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THE end of January is an unfortunate time for a man to succumb to an attack of the grip. The recent epidemic conflicted more or less seriously with the final examinations, to say nothing of its interference with basketball in various ways.

ROSE has received a great deal of unenviable notoriety at the hands of the newspapers, recently in connection with the death of Wm. Keiper, Jr., of Louisville, who was a student here in the fall of 1905.

Whether or not the newspaper story of Keiper's hazing is altogether true, or whether Keiper was or was not hazed at all, we are not prepared to say. It is a fact, however, that for several weeks before leaving Rose he came out for football practice and played with his class team, and intended to practice with the basketball men, he being apparently in good health at that time; and we can say, on the word of competent authority, that during his stay at the Institute he was not suffering from any ill-health traceable to exposure.

In the world within a world which pertains to college life, an insular conceit sometimes arises, which encourages a spirit of irresponsible lawlessness, which results not only in hazing, but in such acts as the breaking up of banquets, an example of which occurred last month in an Eastern college; to opposition to civil law, such as lead to the arrest of a number of college athletes in a hotel recently, for gambling and resisting officers; to the initiation hazing by college fraternities; to the abuse of college athletics, and in various other features of college life which are continually being condemned by public opinion, as reflected in the daily press. The usual excuse for these excesses is that they display and cultivate a courageous spirit; they often do, but the courage is so often mingled with a lack of discretion that all activities outside of the routine school work are in a fair way to become altogether a reproach and a disgrace to American colleges.

When some serious result follows a student prank, the students themselves usually put a stop to the practices which lead to it, for a time; but while college traditions continue and the desire to emulate and excel arises in the students' minds, customs contrary to reason and discretion are likely to continue, until a systematic effort is made by the students themselves to discourage such acts as that which is said to have taken place here, and which, whether the report be true or not, has placed a blot on the good name of Rose men which it will require many years of irreproachable conduct to conceal.

RECENT DEVELOPMENTS IN METHODS OF HIGH TEMPERATURE MEASUREMENTS.

By C. E. MENDENHALL, '94.*

THE field of high temperature measurements during the past few years has been one in which the interaction of industrial needs and scientific experimentation has been unusually close and stimulating. The industrial needs have sprung partly from the introduction of electric furnaces, which have made possible the use of higher and more controlable temperatures than were previously attainable; and partly from a gradual realization by users of other methods of heating that a more accurate knowledge and more careful control of the *temperatures* involved in their processes of manufacture would lead to a better and more uniform product. This realization is by no means complete as yet, and the use of reliable high-temperature measuring devices is certain to be even further extended. In the following article I propose to give a brief resumé of the most important methods of high temperature measurement, with especial emphasis on one class—radiation methods—whose scientific basis is less generally understood, and whose future development is the most promising.

First, however, we must consider the general question of the establishment of a temperature scale—especially a *high* temperature scale; or for the sake of brevity, let us call it the "H. T." scale.

The fundamental basis of all temperature measurements it is the thermodynamic scale introduced by Lord Kelvin; though it is itself unrealizable as a working scale, nevertheless the relation can be determined between it and various gas-thermometer scales (*i. e.*, scales which assume that equal temperature increments produce equal pressure increments in a gas heated at constant volume, or equal volume-increments in a gas heated at constant pressure). The gas thermometer thus becomes the practical standard; but on account of experimental difficulties the use of the gas-thermometer is confined to standardizing laboratories for the purpose of calibrating some form of practicable thermometer or pyrometer. The experimental difficulties and the resulting uncertainties involved in the use of the gas thermometer increase enormously as high temperatures are reached; so that our knowledge of real (thermodynamic) temperatures becomes less and less accurate as we go up in the scale.

Up to 1100° C. there have been a number of independent researches upon the gas thermometer and the results are in fair accord; above 1100° there has been but one, very recent, investigation, carried to 1600° C., the results of which are open to considerable question. Leaving this last work out of account for the present, it may be said that temperatures are known directly in terms of the gas scale only to 1100° C., while above that our knowledge rests on the *exterpolation* of some physical "law" which has been experimentally determined in terms of the gas-scale as far as 1100° C. In determining the H. T. scale it is convenient to proceed, just as is done in determining the low temperature of certain "fixed points." For ordinary ranges the most important fixed points are the freezing point of water, the boiling point of water, and the boiling point of sulphur; for the H. T. range the most important so far used are the melting points of gold, palladium and platinum, at about 1064° C., 1546° C., and 1750° C. respectively. These temperatures are the *most probable* which can be assigned to the melting points in question, in the present state of knowledge; while the outstanding uncertainties can best be shown by saying that the gold melting point probably lies between 1057° and 1067° C.; the palladium between 1546° and 1580° C., and the platinum between 1745° and 1789° C.—and this increasing uncertainty in the knowledge of the H. T. scale

* Professor of Physics, University of Wisconsin, Madison, Wis.

amounts at 2300° C. to about 100°. On account, however, of the way in which these very high temperatures have been determined, the uncertainties throughout the entire scale will be greatly reduced as soon as *one* temperature—say the platinum point—is accurately fixed.

So much for the range and present knowledge of the H. T. scale. Practicable methods of measuring the temperatures fall naturally into three groups: (a) resistance methods, (b) thermo electric methods, (c) radiation methods.

(a) Resistance methods depend of course upon the measurement of a change in electrical resistance produced by a change in temperature. Platinum is the one substance which has proved suitable for the construction of "resistance thermometers," hence this method is usually referred to as "platinum thermometry." Its development is largely the result of work of Callender and Griffiths. A platinum thermometer is simply a coil of platinum wire—the wire as fine and the coil as compact as is consistent with with mechanical permanency—placed in a protecting tube of porcelain or other refractory material, and provided with two sets of leading-in wires, current leads and "compensating" leads if the Wheatstone bridge method is to be used, or current leads and "potential" leads if the potentiometer method of measuring resistance is to be applied. The coil is usually so chosen that the change of resistance in passing from 0° C. to 100° C. is 1 ohm. The change of resistance is of course not proportional to temperature, but by means of a "difference formula" due to Callender and Griffiths it is very easy to compute the temperature from the corresponding change in resistance, once certain constants of the thermometer have been determined. To determine these constants it is only necessary to measure the resistance of the thermometer at *three* known temperatures, for which 0° C., 100° C. and 444.5° C. (sulphur boiling point) are usually chosen.

Platinum thermometry affords the most accurate means of measuring temperatures up to 1200° C., above which point permanent changes in the wire are likely to cause trouble. Furthermore it can be used as an *indicating* or *recording* instrument (for approximate work), and the indicating or recording devices may be located at a distance without introducing any error. Used in this way it has many industrial applications, both for high and low temperature work, for which purposes many special instruments and devices are available, which cannot be considered here.*

(b) Thermo electric pyrometry is based upon the measurement of the e. m. f. produced in a circuit of two metals (a "couple") when the two junctions are a different temperatures; for the measurement of this e. m. f. either a potentiometer method or a "direct deflection" method may be used. Again, it has been found that platinum, platinum alloys and related metals are the only ones suitable for H. T. work, on account of the permanency of their indications, and a word of warning is proper in this connection, *against* the use of other metals and alloys offered as "just as good." For temperatures up to 1700° C. the best couples are those first studied by Le Chatelier, consisting either of a wire of pure platinum joined to a wire of an alloy of platinum and 10% iridium, or pure platinum joined to an alloy of platinum and 10% rhodium. The Pt : Pt—Ir couple gives a higher thermal e. m. f. than the other, but is less suited for use at the higher temperatures (say above 1200° C.) on account of the tendency of the iridium to sublime from the one branch of the couple and contaminate the pure platinum wire, thus changing the thermoelectric power of the couple. A third couple, consisting of a fine rod of iridium fused to a rod of of iridium and 10% ruthenium has lately been introduced by Hercaus, which can be used up to 2000° C., but must be used with great care on account of the extreme brittleness of its constituents. Probably also they would be very liable to self-contamination. In all cases in order that the

*Special attention is given to this work by the Cambridge Scientific Inst. Co., England, and Leeds & Northup, in this country.

behavior of the couple may be permanent and independent of special distributions of temperature along the couple from the "hot junction" to the "cold junction" it is necessary to use only the purest and most homogeneous* materials, obtained from the most reliable makers. Thermo couples can also be used with direct-reading or recording instruments with sufficient accuracy for many purposes, and they have the advantage over resistance thermometers of small bulk and in general more rapid action, besides their availability for much higher ranges of higher temperature, as already mentioned.

(c) Recent progress in radiation pyrometry is fundamentally based upon renewed interest in and development of work done by Kirchhoff, Bartoli and Boltzman. Kirchhoff introduced the idea of a radiating body, called a "black body," whose radiation should be dependent only upon the *temperature* of the body, and showed that an enclosed space whose walls were at a *uniform* constant temperature would contain radiation identical with that which would be sent off from a black body at the same temperature. It was many years, however, before it was fully realized that by constructing such a uniformly heated enclosure and making an opening in the walls, a source of radiation could be obtained practically identical (if the opening is not too large) with a black body, whose radiation would therefore be independent of the physical nature of the walls and dependent only on their temperature. The radiation coming from such a black body may be considered in two ways—first, merely as a stream of energy, whose only measurable characteristic is its *total quantity*; second, as made up of trains of *waves* of various lengths, each wave-train carrying a certain amount of energy, the whole forming a complete *spectrum* (ultra-violet, visible and infra-red) in which the *distribution* of energy among the various waves and at various temperatures becomes a matter for study. The theoretical work of Boltzman, Wien, Planck and others has shown that as regards total quantity, black radiation obeys the simple law

$$E = \sigma T^4$$

(Boltzman-Stefan Law)

where E = radiant energy in ergs per sq. cm. per sec. per solid angle of 2π

T = absolute thermodynamic temperature.

σ = constant

As regards the distribution of energy we have for wave lengths in the general region of the visible spectrum,

$$\log E_\lambda = K_1 - K_2 \frac{1}{T}$$

(Wien's Law)

where E_λ = radiant energy corresponding to wave-length λ.

K_1, K_2, = constants as regards temperature, but dependent on the particular wave-length considered.

T = absolute temperature.

The first law has a rigorous theoretical basis, the second must be regarded as an approximate expression, which is, however, very close to the truth for all visible wave-lengths. The first law is the basis of total radiation pyrometry, the second of optical pyrometry; and it is of extreme importance to the future development of the subject that the Boltzman-Stefan law gives a rigorous means of establishing the thermodynamic temperature scale independent of air thermometer work.

The only practical instruments so far devised which measure temperature by measuring total radiation are two due to Féry. In the first the radiation from the hot body is concentrated upon one junction of a thermocouple, the circuit of which is completed outside the instrument through a sensitive high resistance moving-coil galvanometer, whose scale is calibrated either directly in temperature, or in millivolts.

The range of the instrument can be extended by reducing the amount of energy falling upon the thermo-junction by placing a known diaphragm in front of the lens or mirror. As usually furnished the instrument has two scales,

* For the study of the influence of non-homogeneities, etc., see White, Physical Review, Dec. 1906.

one up to 1200° C., the other to 2000° C., and it can be made recording. If it is to be used as a *measuring* instrument dependent strictly upon Boltzman's law, care must be taken to eliminate selective reflection or absorption from the optical parts, and the proportionality of deflections to absorbed energy must be carefully verified. The second Féry instrument, only recently described, consists again of a lens or mirror for concentrating radiation upon a spiral composite spring, whose expansion moves a pointer over a calibrated dial; this is probably less sensitive and reliable than the first. In both of these instruments an eye piece is provided for "sighting," *i. e.*, adjusting the image of the radiating source to fall on the absorbing surface.

Optical pyrometers measure temperature by measuring the energy of a small group of (visible) waves—monochromatic radiation--as a function of temperature; in other words, they depend upon measuring the variation in *brightness* of the radiating black body, as observed by a particular wave-length or color. Wien's law (above) shows that if the logarithm of this monochromatic intensity or brightness be plotted against $\frac{1}{T}$, T being the absolute temperature of the black body, the result is a straight line. To determine a straight line only two points are necessary—so that a properly constructed optical pyrometer can be standardized by observations at only two known temperatures. There are various instruments depending on this principle, of which two only will be considered here. The Wanner pyrometer consists essentially of a direct-vision spectroscope whose slit is divided into two parts; into one part light from a small incandescent comparison lamp is admitted, into the other light from the body whose temperature is being measured; and the spectroscope prism is so adjusted that only red light of wave-length, about .64 μ can reach the eye. By the suitable addition of a biprism and double-image prism it is arranged that the observer sees two fields sharply touching (as in a saccharimeter), one illuminated by the comparison lamp and the other the hot body, one by light polarized vertically, the other by light polarized horizontally. By rotating an analyzing nicol contained in the eye piece it is possible to equalize the intensity of the two fields; as the temperature of the hot body increases the nicol must be turned to maintain "balance," and the temperature scale can be expressed in terms of the position of the nicol required to balance. The ordinary range is from 800° C. to 2000° C., but to make the readings accurate at high temperates some auxiliary scheme of reducing the intensity of light from the hot body in a known ratio must be added. As auxiliaries are required also a battery of constant e. m. f., a rheostat and an amyl acetate lamp as standard of light.

The Holborn-Kurlbaum pyrometer may be described as a telescope having a small incandescent lamp mounted with its flat (horseshoe) filaments in the focal plane of the eye piece; a battery, rheostat and ammeter permits of the adjustment and measurement of the current through the lamp. By moving the object glass of the telescope an image of the hot radiator under examination is focused in the plane of the filament, where both it and the filament can be examined by means of the eye piece; the filament is then made to disappear against the image of the hot body, by adjusting the current in the lamp until filament and image are of equal brightness. The hotter the body examined the larger the current required for "vanishing" of the filament; hence the temperature scale can be expressed in terms of lamp-current. It is necessary to have monochromatic light in using the instrument, otherwise the simple linear relation between brightness and temperature does not hold, and besides adjustment is difficult; this can be well enough accomplished by placing one or two thicknesses of a special red glass in front of the eye piece. The range of the instrument as above described is from 600° C. to 1600° C.; but this can be indefinitely extended by reducing in a known ratio the intensity of the light coming from the hot body, by the use of suitable absorbing glasses or (partial) reflecting surfaces. Thus one absorbing glass can conveniently be made to extend the scale to 2300° C., and two to 3000° C.

This form of pyrometer is on the whole the most convenient and reliable instrument so far developed. Unfortunately it is represented in this country (on account of patent difficulties) only by a very inferior form, the Morse thermogauge.

It must be remembered always that the radiation laws with which we have been concerned apply only to *black-body* radiators, and that the use of these laws in determining the scale of a radiation pyrometer, or in extending it beyond the range of direct calibration, will lead to correct results only when the pyrometer is used to determine the temperature of *black bodies*. Fortunately in many industrial cases black body conditions are nearly satisfied—for example, the interior of furnaces—and in most cases it is possible to produce the required conditions by inserting a long tube into the space whose temperature is to be measured, and sighting the pyrometer upon the interior closed end of the tube which should, for a considerable length, be at the temperat ure which is to be determined. If the pyrometers are calibrated for black-body condtions and then sighted at exposed hot surfaces, bearing no resemblance to a *uniformly heated enclosure*, the temperature indicated (called the black body temperature) will always be *lower* than the true temperature, by an amount which depends on the radiating properties of the surface and increases with the temperature. For a polished platinum surface it amounts to 200° C. at 1700° C., as observed by red light; for a rough "black" surface it would be considerably less—for example, for carbon at a *true* temperature of 2000° C., the apparent "black-body" temperature is only 100° lower.* In some industrial cases it is not at all necessary to know *true* temperatures; and if only the radiating surfaces dealt with are sufficiently fixed and definite the radiation pyrometers will give readings according to an arbitrary but reliable scale.

In conclusion the following table indicates the range of high temperatures which are now known with some approach to accuracy; increasing of the knowledge of this range forms a most fascinating field of research, and the increasing use a most important phase of industry.

*These figures are from Waidner & Burgess—Bull. Bureau of Standards; their various articles are full of valuable material, to which I am glad to acknowledge my indebtedness.

TABLE.

	° C.		° C.
Gold melting point, . . .	1064	Normal burning temperature, carbon lamp . . .	1850
Iron " " . . .	1505	" " " tantalum lamp . .	2000
Platinum " " . . .	1750	" " " Nernst " . .	2130
Iridium " " . . .	2300	" " " tungsten " . .	2300
Nernst glower melting pt.	2380	" " " carbon arc . .	3700(+)
Tungsten " "	3200		

Miss Margaret F. Rood and Mr. W. R. Heick, '05, were married in Terre Haute on January 25, 1908. Mr. Heick is connected with the McWilliams Construction Co. of Louisville.

Miss Ethel E. Benjamin and Mr. Clifton Brannon, '04, were married in Terre Haute on Janu-ury 14, 1908. They are residing in Evansville, Ind., Mr. Brannon being the Assistant Engineer of Maintance of Way for the E. & T. H. Railroad.

The January meeting of the Rose Alumni Club of Terre Haute took the form of a banquet in the ordinary at the Terre Haute House. A good social time is reported, the serious discussion being in regard to matters affecting the welfare of the Institute.

Those present were Prof. John B. Peddle, '88, Toastmaster, Messrs. Scott, '86, Roberts, '89, Mewhinney, '91, Balsley, '91, Hussey, '92, Johonnet, '93, Royse, '94, Kidder, '99, Paige, '02, Rumbley, '03, Cushman, '03, Trowbridge, '05, Shryer, '05, Larkins, '05, Speaker, '05, Snider, '05, Reynolds, '05, Everson, '05, Blanchard, '05, Kadel, '05, Greenleaf, '05, Reed, '05, Miner, '07, and H. Shickel, '07.

GAS ENGINES.

By WM. H. BRANNON, JR.. '09.

THE gas engine, as it is called, is, strictly speaking, an internal combustion engine, because the gases are not admitted under pressure into a cylinder and there allowed to expand, but on the contrary, a combustible gas is generally sucked in by the vacuum caused by the movement of the piston, compressed, fired by a hot tube or electric spark and permitted to expand, and then exhausted. These four distinctive operations may take place in one or in two revolutions of the engine crank shaft or in two or four cycles, giving rise to the two principal types of internal combustion engines, namely, the two cycle and the four cycle.

The origin of the gas engine dates back nearly 200 years, but a successful gas engine was not produced until about seventy years ago. Even at that time they were of little practical value and of extremely low efficiency, but up to 1860 many patents were issued, most of which were in European countries, few being issued in the United States.

Dr. Otto, a German, invented the Otto cycle, or what is now commonly known as the four cycle; the two cycle having been previously used quite extensively, however; in recent years the development of both types has been wonderful. The reason for the gradual evolution in early times was probably due to an erroneous idea that slow combustion was necessary, but after years of failure along these lines experimenters grasped the fact that the success of the internal combustion engine lay in the rapidity of combustion and expansion. With this fundamental principle known the gas engine has become an indispensable prime-mover, fast superseding steam and many other forms of power.

In this country alone there are hundreds of manufacturers supplying the great demand for these cheap power plants. Some are following conservative designs while others are making extensive experiments and improvements both in the engine proper and accessories, but the present tendency is toward the use of better materials and increased refinements in construction. This refining has steadily gone on until the present day engine is a serviceable, well built, com pact and reliable piece of mechanism.

As intimated before, the force exerted on the piston of a gas engine is due to the combustion and expansion of gases in the cylinder, which would necessarily heat the engine to a temperature beyond safety, since the temperature of the gases due to compression before ignition, is near 400 degrees F., during combustion about 2800 degrees F., and the exhaust gases about 800 degrees F. Even the temperature of the exhaust is too high for the satisfactory working of the piston and cylinder, without considering the premature explosion that would result. Therefore it is evident that some positive means of cooling are required, in order to radiate sufficient heat to keep the temperature of the cylinder well within a certain limit. There are two different methods adapted to doing this, namely, cooling by means of air forced over flanges or pins, cas or made integral with the cylinder, and by circulating water or other fluids through a jacket surrounding all heated portions. True, the cylinder walls should be cool, yet to obtain great economy in fuel consumption and high efficiency the temperature of the cylinder should be as high as is practical, for the cooler the walls the more heat they will absorb and convert into useless energy.

Suppose we tested a gas engine and obtained the following results approximately:

I. H. P.	12.2
B. H. P.	10
Cu. ft. of gas per hour	120
Temp. of water entering jacket	63°F
" " " leaving "	174°F
Pounds of water per hour	617.1

Suppose the gas used had a heating value of 1100 B. T. U. per cubic foot, then 120 cu. ft. equals 132,000 B. T. U. per hour.

One horse power is equivalent to 2545 heat units per hour.

The I. H. P. is 12.2 or 31049 heat units per hour
The B. H. P. is 10.0 or 25450 " " " "

The difference of temperature of the water entering and leaving the jacket is 111 degrees F., therefore 111°×617.1 lbs. is equivalent to 68500 heat units lost in jacket water.

Heat units transferred into useful work	19.28%
" " transferred into work	23.52%
" " taken by cooliug water	51.90%

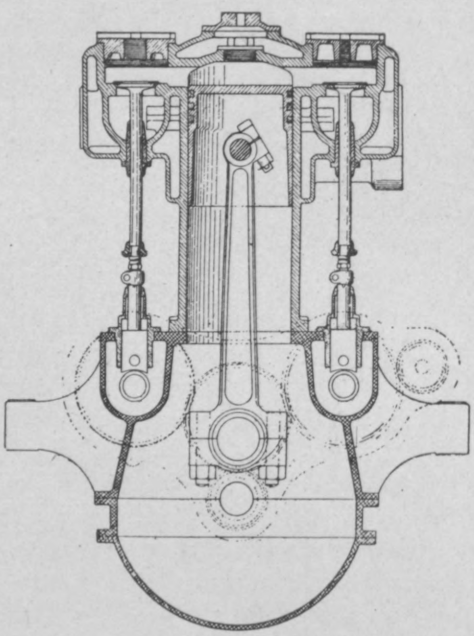


FIG. 1.

This gives one an idea of the amount of heat actually utilized in producing power and wasted in the exhaust and cooling system. Different types of engines vary as to efficiency and some transfer a larger percentage than the above into work, while others do less.

In this connection let us consider the interior shape of numerous high-class motor cylinders that we may readily see their advantages, as well as disadvantages, as to the radiation of heat and mechanical complications.

In Fig. 1, the valves are placed vertically on opposite sides of the cylinder. (Four cycle type.) This construction requires the burnt gases, during the exhaust stroke of the engine, to flow from the top of the cylinder, across to the valve opening, down between the valve and its seat and make one more turn in order to reach the exhaust pipe. The fresh charge entering the cylinder goes through the same shaped passage in a reverse direction. These angles in the passages, through which the gases must enter and

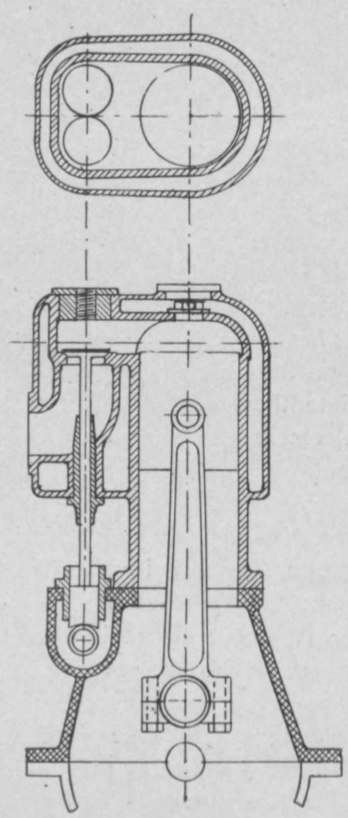


FIG. 2.

leave the cylinder at very high velocities, offer great resistance and therefore may reduce the charge and amount of gases exhausted. Also, much surface at the top of combustion chamber, and over and around each valve, of comparatively low temperature, (somewhere about 400 degrees F.) is presented to the fired mixture at nearly 2800 degrees F. Consequently the heat of combustion is rapidly absorbed by the walls and reduces the M. E. P., which results in decreased power and greater fuel consumption.

The combustion chamber shown in Fig. 2 retains the same faults as that in Fig. 1, yet with valves on one side of the cylinder one cam shaft is necessary to actuate the valves, while with valves on opposite sides two such shafts are required. In any case it is understood the cam shaft runs at half engine speed.

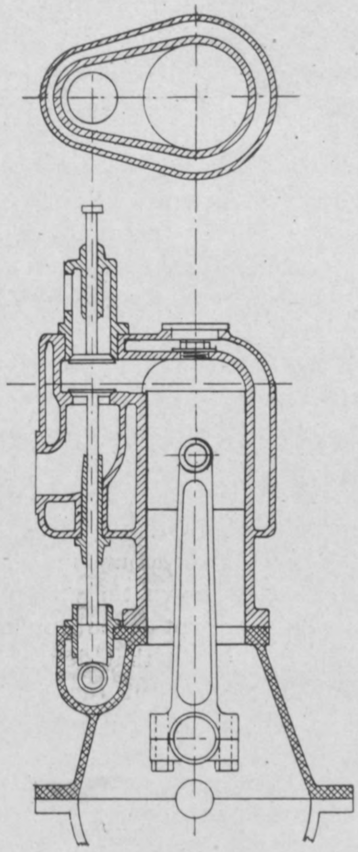


FIG. 3.

A design such as is shown in Fig. 3 slightly diminishes this area of cool surface and only one cam shaft is needed to operate both valves.

For a given volume the area of the surface of a sphere is less than any other possible shape; therefore, if the combustion chamber be made hemispherical and containing the valves (as shown in Fig. 4) then the least amount of surface is exposed to condense the expanding gases, which also have a direct passage through the valves. (For convenience of grinding and repairing, the valves in this style of cylinder should be contained in cages, which makes them more accessible than in the other forms.) A more rapid combustion is obtainable with this construction, due to a lack of crevices for the gas, and a higher pressure prevails throughout the stroke. Only one cam shaft is required to operate the valves

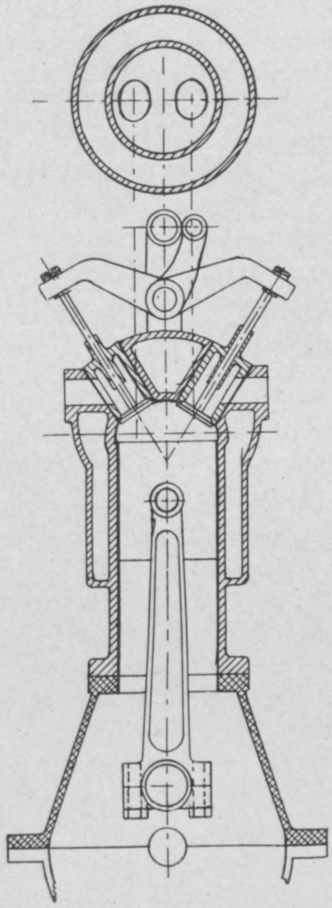


FIG. 4.

and may be placed over the cylinders run by worm gearing or in the engine base in connection with push rods and rocker arms.

Engines constructed with valves in the top o the cylinder head are a few inches higher than those with valves at the side. But shall we practice economy by accepting better designs or shall we sacrifice dollars and cents for a few inches in height?

Lubrication of a gas engine is accomplished by gravity or force feed lubricator and by the splashing of oil in the engine base, for small vertical types. Since the piston has a speed or travel between 500 feet and 1000 feet per minute, it is evident that it is necessary to lubricate it, in order to reduce the friction of it and the rings on the cylinder walls, with an oil possessing a body that will efficiently peform its function of lubricating at working temperatures. For this purpose a pure petroleum oil of a flash test of about 440 degrees F. is necessary, although one that varies nearly 40 degrees F. either way would suffice. If the oil used has a flashing point that is too low, it will not remain on the hot surface long enough to fulfill its purpose as a lubricator, for it will vaporize the instant it strikes the hot cylinder walls. On the other hand, if the flash point is too high, or if the oil contains animal fats, it will carbonize and cover the piston and rings with burnt oil, causing a leaky piston. The carbon thus deposited will eventually cause premature ignition and make the cleaning of all interior surfaces of the cylinder necessary.

Firing the combustible mixture was originally accomplished by a flame or hot tube but in recent years these means have been superseded by the electric sparks, at first performed by a primary current from a battery or dynamo, known as the contact spark; then the induction coil, with its primary and secondary windings, making a jump spark, used with a battery or dynamo was placed upon the market. Now we have the magneto, containing the primary and secondary coils on its armature, producing a jump spark when running at slow speeds. One form is used about as much as the other but the make-and-break, or contact, is prevalent in large engines and is, in the opinion of many, more powerful and reliable than the jump spark system, all though it is true, in some cases the jump spark can be more suitably located and produce quicker ignition.

Gas producers and carburettion of fuels are demanding the attention of builders more than any other detail. Kerosene will develop seven-sixths as much power as gasoline for a given fuel consumption per hour and costs slightly over one half as much as gasoline, thus the cost of a B. H. P. per hour is twice as much when gasoline is used as when oil is used. Of course the engine must be adapted to its particular fuel in either case. Hydrocarbons in oils have always been a menace to builders, inasmuch as the carbon is deposited in the passages until they become clogged with tar and other carbonaceous products; however, under proper conditions these hydrocarbons will burn, but this has proven the problem which has been imperfectly solved in many cases.

Combustion of kerosene, unlike that of gasoline, does not give rise to extreme pressures but produces an evener pressure, with consequent smoother runnings, less vibration and less wear on the bearings. Engines using oil have been installed in the latest types of British submarine boats with satisfactory results.

Not considering blast furnace gas, which is a waste product around rolling mills, producer gas is probably the cheapest fuel of all for operating internal combustion motors, requiring from three fourths to one and a half pounds of coal per H. P. hour. This has shown that the possibilities of the gas engine are not dependent upon gasoline alone as a fuel, but that development will be due to the perfecting of the gas producer, whose real value has not been fully realized, for there is scarcely any branch of industry where the gas engine using natural or producer gas cannot be successfully and economically utilized. Rapid strides are evident in this branch from the numerous large power plants recently installed, especially around rolling mills where the excess of blast furnace gas is converted into electrical power, which minimizes the waste products and expense of operating these industries.

Another field containing small and medium sized plants will be developed, without much doubt, when greater confidence has been created in the gas producer, and this phase of power will be taken up largely by those now using steam or other more expensive means of generating power. Think of the dollars pouring forth from the chimneys of Chicago in one day, think of the waste of Nature's gifts and think of your dirty cities! Isn't this new prime mover worthy of an engineer's time and talent?

A great advantage of the gas engine is the ease and rapidity of starting and stopping, simultaneously with the beginning and ending of the fuel consumption, while with a steam engine fully five minutes are necessary to get the engine warmed up and in good running condition against one minute for the gas engine. Again, without consuming considerable time and fuel, sufficient to run the same power gas engine for hours, for raising steam, the steam engine would not move. Consequently the comparison of cost for gas power and steam power is needless to convince even the most skeptical of the economy of the gas engine.

As an indication of the rapid development in the manufacture of this prime-mover and its importance, it is interesting to note the large number of manufacturers of large Corliss steam engines taking up the building of high-powered gas engines, both single and double cylinder, tandem, and single and double acting. Also the fact that in a single power house of a steel plant twenty-five gas engines of 4000 H. P. each, operate on blast furnace gas and are direct connected to alternating current generators, is bountiful proof of their worth, without mentioning some engines direct connected, operating generators in parallel.

Nothing has been said regarding form and other uses for these engines in small units because of the assumption that the reader was already familiar with these applications.

R. L. Smith, '09, has been elected captain of the track team for the coming season.

L. J. Backman, '10, has been elected captain of the football team for the next fall season.

F. C. Wiest, '09, has left Rose to continue his study of architecture at the University of Pennsylvania.

H. W. Heidenger, '08, was recently elected captain of the baseball team, to take the place of F. P. Mooney, '09, resigned.

Mr. Theodore L. Faust, the popular instructor in the blacksmithing department, resigned his position in the latter part of January, to the great regret of the boys working in that part of the shop.

J. L. Herman, '10, left Terre Haute on January 31st, for the East, where he will take up work in the Chemistry course at the University of Pennsylvania.

Electric Power From Wind.

The Danish government is carrying on experiments of generating electric current by means of wind motors. Motors with four wings have given the best results as a smaller number does not fully utilize the power of the wind while a larger number acts detrimentally to the current between the wings. A medium large motor with a wing surface of about 530 sq. ft. when drien by wind at a velocity of 20 ft. a second develops 8 H. P. At a velocity of 26 ft. a second, a not uncommon one, the horse power is doubled. —*Am. Machinist, Jau. 16, '08.*

ROSE 13, WABASH 32.

In the one of the hardest fought games of the season, Rose lost to Wabash by the tune of 32 to 13, at Terre Haute, Saturday, Jan. 18.

In the first half Rose seemed to be a little off, and Wabash registered 23 points before Rose started in and mixed things up.

In the second half Rose played a brilliant defensive game, holding Wabash to 9 points. The game was rough from start to finish. Capt. Diddle, of Wabash, was the star of the game, getting six field goals in the first half.

WABASH.	POSITION	ROSE.
Diddle, Waltersford,	Forward,	Curry
Freeman,	"	Markley
Sprow,	Center,	Schmidt
Wicks, Capt.	Guard,	Lindeman
Stump, Gipe,	"	Hadley, Gray

Field Goals—Diddle 6, Wicks 3, Watersford 1, Sprow 1, Curry 1, Lindeman 1, Schmidt.

Foul Goals—Wicks, 10 out of 13 chances; Lindeman, 7 out of 14 chances.

Score at end of first half—Wabash 23, Rose 6.

Referee—Rieman, of Purdue.

Time of halves—20 minutes.

ROSE 24, DE PAUW 12.

On Monday night, Jan. 20, at the Opera House at Greencastle, the basketball team easily defeated the DePauw five in a game noted principally for holding on the part of the Methodists. They seem to realize that they cannot beat a team at straight basketball, so resort to holding in an effort to keep the score down as low as possible, and in this they were succsssful in the first half, but the Rose men solved their methods in this in the second half and were able to toss 6 field goals. At the first of the game the floor was unfamiliar to the Polys, and at one time the score stood 4 to 1 in favor of DePauw, but this was soon overcome and the first half ended 10-7 in our favor. In the second half DePauw changed four men in a effort to stem our onward rush, but were unsuccessful, the half ending 14 to 5, with our boys at the long end, thus making the result of the game 24-12.

The box score:

ROSE.	POSITION.	DE PAUW.
Markley, Webster and Curry,	Forward	Johnson, Crick, Sheets (Capt.) and Ell
Schmidt,	Center,	Bachelor and Pruitt
Hadley, Lindeman (Capt.)	Guard,	Grady, Hardin and Holopeter

Field Goals—Markley 1, Webster 3, Hadley 2, Lindeman 2, Johnson 1, Ell 1.

Free Goals—Lindeman, 8 out of 11; Sheets, 7 out of 14.

Referee—Kisner.

Umpire—Rieman.

Point Awarded—DePauw.

Time of Halves—20 minutes.

ROSE 33; I. S. N. S. 19.

On Friday, January 24, Rose defeated the Normal in a very close and exciting game. Rose was very much weakened by the absence of Schmidt and Lindeman. Schmidt started in the game but had to retire after the first two minutes of play on account of running three teeth through his upper lip.

In the first half things were rather interesting and the game was close although this period ending with score 14 to 13 with Poly in the lead.

In the second half Lindeman went in the game and the score began to pile up. From then on

Rose played circles around the wearers of the blue. When the smoke of the battle cleared the score stood Rose 33, Normal 19.

ROSE.	POSITION.	NORMAL.
Webster	Forward	Walters
Piggott, Nicholson	Forward	Nichsels
Schmidt, Gray	Center	Lovelace, Shockle
Curry, Lindeman	Guard	Brechner
Hadley	Guard	Silvers

SUMMARY.

Goals—Gray 2, Webster 2, Hadley 1, Piggot 3, Lindeman 5, Lovelace 1, Nichsels 1, Brechner 3.

Foul Goals—Hadley 4, out of 6 chances; Lindeman 3, out of 8 chances.

Referee—Kisner.

ROSE, 11; INDIANA, 30.

Rose was defeated in a very fast and rough basketball game Monday, February 4, by the fast Indiana five at Bloomington. Rose was somewhat weakened by the absence of her captain, Lindeman, while Indiana was also weakened by the absence of Capt. McCoy.

The game became so rough that Referee La Follette had to call the game and warn the players. Schmidt and Rogers fought an awful game, neither one being able to register a point.

In the second half, Rose made a desperate attempt to stop the Crimson's team work, and to some extent was successful.

The line-up:

INDIANA.	POSITION.	ROSE.
Woody,	Forward,	Webster
Chatlin,	Forward,	Markley
Craig, Rogers,	Center,	Schmidt
Trimble,	Guard,	Curry
Thompson	Guard,	Hadley

SUMMARY.

Field Goals—Woody 4, Chatlin 3, Thompson 3, Hadley 2, Webster 1.

Foul Goals—Woody 12. missed 4; Hadley 5, missed 10.

Fouls—Indiana 15, Rose 16.

Score at end of first half—Indiana 15, Rose 5.

Referee—La Follette, of Purdue.

Umpire—Rieman, of Purdue.

Time of Halves—20 minutes.

SENIOR HULLABALOO.

On the afternoon of January 24th, at the close of the last recitation of the term, the seniors being in doubt as to whether there would be any cause for rejoicing after the lapse of another week, celebrated. While the tower clock refused to toll the hour, and the warm rays of the four o'clock afternoon sun shone down through the circumambient atmosphere, the seniors celebrated. Within, without, around, about, there reigned a scene of perfect rout, of laugh and shout, quite loud no doubt, till the wind put the cannon fire out. Nevertheless, it was a glorious celebration.

THE SCIENTIFIC SOCIETY.

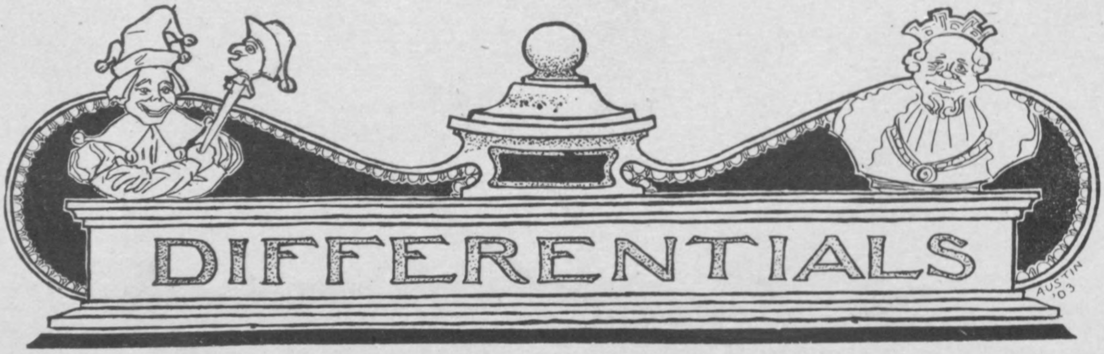
The Scientific Society met on January 18th, the paper for the meeting being by L. P. Webert, '09, on American Weather. In the preliminary business meeting, S. E. Mitchell, '08, was elected Senior Councilman of the Society.

Mr. Webert gave a very interesting talk on the work of the Weather Bureau, illustrated by blackboard maps, and smaller printed maps, which were passed around. The influence of the barometer's pressure on temperature and wind direction was explained, also the methods of predictions of the paths of storms. The nature and origin of thunderstorms, tornados and hurricanes was spoken of, and the many influences which "highs" and "lows" have on the temperature and weather condition was made plain.

Mr. Webert was tendered a vote of thanks by the society before adjournment.

Electric Shovel.

The Western New York and Pennsylvania Traction Company are using an electrically operated shovel on maintenance work, and report it highly satisfactory as regards economy and efficiency. The shovel is of Vulcan make with a $1\frac{1}{2}$ cu. yd. dipper geared to cut 25 ft. wide at the rail and lift to a clear height of twelve feet. It is equipped with a 50 H. P. hoisting and two 20 H. P. auxilliary motors of the railway type using trolley line current. It is operated by inexperienced labor.—*Eng. Rec. Jan. 18, '08.*



Washburn, '10, looking for *Sulphur* in the index, but finding it in the table of atomic weights: "This is the funniest index I ever saw: it says page 32.06."

Mr. Plew, in Geometry: "What is a lemma?"

Bob Templeton, '11: "A rather nauseating fruit."

Wicky: "Translate, 'Which one is the prettiest girl?'"

Leeds, '09: "Professor, I can't say 'Which one'!"

Waggie: "Mr. Cannon, do you have in mind the shape of a wheel?"

Hiram: "Yes, sir."

Mr. Plew: "What is a prism?"

Stump, '11: "Waal, it's a kind o' tetrahedron!"

Mac, speaking with great fervor and conviction: "I would any day rather have trouble with a man than with a woman!"

Bennett, (seeing that Flood, '10, spells his name R-a-l-f): "I ought to change the last letter of my name to *c* and then it would be a franc."

Washburne (aside): "He ought to change the first letter to *c* and then he'd be a crank."

Mr. Plew: "Demonstrate the second proposition on the blackboard, Mr. Floyd."

Floyd, '11: "There are several points in that proposition which I can't quite grasp."

Mr. Plew: "Why, Mr. Floyd, there's only one point in it."

SUGGESTIONS FOR THESES.

(References given after each subject.)

1. An investigation as to whether the chief duty of mortar is to keep bricks apart or hold them together.

2. An analytical method for determining the stresses set up in the compression members of Roman chairs and sofas under a double concentrated live load.

3. Design of an apparatus to utilize the power developed by wax chewing stenographers, to run a lighting system and electric fans.

-- Prof. Frisz's *Man as a Prime Mover.*

4. Design of a quick return motion to transport members of the Louisville "anvil chorus" homewards.

Prof. Hummel's *Every Place but Home is H—.*

5. Investigation of the value of alcohol in its various forms as a hair tonic.—*Defence of the Distillery* by Dr. Green, D. F., Lakeland University.

6. Determination of relative calorific values of Arcadia Mixture and Edgworth plug cut — Dr. Wanner's *Tobacco as a food* (*revised by Am. Tobacco Co.*)

7. How to obtain a job and live a Don Antonio life on a stogie salary. — Hon. McKim Duncan's *1001 Stories of Successful Dynamite Blasters and Elevator Boys who have risen.*

8. Proximate Analysis to determine amount of pork in pig iron.

Wood & Smith's *Transference of Chemical Energy into Electrical.*

Superheated Steam for Locomotives.

Although European builders for a number of years have been successfully using superheated steam in locomotives, American railroads have to a large extent neglected the development of the superheater owing to its complication. But thanks to the pioneer spirit of the Canadian Pacific, the superheater is rapidly becoming more widely adopted. Superheaters may be divided into two classes, the fire tube type and the smoke box type. The former are in more general use and represent the original method of superheating locomotive steam. The latter type is of more recent development and is the kind in use on American roads. The latest design consists of two groups of horizontal tubes arranged between vertical headers and interposed between the dry pipes and valve chambers. The hot gases on their way to the stack thus superheat the steam as it passes from boiler to cylinder. This type of superheater gives a superior cylinder performance, is simple, and enables work to be done on the flues at any time without disturbing the superheater.—*Railway Master Mechanic, Dec. '07.*

Accuracy of Slide Rule Computation.

John Berg in the *Engineering Record*, Dec. 21, '07, says concerning the slide rule: When preliminary estimates are of such a nature that the slide rule can be used in their computation then this little instrument ought to be used. It saves both time and mental effort and the final results are more apt to be free from large errors than when the work is done the long tedious way. Practical opportunity was recently afforded, of testing the accuracy of the rule. Of 28 three figure quotients ranging in magnitude from 391 to 999, the maximum error was .11 percent, while the average error was only .01 percent. The test was continued for 116 more quotients ranging in magnitude from 1007 to 8590. The percentage of maximum error decreased while the average error increased as the quotients became larger. The maximum error for all 144 trials was .11 per cent and the average error .024 per cent. By comparing these results with those quoted concerning planimeters in Johnson's "Surveying" it will be seen that the slide rule is far more accurate shan the polar planimeter and that it compares very favorably with suspended and rolling planimeters.

Waterproof Engineering.

Mr. Edward W. De Knight's paper on "Waterroof Engineering" as read before the Boston Society of Engineers is printed in the December Journal of the Association of Engineering Societies. Waterproof engineering consists of promoting the sanitation, safety and durability of structures, by fighting moisture. Concrete may be treated to make it in itself impermeable or it may be protected by something apart therefrom to render it waterproof. The first method may either be accomplished by mixing with the regular constituents of concrete such chemicals as lime, soap, alum, and the like. But this method only adds to the difficulty of the situation for the hardest proposition is to get ordinary sound concrete properly mixed in the field, and when the waterproofing is based on such a haphazard method, little or no benefit is derived. A cement plaster or wash may be applied, but it is poor judgment to rely on such a flimsy protection which is but adding one bad thing to another.

Under the head of protecting concrete with something apart therefrom come materials and methods of preventing the water from ever reaching the material at all. Pitch, asphalt, reinforced with burlap and tar paper have all been used but without much success, as the settling of the masonry caused them to crack and let in the water. The best material is a strong fibrous felt made in one sheet, absolutely impervious to water by a process of saturation and coating of materials which are really waterproof, and not the least important, it must conform to the outlines assumed from time to time by the structure. The article concludes with instructions of how to apply the waterproofing together with photographs of work in progress.

The Microscope in Manufacturing.

The *American Machinist* for January 16, 1908, contains an illustrated article on the use of the microscope in type founding establishments. It is used to test the accuracy of the matrix. The matrix is the mould from which the type is cast and is formed out of hard copper by means of a punch finished in an engraving machine. It is very essential that all the type of a particular font be of the same width, height, and square with each other. It is here that the microscope comes into service. It is provided with two cross hairs at right angles to each other; and by means of these it is an easy matter to square up the matrix. The width of the lines of a letter may be checked by setting one side coincident with a cross hair, and then turning the micrometer screw with which the instrument is provided until the other edge of the letter coincides with the cross hair. The width can then be read from the micrometer dial. Other microscopes are used which have two micrometers whose center lines are at right angles with each other for testing the correct centering of such letters as o. The micrometer dials read to the .0001 of an inch and form a convenient and accurate means of testing and measuring the work.

Cooling Tower Practice.

Those interested in devices designed to further the efficiency of power plants will find a well written and finely illustrated article on cooling towers for condenser water in the January number of the *Engineering Magazine*. Both open and closed types are discussed, and their relative efficiencies compared, the conclusion being that where cost is a prime consideration the open type is better suited; but the closed tower, though more expensive, is more reliabe.

Commutator Brush.

The latest thing for cleaning and polishing the commutators of dynamos and motors according to the *American Machinist*, Jan 9, 1908, is a glass brush placed on the market by a Vienna firm. These brushes are said to clean the commutators without scoring the metal and their use avoids the inconveniences and dangers of emery cloth which they are expected to replace.

Largest Gas Engine.

The Carnegie Steel Company recently tested their new gas engine at the Edgar Thompson Mills. The results were perfect. The engine is to use blast furnace gases resulting not only in a large saving of fuel expense but also doing away with the problem of the waste gas which has been poisoning the atmosphere of Pittsburg. The engine weighs 1500 tons, is 86 ft. long and develops 5000 H. P.—*Am. Machinist, Jan. 15, '08.*

Power Shut Down.

An example of how a little thing may cause a great trouble is given by the *Engineering Record* of Jan. 18, '08. The Edgemere Mills of Great Barrington, Mass., recently had to shut down because some waterbugs crawled into the push button of the engine stop, and produced a short circuit and consequent stop.

The American Machinist for January 16, 1908, is an unusually good number and will repay careful reading. Among the excellent articles is one on the application of friction formula to the design of journal bearings, one on the design of gear teeth with especial reference to wear, and a good description of the new automobile dynamometer recently installed by the Automobile Club of New York.

Frank P. Mooney, '09, captain of the basebal team, recently decided to leave the Institute, to take a position in Cincinnati, Ohio. It was with great regret that the boys said "good-bye" to him, and it is the universal hope that his success in any line that he may take up may be equal to that which attended his captaincy of the ball team last spring.

The recently constructed enlarging apparatus of the Camera Club is ready for use, in the room of the club in the west basement of the main building. The advantages of photography to an engineer are many, and members of the club can enlarge their knowledge of this interesting work by making use of the apparatus.

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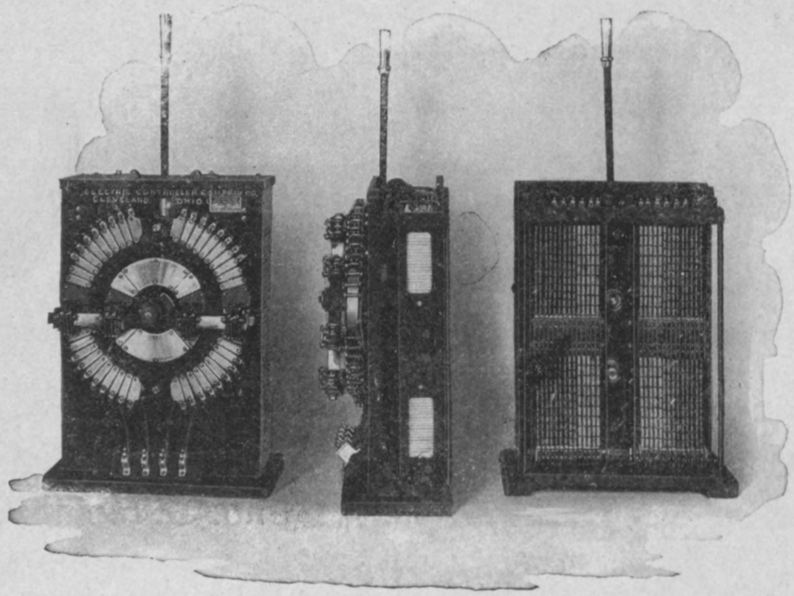

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