parents.



Compressed Air.

By CHENOWETH HOUSUM, '02.

COMPRESSED AIR is probably one of the oldest forms of power for mechanical purposes known. It has been only in the past century that its real value as a means of power transmission has become known. The ancients used it for some purposes, as in their blast furnaces, in their idols, to hoodoo the people, etc.

In England, in 1828, it was proposed to use compressed air for tram-cars. At about the same time the first air brake made its appearance. It was not like the present Westinghouse air brake, but was arranged with a piston fastened to a crank, the crank, in turn, had an eccentric from which the brakes were applied. In 1869 Westinghouse demonstrated the practicability of his form of air brake. Various forms of compressed air locomotives and vehicles were patented in the old country, but used only to a small extent. They had already learned the advantage of compound compression and inter-cooling. Tube transmission had been tried several times, but not until 1865 was any practical success gained. Since that time it has been very widely developed, both as to the postal service and cash delivery in large stores.

The conveying of air under pressure for a short distance has been in use for a long time without any great loss of power, but when it was conveyed more than a distance of a few thousand feet, especially if under much of pressure, there was such a great loss by leakage that it was abandoned. Recently, or since the manufacture of pipe to withstand great pressure, pipe lines of several miles in length have been laid. The air has been used for various purposes, as small factory power, refrigeration, elevators, etc.

It is common practice nowadays to have a central boiler plant and pipe the steam to buildings for heating and power. There are objections to this plan ; first, the condensation of steam in the mains, thus causing a great decrease in efficiency from boiler to place of using ; second, to properly insulate the pipes requires a very large outlay of capital. The combination of the two things have caused the failure of several concerns of this kind throughout the United States. On the other hand, compare its range of usefulness with compressed air. Of course compressed air cannot be used for heat purposes, but it can be used for many things for which steam is not applicable, as cleaning castings, refrigeration, small hand tools, etc. A use for compressed air is also given in the following paragraph taken from Mr. Hiscox's book on Compressed Air :

"The purifying of alchoholic liquors is accomplished by compressed air through the Cushing process, which has been in vogue for many years. The liquor is placed in receptacles for the purpose, and air, after it has been washed and purified by Prof. Tyndall's well known method, is compressed and forced through perforated pipes entering the liquor in minute streams. The liquid is violently agitated and air permeates every portion of it. The air being warm oxidizes the fusel oil and at the same time votalizes and expels into the open air the light poisonous ethers, leaving the liquors thoroughly pure and free from aldehydes. It is claimed that by this process new liquor for medicinal purposes is made practically as good as old, and that the drinking of liquor treated thus does not cause stupefaction, headache, and other disagreeable results."

In mines and other places which are hard to ventilate and in which compressed air is used the exhaust from the tools is a very good ventilation.

AIR COMPRESSORS.

Compressed air is used at pressures varying from 1 to 3000 pounds, but is most used between 50 and 100 pounds gauge pressure. For pressures from 100 to 300 pounds best economy is found in two stage compression, from 500 to 1000 three stage, and 1000 to 3000 pounds four stage pressure.

The following table gives the percentage of work lost by heat of compression, taking compression without heat as a base:

Gauge pressure	One stage.	Two stage.	Four stage.	Gauge pressure	One stage.	Two stage.	Four stage.
60	30.00	13.30	4 65	1000	96.80	39.00	16 90
80	34 00	15.12	5.04	1200	106.15	40.00	17.45
100	38.00	17.10	8 00	1400	108.00	41.60	17.70
200	52.35	23.20	9.01	1600	110.00	42.90	18.40
400	68.60	29.70	12.40	1800	116 80	44.50	19.12
600	84 75	32.65	15.06	2000	121.70	44.60	20.00
800	90.00	35.80	16.74				

The following table gives horse-power developed to compress 100 cu. ft. of free air from atmospheric to various pressuies:

Gauge pressure.	One-stage Comp.	Gauge pressure.	Two stage.	Four stage.
10	3.60	60	11 70	10.80
15	5.03	80	13.70	12.50
20	6.28	100	15.40	14.20
25	7.42	200	21.20	18.75
30	8 47	300	24.50	21.81
35	9.42	400	27.70	24.00
40	10.30	500	29 75	25.90
45	11.14	600	31 70	27.50
50	11.90	700	33 50	28.90
55	12.07	800	34.90	30.00
60	13.41	900	36 30	31.00
70	14.72	1000	37.80	31.80
80	15.94	1200	29.70	33.30
90	17.03	1600	43.00	35.65
100	18.15	2000	45.50	37.80
		2300		39.06
		3000		40.15

The efficiency of air compressors actually tested range from 65% to 82%.

TRANSMISSION OF AIR.

When compressed air flows through pipes there is necessarily a fall of pressure due to resistance of the wall surface of the pipe. The loss of pressure is independent of any changes in temperature, it is directly proportional to the length of the pipe line and to the square of the velocity, and inversely as the diameter of the pipe, all times a coefficient of friction. Other formulae have been found by experiment, some of which contain a coefficient dependent upon the size of the pipe. When air is transmitted through long lines of pipe it is cooled to the temperature of surrounding earth or air. In using this cold air in pneumatic tools much trouble was experienced in exhaust passages. They were frozen up. There are two ways to overcome this; one, by drying the air perfectly, but this proved too expensive; second, by reheating the air just before using. The latter proved very efficient, as it still remains in use. There are two kinds of reheater, one called simply a reheater, and the other an internal combustion reheater. The first resembles, in appearance, the ordinary water heater used for domestic purposes. Inside it exposes a thin layer of air to a large amount of heating surface, so that the air is heated quickly and to a temperature as high as 300° F. or 350° F. In the internal combustion reheater fuel is burned in the path of the air, and the heat and all other products of combustion are carried along with the air.

An average saving of 2.4 h. p. per pound of coal per hour may be made by the use of a reheater.

A kind of reheater used a great deal in tram-cars in France is the water reheater. It is charged at the station with water at 100 lb. pressure at a a temperature of 335° F., containing nearly 1200 h. u. per pound of water. The air is admitted at the bottom of the heater, and squirts through a nozzle or is squirted through the water in a fine spray. At the top of the heater is passed a sort of separator to keep the water from being carried along with the air.

APPLIANCES.

Compressed air can be utilized for so many things that one can hardly name all of them. At present it is used in engines, drills, hammers, drills, hoists, tube systems, air brakes, for painting, etc.

In Paris a compressed air plant is operated which has a capacity of 24,000 h. p., the main pipe and distributing lines being about 150 miles long. Some of the motors used have an efficiency of only 65 to 75%, occasionally as low as 45%, but the modern machines have an efficiency as high as 91% per cent. In one of the tests of late date, an 80 h. p. engine, which had been used as a steam engine, but for this purpose was supplied with a reheater to reheat the air to 320° F., the engine used 7.45 cu. ft. of free air per horse power hour, corresponding to an efficiency of 80%.

The following efficiency is taken from Prof. Kennedy's report on the Paris plant:

One i. h. p. at plant gives .845 i. h. p. in compressor, which corresponds to compression of 348 cu. ft. of air per hour from atmosphere to 6 atmospheres absolute.

.845 i. h. p. in compressors delivers as much air as will do .52 i. h. p. in adiabatic expansion after it has fallen to the normal temperature of mains.

$$\text{Efficiency of compressors} = \frac{.52}{.845} = .61$$

Efficiency of transmission through mains = .96
Efficiency of motors . . . . = .78

The final efficiency becomes .47 with heated air when coke required to heat air is considered.

Since the first installment of the Paris plant air compressors have been greatly improved, and an efficiency of 98% is claimed between i. h. p. of engine and compressor.

The following abstract of a report furnishes some interesting details of the air plant of the North Star Mining Co., Grass Valley, Cal., and what has been and can be done through the medium of impact wheels under high water pressure:

"For this plant the water supply is obtained from the So. Yuba Water Co. at a point on their canal about four miles from Grass Valley, Nevada County, Cal. Thence it is conveyed about two and one-half miles to the Empire Mining Co.'s works in 22″ rivetted iron pipe, built more than ten years ago. The new conduit is a 20″ rivetted steel pipe, joined to the lower end of this one under a head of 420 feet, and continues 7,070 feet to the power house, situated at the lowest convenient point on Wolf creek, just below the town of Grass Valley, where a head of 775 feet or a static pressure of 335 pounds per square inch is obtained. The capacity of this pipe is sufficient to develop 800 to 1,000 h. p.

At the power house there is a Pelton water-wheel, 18′–6″ in diameter, running on a 10″ shaft, to which a duplex compound air compressor is connected directly. The initial cylinders are 18″, second cylinders 10″ in diameter, with a 24″ stroke. They are designed to run at 110 r. p. m., and require 283 h. p. from water-wheel.

A 6″ lap weld pipe conveys the air at 90 lb. pressure from the power house to the company's Stockbridge shaft on Mass. Hill, 800 ft. distant and 125 higher. Here it is being used in a 100 h. p. cross compound Corliss pneumatic hoisting engine and a 75 horse power pump, besides other pumps, blacksmith forge, drills, etc.

About 1,000 feet from the lower end a 12″ inch branch with a gate is put in for possible future use, and near it is a 20″ gate. At the lower end of the pipe in the power house there is a 20″ gate, below which is a 12″ branch leading to the Pelton wheel, and adjoining this is the receiver, 2 feet in diameter, on which are the air chambers, charging tubes and relief valve. The air chamber is a 10″ lap-weld tube 18 ft. long standing on the receiver, with an 8″ gate between. The charging tube is similar, but 8″ in diameter. Both have 2″ water discharge pipes and gates, and by proper manipulation of the gates and the of inlet check valves on top of the tubes, the air chamber may be filled. Ordinarily the charging tube is filled up to the 90 lb. pressure from the air compressor delivering pipe, and then raised by the water pressure. It is found necessary to put in about $\frac{1}{10}$ of the volume of the air chamber every day. Where the air goes is thus far a mystery, as no leak has been discovered. The author, Mr. Hiscox, here makes the statement that it should be no mystery, as water will absorb air under that pressure. A description of the size of the wheel is then given, and the conditions under which it has to work and what it must do.

"The compressors were built by the Fulton Eng. and Ship. Build. Co., San Francisco. They are made very heavy in order to stand the high piston speed required by conditions of water power.

The most novel feature of these machines is the intercooler. This is made up of 49 soft copper pipes, 1″ in diam. 18 ft. long, each with a stuffing box at each end connected with manifold castings. The air delivered from the first cylinder into one manifold passes through these pipes to the other manifold, from which it is taken to the second cylinder. The whole is placed in the wheel pit directly under and in front of the wheel, so that the water dashes all over and through it. The air leaving the first cylinder at a temp. of 200° F., passes through the cooler and enters the second cylinder at 60°, slightly cooler than when entering the first cylinder. The temp. is again raised to about 204° F. on leaving the second cylinder and passing into the transmission pipe, showing a total rise in temp. of 282° F. from both stages.

The transmission pipe conducting the air at 90 to 100 lb. pressure about 800 ft. from the compressors to works at the mine, is ordinary well tubing 5¾″ inside diameter. At the mine there is the ordinary air receiver and also three 50 h. p. boilers set ready for steam, which are used for receivers.

The air is taken from there into the reheaters. It requires a little over a cord of good pine wood each 24 hours to heat about 700 cu. ft of free air per minute to a temp. of 350° to 400° F. The heated air passes through pipes covered with magnesia and hair-felt to the first cylinder of the hoisting engine, from which it is exhausted back into the upper heater, where its temp. is again brought to 350°, whence it passes to the second cylinder at 30 lb. pressure. From this it is exhausted through a flue to the change house, where it is used for drying clothes. From the first heater also the air for the pump is conveyed some 300 ft. down the shaft in a similarly covered pipe. It receives the air at about 275° and exhausts it into the shaft at about 60°, thus giving plenty of pure cool air to the men, without the usual fans or ventillators.

A direct-acting donkey pump is situated in another shaft 750 ft. distant, to which air is carried cold in a 2″ pipe over the surface. An old hot-water heater is used as a reheater for the air, and consumes twelve sticks of pine cord-wood per twenty-four hours.

The heating engine is a compound direct-acting Corliss of 100 h. p. with cylinder jacketed for air, and is calculated to work 3,000 ft. down an incline of 35°.

There is 304 theoretical h. p. in the water used at the power-house, the work actually accomplished at the mine amounts to 203 h. p. and cost of reheating $3 per day."

Eff. of comp. and trans. from water wheels to motors	79.5
" " " " theo. power of water to motor . .	74.0
Eff. including reheating, of comp. and trans. from water wheels to motor	.73
Eff. of comp. and trans. from their power to motors	68.4

THESIS SUBJECTS.

E. L. JONES—Design for a viaduct for the Wabash R. R. over W. Main street, Decatur, Ill.

J. T. DICKERSON—Design of a 150 ft. Thro. Pratt railway bridge.

IRA MARSHALL—A design of a sanitary sewer system for the town of Kunmundy, which has a population of about two thousand.

C. H. HILLS—Design of an air compressor for R. P. I. shops.

EDGAR B. POWELL—Fire proofing and fire proof construction.

R. C. WARREN—Camphononic Acid.

E. L. FLORY—The Hydrolysis of Dextrine.

C. H. JUMPER—The Hydrolysis of Maltose.

F. R. FISHBACK AND C. C. PARKS—Experimental determination of some of the laws of electro-magnetic attraction.

VICTOR HOMMEL—Plans and specifications for a fire-proof warehouse.

DON OSBORNE—Efficiency of transmission of an electrically propelled automobile.

HENRY W. UHL—The investigation of the relations existing between polyphase and direct current motors.

ARTHUR J. PAIGE AND CLAUDE E. COX—A study of the thermodynamic action of the gases in an internal combustion motor, with tests of an automobile motor and transmission gear.

CHENOWETH HOUSUM—The design of a direct-connected engine for a 20 K. W. generator for the Rose Polytechnic.

JOHN A. NICHOLSON—Design of a steam hammer for the R. P. I. shops.

THE A. T. O. DANCE.

The Alpha Tau Omega fraternity gave a dancing party on April 7, at the Naylor-Cox hall. Fraternity badges and the colors, blue and gold, were in evidence and formed the principal decorations. Baskets of ferns were suspended from the ceiling, and the musicians were hidden behind palms.

Punch was dispensed throughout the evening in the room adjoining the dancing hall, and here the refreshments were served by Mrs. Evelyn Johnson, the cateress. A corner of the room was fixed up in Turkish style, and the comfortable couches there were seldom vacant.

A number of the professors, with their wives, honored the fraternity by their presence.

One of the numbers of the dancing program was the Poly Two Step, composed by Mrs. Allyn Adams, and to say that it was well received would be putting it mildly. The Poly Two Step made a hit. Breinig's orchestra furnished the music, and it was well on towards the break of day when the last number of a program of thirty-five dances was played.

At a meeting of the Orchestra, held on Thursday evening, April 10th. The following officers were elected: R. D. Landrum, '04, Pres.; L. F. Dorn, '04, V.-Pres.; J. E. Daily, '05, Sec'y and Treas.; J. Dow Sandham, Director.

The officers of the Rose Symphony Club have been elected, and are as follows: President, N. H. Cox; Vice-Presidents, Fred B. Lewis and R. D. Landrum; Sec'y and Treasurer, John Regan.

NATURE seems to favor Rose at the very outset of this year. The early spring has given us a start that cannot fail to bring the best results during the first of the base ball season, while the track team has an even two months to get into shape for the State meet. With a good start and the proper amount of spirit we will make some of our rivals recognize the fact that the R. P. I. is on her way to the place she once held among the other institutions of the State.

During the last two weeks the grounds have been thoroughly overhauled, and the much-needed repairs to the track, tennis courts and base ball diamond, have been made. The diamond was "skinned" the edges, straightened, so that it is now possible for some of the players at least to get a line on the ball. Two tennis courts have been put into shape and new netting put up for the backstops. The eastern straightaway of the track has been widened and the whole surface harrowed and recindered. We expect that some fast time will be made on this stretch, as the track is both springy and down grade. Even old Dan, the Poly horse, acquired some considerable speed on the track during the repairs.

Among the other things put in shape were places for the high jump, pole vault, hammer throw, shot put, broad jump and discus throw.

The base ball team seems to be doing all that one could ask. Although the batting is poor and many errors are made, the men are taking hold with a spirit that means improvement with each practice. Manager Gibbons has nearly completed a very satisfactory schedule, and much credit belongs to him for the time and patience he has used. The following are the scheduled games:

April 5th—Terre Haute High School. Practice.
" 12th—Commercial College. Practice.
" 19th—Indiana Law School, at Terre Haute.
" 26th—Franklin College, at Terre Haute.
May 3rd—State Normal, on our grounds.
" 10th—Wabash College, at Terre Haute.
" 14th—Indiana Law School, at Indianapolis.
" 16th—Wabash College, at Crawfordsville.
" 17th—Open. Probably play DePauw here.
" 24th—Normal, in morning, on their grounds.
" 24th—Afternoon open. Probably play Vandalia shops.
" 30th—Franklin College, at Franklin.

The State meet of the I. I. A. A. is to be held at the State Normal here on the 31st of May. This gives us an opportunity to put a large track team into the meet with very little expense. One can work for considerable time on the home grounds and not get the experience out of it that you will in one of these meets. It is almost necessary to the making of a good track man that he go into several meets and suffer repeated defeats before he will realize the importance of hard, careful training. No athlete is made in a season; it takes a year to get a foundation that can be built upon.

We should put at least twenty-five men into this State meet, and every fellow that has any idea of becoming an all-round well-developed man should not miss this opportunity for experience. We are endeavoring to get a dual meet with some of the outside institutions for about the first week in May, previous to that time there will be the preliminaries and an inter-class meet. With this program before us each one can see the necessity of a united effort. Come out and give each of the events a good, earnest try; even if you don't succeed in making a star, you have had some very beneficial exercise, with plenty of fresh air.

As to our chances at the State meet, it is a little too early to give any satisfactory statement, but I do not think we can hope to win from Notre Dame this year since Wisconsin was defeated by them in an indoor meet this winter. While our chances are small to win first place, we will do our best against a rival out of our class, and endeavor to come out second best, with good number of points and many medals to our credit.

The following is a list of the outdoor events:

Running high jump.	Pole vault.
Shot put.	Running broad jump.
Hammer throw.	Discus throw.
100 yd. dash.	220 yd. dash.
440 yd, run.	880 yd. run.
Mile run.	120 high hurdles.
220 low hurdles.	$\frac{1}{4}$ mile bicycle race.
1 mile bicycle race.	

DANA H. CRAWFORD.

The Juniors and Sophomores held their athletic contest in the gymnasium on Saturday, March 15th. There was not the interest in this meet that there had been in the one on the previous Saturday between the Freshmen and Sophomores. As a result of the two contests the Sophomores claim the school championship, for they were again victors at the meet on the 15th by a score of 35 to 19.

There were no especially good performances during the afternoon, excepting, perhaps, the high jump and fence vault of Von Borries. In the high jump he cleared the height of 5 feet 1 inch with apparent ease. He made 6 feet $2\frac{3}{4}$ inches in the fence vault, winning the event, but Post came a close second with 6 feet $2\frac{1}{4}$ iches.

The events were chosen according to the conditions of the challenge of the Sophomores, which specified that each class should have the choice of three different events. The Juniors chose the high jump, fence vault and shot put, and the Sophomores the snap under, potato race and the pole vault.

The following are the results of the different events:

High Jump—First, Von Borries, '04, 5 feet 1 inch; second, Pine, '03, 4 feet 11 inches; third, Chamberlain, '03, 4 feet 9 inches.

Snap Under—First, McCormick, '04, 9 feet 3 inches; second, McNabb, '04, 8 feet $3\frac{1}{2}$ inches; third, Gilbert, '03, 7 feet $6\frac{1}{2}$ inches.

Pole Vault—First, McCormick '04, 7 feet 4 inches; second, N. H. Cox, '03, 6 feet 8 inches; third, Toner, '04, 6 feet 4 inches.

Fence Vault—Von Borries, '04, 6 feet $2\frac{3}{4}$ inches; second, Post, '03, 6 feet $2\frac{1}{4}$ inches; third, Krieger, '03, 5 feet 11 inches.

Shot Put—First, Bowie, '03, 34 feet 9 inches; second, Peck, '04, 34 feet 5 inches; third, Post, 31 feet 10 inches.

One-eighth Mile Potato Race—First and second, Knight, '04, and Crain, '04, $53\frac{2}{4}$ seconds; third, Gilbert, '03, $55\frac{3}{5}$ seconds.

As a result of a challenge from the Freshmen, the classes of '04 and '05 played a game of base ball on Saturday, March 29th. The Freshmen won the game easily, and the game was theirs from the start. The pitching of Daily for the Freshmen was a feature of the game, and his work in the box bids well for coming work on the school team. The score was 14 to 4.

On April 5th the Rose base ball team made its first appearance of the season, when it lined up for a practice game with the local High School team. The day was a bad one for good ball playing, as it rained the greater part of the game.

Rose won, by the score of 18 to 2, having the High School boys at its mercy from the start. Captain Randall gave the candidates for the different positions a chance to show what they could do.

Hills and Daily did the pitching, and both showed good form. The new men are Stoddard, Bland and Reed.

The line-up of the Rose team is as follows:

Hills and Daily, pitch.	Tipton and Reed, catch.
Bland, c. f.	Hampton, r. f.
Nicholson, 2nd b.	Braman, 3rd b.
Randall, 1st b.	Knight, s. s.
Stoddard, l. f.	

INDIANA LAW SCHOOL, 22; ROSE, 8.

The Rose ball team played its first regular scheduled game of ball at Terre Haute on the afternoon of the 19th of April, and success, as it has done many times of late years, again evaded the efforts of our boys, and this time it was all the more humiliating from the fact that we thought we were going to win easily.

The game was called at about three o'clock, with Kellogg in the pitcher's box. He pitched for three innings with fair success, although his support, at times was rather poor. Daily was then substituted for Kellogg, and with the visitors ahead with a score of 7 to 2, the score had only changed to 9 to 8 in favor of the Indiana Law at the end of the eighth inning. In the ninth inning, however, Daily lost control of the ball, and he forced in several runs by hitting batters and giving them their bases on balls. Hills was then placed in the box, and after some desperate work the visitors were finally put out, having made 13 scores in their half of the ninth inning.

At the end of the game the score stood 22 to 8 in favor of Indiana Law.

Randall played an excellent game at first, and Nicholson did good work in left. Bland's batting was good, and Daily's pitching was a mystery to the visitors for five innings.

The batting order and score is follows:

ROSE.

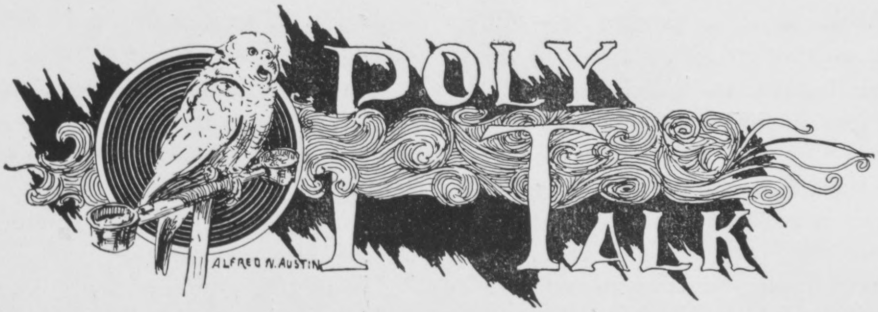
	A.B.	R.	H.	P.O.	A.	E.
Bland, c. f.	4	2	2	0	0	1
Braman, 3rd b.	5	1	2	0	1	2
Nicholson, l. f.	3	1	0	1	0	0
Randall, 1st b.	5	1	0	3	0	0
Reed, c.	5	0	0	13	1	0
Fishback, r. f.	5	1	1	2	0	1
Knight, s. s.	4	1	0	1	1	3
Stoddard, 2nd b.	5	0	0	2	3	1
Kellogg—Davis—Hills, p.	5	1	1	0	3	0
TOTAL	41	8	6	27	9	8

INDIANA LAW SCHOOL.

	A.B.	R.	H.	P.O.	A.	E.
Somers, 1st b.	5	3	1	9	1	0
Winters, 2nd b.	6	2	2	3	3	0
Dulin, r. f.	s	1	0	0	9	0
Huffer, 3rd b.	5	1	0	1	1	5
Henderson, s. s.	6	1	1	2	0	4
McConnell, l. f.	5	2	2	1	0	0
Ogdon, c. f.	3	4	2	1	1	0
McMaster, c.	2	4	1	8	0	0
Sheets, p.	2	4	0	1	2	1
TOTAL	22	22	9	z6	8	10

Stolen bases—Rose 1, I. L. 1.
Two-base hits—Rose 1, I. L. 1.
Three-base hits—Rose 0, I. L. 2.
Umpire—Franklin.

The Student Council has allowed the Athletic Association money for the purchase of new base ball suits. As soon as the team has been chosen the new suits will be ordered. We will be proud of the appearance of our team this year, and we hope to be proud of their playing.



We would advise Schroeder to see that he has a better hold when he again tries carrying something from a store. Might also suggest that he would probably find a pair more useful than a single shoe.

Hath :—" In the spectrum we have the chemical lights."

Katzie :—" Yes, I am one of those chemical lights."

McDonald and Von Borries will hereafter be sure that they have a tip for the messenger boy when they are anxious to read the young ladies' reply.

The Hahn-Levi potato race was an occasion of a great deal of amusement.

" X : "—"When I die I want to be cremated."

Brannon :—" That will come in the next world."

" X :"—" Yes, but I want it done here first."

B :"—Oh ! I see you want it well done."

Dr. Gray :—" If the number of your seat is not covered you will be marked absent-"

Several suggested pasting a piece of paper over the number. We have heard of no one trying the experiment, however.

Landrum (going to Dr. Noyes with a couple of fingers pinned together with a glass rod) :— " What must I do, Doctor?"

Dr. Noyes :—" Why, Mr. Landrum, I would advise pulling out the rod."

" Mr. Regan is without doubt the boldest, bravest man I have ever had in a class."

Quoted from a fond mother's letter :—" Yes, John, you may play base ball, but don't fail to wear a nose guard."

" Hath:—" What is your problem, Mr. Aguilera?"

Aggie :—" The determination of the electric time constant."

Hath :—But what does *n* represent?"

Aggie (looking at book) :—" It is used here for the time-constant."

Hath :—"What is the electric time-constant?"

Aggie :—" Oh, I don't know what it is, but here is the solution of it."

Reynolds (to Professor Hathaway) :—"Won't you please write upon the blackboard a little louder ; the short-sighted men can't hear it."

Schroeder (in Hath's class) :—" What do you substitute in that denominator?"

Hath : " Why, just common sense."

Staff :—" That equation is surely a wringer."

Dr. Johonnott :—"The next one is likely to be a hover."

The orchestra has commenced to practice again after vacation, and new music is being worked upon each meeting.

The Sophomores are attending a series of lectures given by Professor Hathaway upon the subject of algebraic synthetic division by partial obliteration.

Tipton says that " the present production of nickel exceeds the world's supply by one hundred tons."

Professor Wickersham (to Ketcham):—"What does that next word mean?"

Ketcham:—"Search me."

Ask Touzalin what he means when he speaks of "sophisticated air" as being hard to breathe.

It is a certainty that Hills is Parks' wife. Hills was seen to go to Parks and ask for money, which was given him rather reluctantly.

There have been a number of explosions lately in the chemical lab., and the Seniors think that Doctor Noyes must be tired from running to the scene so much. Flory was heard to remark the other day that as everything was exploding he was going to have his life insured, as the next thing he knew one of the balances would blow up while he was using it.

Lindenberger says that an infiniter number of curves can be drawn through two points than three.

Jumper says that he has heard of a wire gauge, but never of a bag-gage.

Marshall has lost his last hope for the class of 1902. He at last discovered that Powell goes to dancing school.

Sol. says that the machine was driven by a ½ horse power dynamo.

Housum (to Professor Wagner, just before last lecture in Thermo):—"Are we going to have a recitation in this stuff tomorrow?"

As Mr. Wires was explaining about the different kinds of wood, and telling where the trees grew, Hopkins:—"Professor, where does the single-tree grow?"

Professor:—"Right alongside the double-tree."

Professor Wires, while explaining the different kinds of castings, was interrupted by Jencks, who asked: "Professor, how does one cast a pipe-line?"

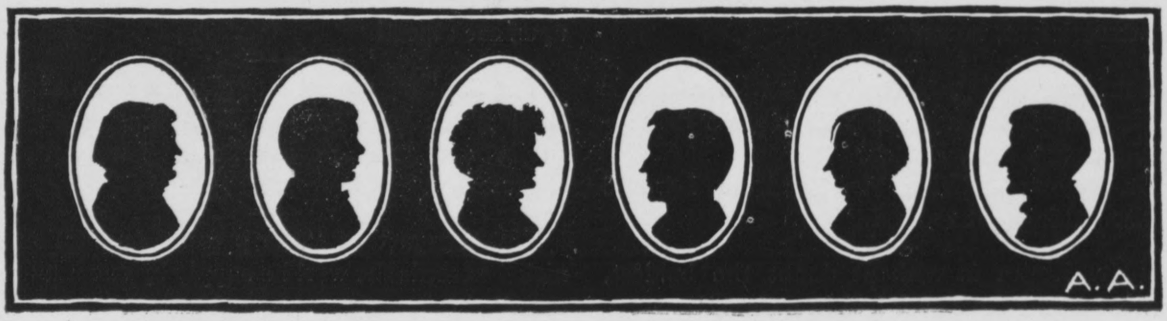
Professor answered: "I have seen several? attempts made, but I never saw one that was successful."

"Mexico" Wood's latest stunt is to cast a frog of brass by placing a live frog in the flask and tramping the sand around and then baking the frog, after which it can be removed and its impression will be left in the sand.

At a recent meeting of the Glee Club, the following officers were elected: Fred Lewis, '05, President; Hadley Cox, '03, Vice President; and John Regan, '04, Secretary-Treasurer.

The Glee Club is making good progress under the leadership of Mrs. Allyn Adams, and will soon be ready to give a concert. Mrs. Adams composed words and music for a school song, which she named "Sing a Merry Song for the R. P. I.," and with which the Glee Club will undoubtedly make a "hit."

The Feshmen held a meeting and elected Eugene Stoddard as athletic director, to succeed Charles Streeter; and Merle Reed as captain of their base ball team.



THE METRIC SYSTEM.

Editor American Machinist :

I HAVE read with considerable interest the report given at page 236 on the Franklin Institute and the metric system. It seems very much to me that those who strongly oppose the adoption in this country and America of the metric system, would ask themselves common-sense questions such as are discussed by the committee and would abide by the logical answers, instead "conscientious objectors," much of the opposition to this system would go.

I am with a large engine-building concern in this country who have adopted the metric system for linear measures only, but not for weights and volumes. But no mind, having adopted the system for linear measurement, the other two purposes are by comparison of small account, and can be used or not, as the case may require; although I am, with many, strongly against any mixed system. such as pounds per square centimeter or a heat unit of pounds on the centigrade scale.

One objection frequently raised to the metric system is that "the workman has difficulty in understanding." Not complimentary to the workman! I wonder who would say that it is easier to read off 23-64 on a scale, than a dimension expressed in millimeters. But one great objection—and it must be admitted that it is an objection—is that of screw threads. I am not prepared to say whether or not the difficulties are insurmountable as to the adoption of a separate metrical table, in distinction to the Whitworth or Sellers threads—which, by the way, themselves are not interchangeable in all sizes. But there is no objection to using the standard Whitworth or Sellers threads on bolts turned to a diameter in millimeters. In practice we turn the body of the bolt to the nearest millimeter larger than the size of thread, *e. g.*, for a 1-inch screw thread we turn the body of the bolt 26 millimeters diameter.

Much opposition is made out of the process of introduction, as to how it should be done; and in this respect I would commend to your readers the paper by Arthur Greenwood (of Greenwood & Batley, Ltd., Leeds), read before the International Engineering Congress, Glasgow, last year. Mr. Greenwood says: "All good standard works have to be issued in new editions from time to time, and all I would suggest is that when a new edition comes, let it be made in the metric system."

But experience is worth a lot, and all I would say here is that I have seen new machines built in the metric system side by side with existing lines built in the English system, and I have seen standard parts of one set of machines made to work in with standard parts of the other set, and I have also made and sent into the shops drawings in which a single large complicated casting has been figured in each system. I make no defence for this latter, but it shows what can be done in working the two systems side by side during the transition period.

Rugby, England. ERNEST R. BRIGGS.

RELATIVE ECONOMY OF OIL AND COAL FOR FUEL.

PROF. JAMES E. DENTON, of Stevens Institute, Hoboken, N. J., made tests, last November and December, under the auspices of the Export Oil and Pipe Line Company, Beaumont, Tex., upon Beaumont crude oil as fuel for raising steam. A report of these tests is contained in a pamphlet sent us by Henry M. McDonald, 100 Broadway, New York. From the results obtained were deduced the following conclusions as to the comparative fuel costs of coal and oil for producing horse-power upon the commonly guaranteed basis of one horse-power per ten square feet of heating surface, and with an average percentage of moisture and ash in the coal: Moisture in coal, 3 per cent.; ash, 17 per cent.; evaporation per pound of wet coal from and at 212 degrees, 8.75 pounds; net evaporation per pound of oil from and at 212 degrees, 14.8 pounds; ratio of oil to coal, $14.8 \div 8.75 = 1.69$; number of barrels of oil equivalent to 2,240 pounds of coal, 4.12; price of coal per 2,240-pound ton, without cartage and cost of ash removal, $3.00; equivalent price of oil per barrel of 42 U. S. gallons, $73. From this it appears that if oil costs 73 cents a barrel, its economic value is the same as that of coal at the price named, the question of convenience, etc., being set aside.—*American Machinist.*

PROGRESS IN WIRELESS TELEGRAPHY.

ACCORDING to the press dispatches published in the daily papers, the Marconi Wireless Telegraph Company has made a definite contract with the Canadian Government for the establishment of a wireless telegraph system to give communication between the Domion of Canada and England. It is stated that Mr. Marconi's chief engineer in Canada, Mr. R. N. Vyvyan, has placed orders for the power plant equipment of a station to be located at Cape Breton, and expects to establish wireless communication between Canada and England by June 1. The apparatus is to be of the latest and most powerful type, of course, and a tower will be erected instead of a pole for the vertical conductor. In this connection it is interesting to note the salutary effect of government ownership upon scientific progress. The Marconi Company is graciously allowed by the British law to establish wireless telegraph stations on the English coast provided the stations do not communicate with each other and thus enter into competition with the government telegraph system, and do not communicate with any ship or station within three miles from the shore line. Efforts are being made to have the law relating to this subject modified.—*American Electrician.*

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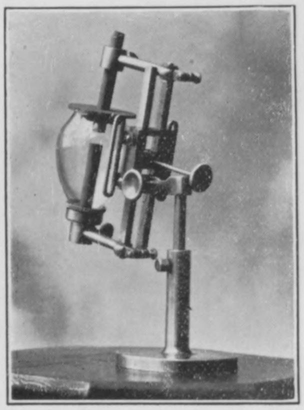

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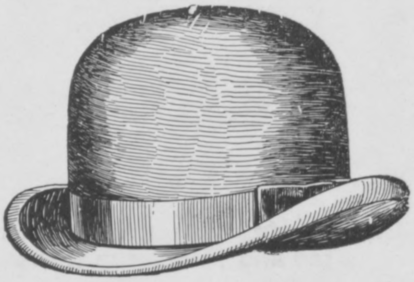

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