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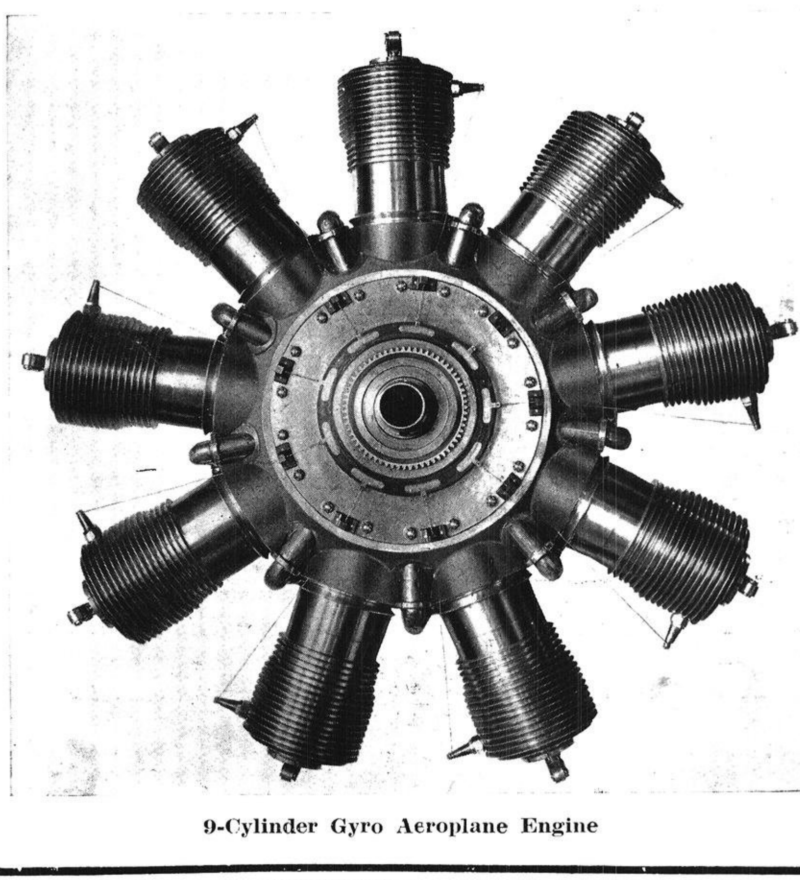

9-Cylinder Gyro Aeroplane Engine

CONTENTS

The Wisconsin Engineer

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RECENT DEVELOPMENTS IN AVIATION ENGINES

ALLISON F. H. SCOTT

Editor's Note: The following article is a most recent resume of advancements in aviation engine practice. Mr. Scott has been conducting experimental research for the Gyro Company of Washington, D. C. We are indebted to this company for the loan of cuts and to the "Automobile" for valuable assistance.

For thousands of years mankind has dreamed of aviation, but the desire to fly mechanically dates back to the fifteenth century when da Vinci aspired to fly through the air with hand and foot paddles. Toward the end of the seventeenth century, Borrelli, an Italian physician and philosopher, concluded that man could never fly if he relied upon his muscular power for the propelling force, and Lillental by his experiments showed the need of a light but powerful agent for propulsion if successful mechanical flight should ever be realized. Early in the nineteenth century, two American scientists, Langley and Maxim, attempted to solve the problem of flight. After successfully constructing gliders for more or less sustained flight, they encountered the problem of obtaining a portable power plant with which to drive their gliders through the air. Both men chose steam, because the available electrical equipment greatly outweighed the steam apparatus of the same power. Langley then developed a remarkable steam unit but found by experiment later that the use of steam was impracticable. About this time, due to the untiring efforts of Daimler, the gasoline engine made its advent, and Langley, seeing the advantages to be derived from this type of engine, constructed a gasoline engine and installed it in one of his gliders. Although he failed to launch the machine successfully, he did however demonstrate the practicability of the internal combustion engine to aeroplane work.

The gasoline engine made possible unheard of values of horsepower output per pound of weight as compared with the prime movers then in use. Furthermore the fuel was then exceedingly cheap, the engine was very flexible, and because of its size, was easily adaptable to the machines under test. With the experimental knowledge at hand it was believed that the horsepower output then obtained from these first motors was more than sufficient for flying, and therefore many of the early engines were of very small power. Early in 1909 A. V. Roe fitted one of his triplanes with a 10 horsepower engine and actually flew later with one of only 14 horsepower. But experience soon showed the necessity of more power. Bleriot made his famous flight across the English channel July 25, 1909, with a three cylinder air cooled radial engine of but 25 horsepower. This achievement established the supremacy of the gasoline motor for aircraft. When it was found that flying was possible, engines of high efficiency of the automobile type were believed practical, but conditions of automobile service are so different from aero requirements that designers soon turned their attention to the especial needs of aviation motors. Two almost contradictory requirements of the aero-engine are high power output and light weight. When the motor develops a constant horsepower, the speed remains constant with reference to the medium in which the aeroplane travels. To move swiftly with reference to the earth in the face of an opposing wind requires therefore a very high speed relative to the sustaining medium and consequently a powerful motor. The horsepower available for climbing is the power output minus that power consumed in horizontal flight, which varies directly as the weight of the machine. Light weight therefore must be demanded of the motor. This is the reason why the gasoline engine monopolizes the aviation field. This demand soon produced many ingenious and beautifully constructed motors, among which was the Burlat four-cylinder rotary. In this engine both cylinders and crankshaft revolved, the crankshaft at twice the speed of the cylinders.

From these initial steps, the gasoline aero-engine has been developed in four different types distinguishable by the arrangement of cylinders and valve mechanism. These are (1) the vertical or ordinary automobile type with cylinders "all-in-line," (2) the revolving radial or rotary type with cylinder axes pointing toward a common center, and with the cylinders and crankcase revolving as a solid piece, (3) the fixed radial or star type, with axes of the cylinders pointing toward a common center and all lying in a plane perpendicular to the engine shaft, and (4) the diagonal or V type with two sets of parallel cylinders at angles of 60 degrees or 90 degrees with each other.

One of the best examples of the first type of engine is the Mercedes-Daimler, vertical multiple cylinder engine of very solid and heavy construction, and yet of no striking originality. The distinctive features of this engine are reliability, simplicity and accessibility. It is made in 4, 6, and 8-cylinders, but in the German aerial service, in which over 80 per cent are Mercedes-Daimler, the six is the favorite. The cylinder barrels of this engine are cast separately of a high grade steel, and to these are welded the steel jackets necessary for water cooling. The cylinders are attached to the crankcase by flanges, studs and nuts. The pistons are of pressed steel with cast iron rings. The connecting rods are of the usual I-section of chrome nickle steel. The valves are inclined in the cylinder heads, each driven by its own rocking lever from an overhead enclosed camshaft, driven by a vertical spindle from the anti-propellor end of the crankshaft. Ignition is provided by two carefully synchronized, high-tension Bosch magnetos, and each cylinder is equipped with two spark plugs, each set being fired by one magneto. There are two water jacketed carburetors, each one supplying the mixture to three cylinders. These carburetors are of the two-jet type in which the fuel for the pilot jet passes through a choke tube. The air intake on these machines is rather unusual in that it passes through the crankcase from right to left, following the bottom surface of the crankcase shell. The bore of the 150 horsepower engine is 5.51 inches and the stroke is 6.3 inches. At 1250 r. p. m. this motor develops 150 horsepower, rising at 1400 r. p. m. to 165 horsepower. Its weight complete with the two magnetos, water and oil pumps piping, and oil tank is 5.5 pounds per brake horsepower. With its long crankcase and crankshaft it is a

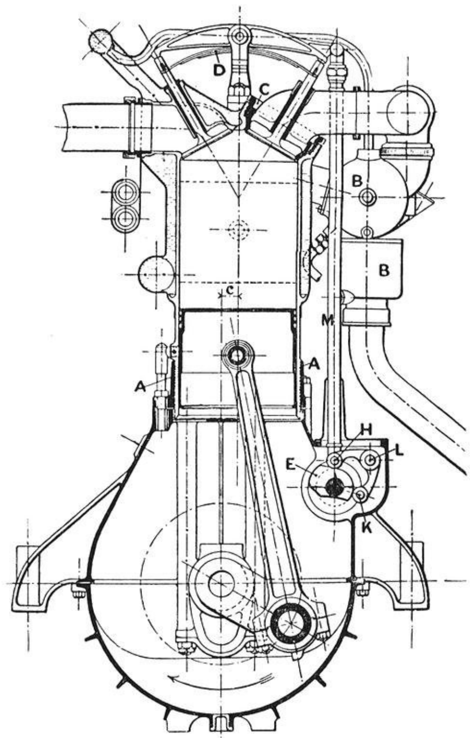

Fig. 1.—Austro Daimler Aeroplane Engine.

somewhat heavier engine for its power than the compact V-type. This undoubted disadvantage is offset, however, by the narrow end aspect which offers very little obstruction to the view of the pilot and by its adaptability to stream line casing, which considerably reduces head resistance.

During the early days of the war an inverted type Daimler of 70 horsepower at 1400 r. p. m. was developed in order that the aviator could have a better view and use his machine gun more effectively. This construction has the further advantages in that it lowers the center of gravity of the machine and raises its center of thrust. The cooling is ideal because the cold water enters around the hottest part of the cylinders. Oil is supplied under pressure to the bearings and the leakage lubricates the cylinder walls. Waste lubrication is used, the oil which passes the pistons escaping with the exhaust. It was at first thought that the motor would fail due to the excess of oil and carbon on the spark plugs, but in competition for the Kaiser prize this difficulty did not appear.

In the Grand Prix race of 1914, five motor cars equipped with Mercedes Daimler engines participated. The hoods were strapped and bolted down so that no one knew their identity. After the race it became known that the motors used in this open competition were the new German aeronautical engines, the Mercedes-Daimler. This is significant because the designers imposed this supreme test for reliability and sturdiness, driving them at speed far exceeding those required in aircraft work. The durability of the Mercedes-Daimler was further demonstrated by Herr Bohm, who remained in the air 24 hours in a biplane equipped with one of the six cylinder 100 horsepower type.

At present there are many prominent vertical engines, one of which, the Austro-Daimler, has given wonderful service in the present war. It is very similar to the Mercedes-Daimler. At BB, Figure 1, can be seen the two water jacketed, annular float feed single spray, nozzle-type carburetors, identical in construction and adjustment, and each supplying three cylinders. The interchangeable, cone seated valves below C are each about one-half the cylinder bore in throat diameter and are inclined thirty degrees to the vertical. The exhaust valve seating and stem guides are formed in the combustion head casting and are also water cooled. The inlet valve on the right is in a separate casing fixed in one position by the removable hollow flange nut C. If this cage is removed, the exhaust valve on the left may be withdrawn. A single laminated spring D clamped at the center on the fulcrum post supporting the rocker arms keeps the valves seated. A single push rod positively operates both valves through the use of two cams in conjunction with a bell crank lever. At H the tubular push rod M is pin-connected to the bell-crank HLK, which is pivoted at L. The arms, however, are not coplanar as LH is located behind LK. Cam E actuates roller K, and as it revolves clockwise its plus-part strikes K, M descends, and the inlet valve is opened. A similar cam behind E acts on H, the plus part raises M, and thus opens the exhaust valve. Relative proportions may be seen as the diameter of the cylinder is 4.73 inches for the 90 horsepower engine illustrated.

American manufacturers have appreciated the demand for simple dependable machines of the vertical type for both school and scout machines. Such engines as the 140 horsepower Wisconsin 6 or the Hall-Scott 4-cylinder of 100 horsepower and 6 of 150 horsepower may be cited as up-to-date proof of their success. A 4-cylinder vertical engine was used by the Wright brothers in their pioneer flying experiments and in their actual achievement of mechanical flight in December, 1903. In spite of its simplicity and fewer parts, the 4-cylinder engine on account of its irregular torque and limited power out-put will probably not be used again in aeroplane service. Recent improvements in the water cooled six, especially those directed to greater stiffness and consequent absence of torsional oscillations of the crankshaft at high speed make this type very desirable for future 75 to 150 horsepower service.

The radial engine was the design selected by aircraft engineers in France, who, unimpressed by the high efficiency claims for automobile type motors advanced by the Germans, attempted to perfect a motor of high power and light weight. Their efforts thus were directed toward developing air cooled motors of both the fixed and rotary radial type, for in these no other cooling medium was employed than air and the rotary type acts as its own flywheel. The radial type is a development of the horizontal or opposed two cylinder engine with two cranks diametrically opposed. It has excellent balance, with a working stroke every revolution, but its cylinder arrangement makes it too bulky for actual service. A 4-cylinder type was built by M. Darracq having two impulses for every revolution; but this type was soon twinned by the addition of a second set of cylinders at right angles to the first, the eight cylinders furnishing four working strokes per revolution, and giving most excellent balancing. This addition really brought the horizontal engine into the radial class.

The popularity which the rotary type of design has enjoyed until recently has been due to the beautiful mechanical construction. The rotating cylinders are of nickle-chrome steel machined from solid ingots about ninety pounds in weight. The cooling fins on the cylinder exterior provide air cooling surface. The working barrels of the cylinder are less than 1/16 inch thick, and great precautions against cylinder distortion must therefore be taken. To lessen this distortion effect the cast iron pistons are provided with two spring rings, one of phosphor bronze of L-section and the other of cast iron. The chrome-nickle steel connecting rods are of I-section, and are pivoted to a cage. One of the rods, known as the master rod, is rigidly fastened to the cage, which revolves once for each revolution of the cylinder. The length of the master rod is such that the position of the cage is definite for carrying the pins of the remaining connecting rods. Rotation of the cylinders is of course due to the side pressure of the pistons on the working barrels arising from the connecting rod's obliquity when the engine is running.

The crankshaft is of chrome nickle steel, made in two parts, which are fastened together at the crank pin. Ignition is provided by a single high tension magneto geared to rotate faster than the cylinders. The inlet valve is located at the center of the piston crown. Two counterpoises and a spring are used for adjustment of the valve and for overcoming the tendency to become unseated due to centrifugal force. The live mixture is drawn in through the hollow crankshaft and is centrifugally thrown through the valve as the valve is lifted from its seat. The exhaust takes place through a single cam actuated valve in the head of each cylinder. Castor oil is fed in with the gasoline for lubrication. Owing to the careful balancing of the engine, there is very little vibration at even the relatively high speed of 1300 r. p. m.

The Salmson radial motor is made in both the horizontal and vertical types. The water cooled cylinders are placed sym-

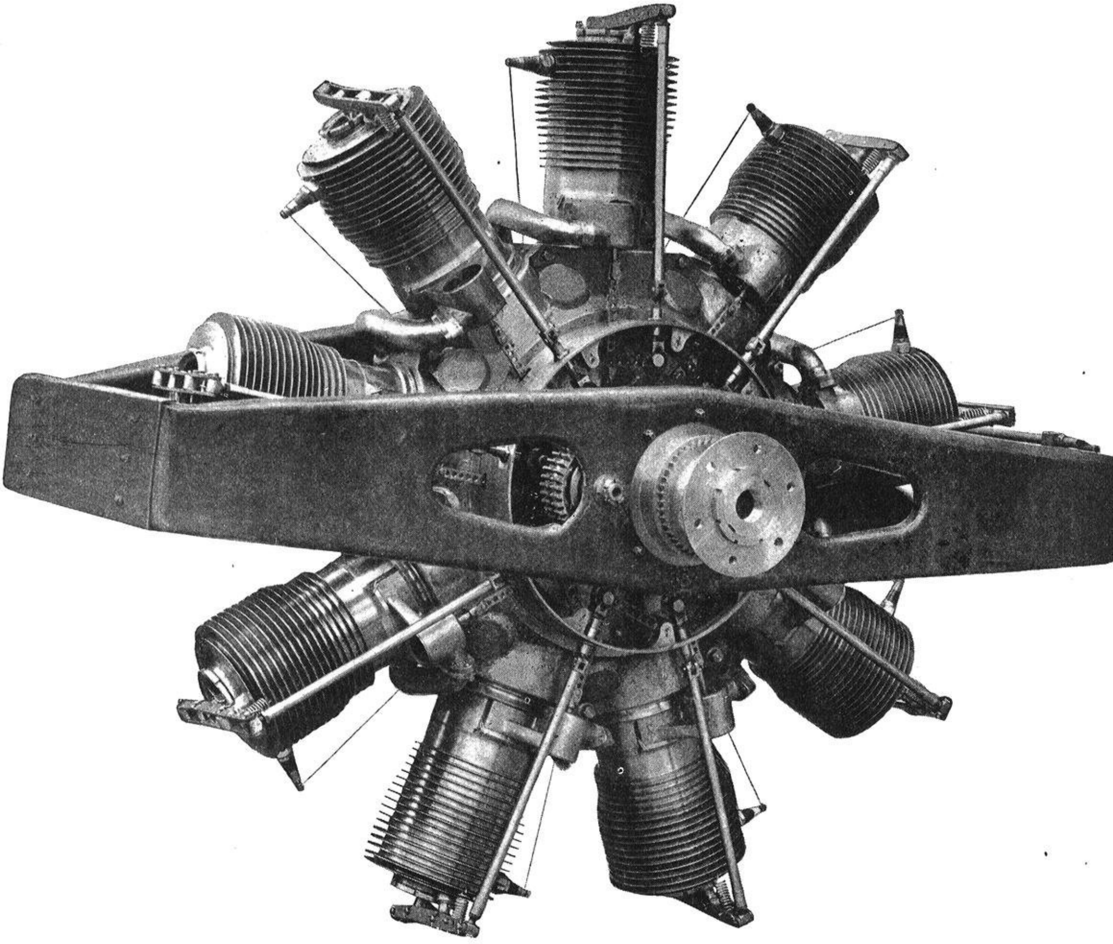

Fig. 2.—Front View, 9-cylinder Gyro Rotary Engine in Cradle.

metrically about the crankshaft, which is at right angles to their plane. All the connecting rods operate on one crank pin. The cylinders are machined from the solid ingot and when finished the barrels are but two millimeters in thickness. A centrifugal pump, geared to the crankshaft, delivers the cooling water to the lowest point of the bottom cylinder, and from there the water is forced to the next pair and so on until from the top cylinder it passes out to the radiator. The pistons are flat topped and are of cast iron. The nickle steel valves are of the cone-seated poppet type and are located in the flat cylinder head, each valve being operated through its own rocker, tappet, and pushrod. Each pair of inlet and exhaust valves is operated by the same cam. The crankshaft is hollow, permitting forced lubrication to parts within the

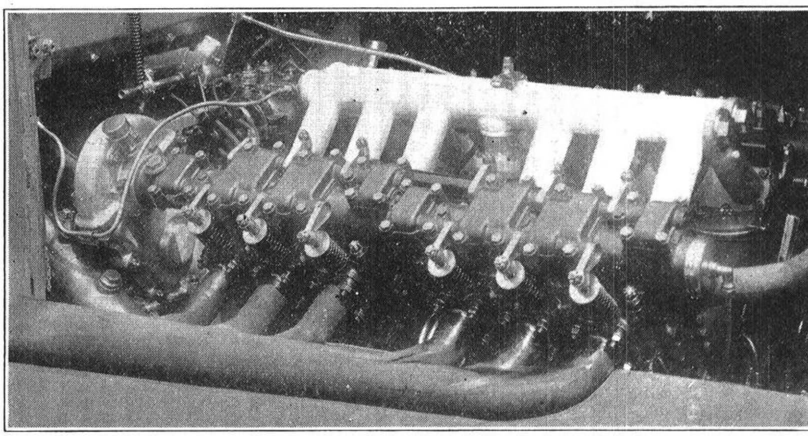

Fig. 3.—Packard Aeroplane Engine.

halved aluminum crankcase. This shaft is carried on self-aligning ball bearings. The Bosch shield magneto is used for ignition purposes. These motors are made in 7 and 9-cylinder types of 90 and 140 horsepower. Two sets of such groupings give the 14 and 18-cylinder engines of modern usage of 200 and 300 horsepower and 3.3 and 4.1 pounds per brake horsepower respectively. In principle the fixed radial motor is superior in many respects to the rotary cylinder engine. Its principal defects are improper cooling and frequent backfiring. Moreover, considerable power is lost in head resistance and the imperfect balance of the motor.

A later design than the one described is the Monosoupape Gnome motor, which contains many refinements in the design of working parts. By far the greatest departure is the elimination of the inlet valve. As the piston begins to move down on the expansion stroke, the exhaust valve opens at such a time that as the piston passes the inlet ports in the barrel, the pressure within the cylinder equals the pressure within the crankcase. For about one-third of the next down or induction stroke, the exhaust valve remains open, allowing a charge of fresh air to be drawn into the cylinder. The exhaust valve then closes, and as the piston passes the ports, the diminished pressure within the cylinder causes some of the rich mixture from the crankcase to enter. On the upstroke the gas is compressed and exploded, the cycle then being completed. Although this engine weighs only three pounds per brake horsepower, it has two distinct disadvantages. First, it cannot be operated for a long period of time because of overheating and the almost constant necessity for readjustment. Moreover, this requires skilled attendants, which is almost impossible for battlefield work. The second disadvantage is found in its extravagant gasoline and castor oil consumption. The quantities of fuel required for several hours' flight often outweighs the motor itself. In a recent test in which a Gnome and a water cooled 9-cylinder radial engine were entered, the total weight for one hour's running at 60 horsepower was 249 pounds for the Gnome and 480 for the water cooled radial. With fuel and supplies for ten hours running the weight for the Gnome was 807 pounds and for the other 777 pounds. From this it was calculated that for one hundred hours' run the Gnome would weigh 6,387 pounds against the 3,747 pounds of the water cooled type. When compared on a one hundred hours running basis, with engines of the same horsepower output another test showed the following weights: Gnome, 2,841 pounds; 9-cylinder water cooled, fixed radial, 2,203 pounds; 8-cylinder automobile engine, 1,366 pounds.

A successful rotary engine is made in the United States. This engine, the Gyro, is very similar to the Gnome except that it has a duplex, cam actuated piston valve working within a cylindrical casing which communicates with the cylinders through the ports, AA, Figure 4, which the piston overruns. The valve is connected to the crankcase by a gas conduit through which super-carburetted air is centrifugally thrown.

Fresh air is admitted through the exhaust valve D, in the head, during a portion of the downstroke. The valve is then closed, and the continued descent of the piston, creating a partial vacuum, draws in the live charge through the ports, AA, when overrun near the extremity of the stroke. After compression the charge is exploded, the main exhaust being through the head, since the piston valve acts merely as an

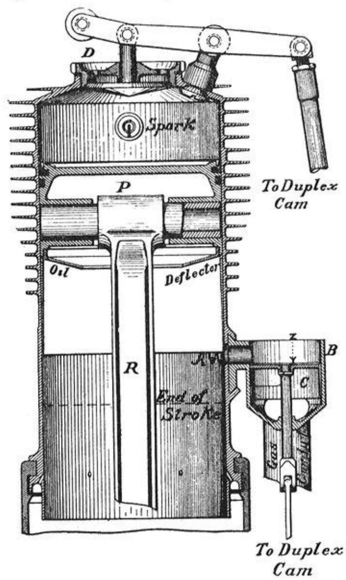

Fig. 4.—Section Through Gyro Engine Cylinder.

auxiliary means for exhaust. The periodic influx of fresh air through the main valve keeps it cool, although the piston valve relieves it of the duty of discharging the main bulk of the hot gases. Another feature of the Gyro motor is a variable compression cam, which allows easy starting and idling at 250 r. p. m. In flight, the fuel consumption in the 7-cylinder 90 horsepower engine at 1250 r. p. m. is 8 gallons of gasoline and 1 gallon of castor oil, whereas in the 9-cylinder, 110 horsepower, it is 10 gallons of gasoline and 1.25 gallons of castor oil. This motor, which weighs about 2.4 pounds per brake horsepower, is ideal for fast scouting monoplanes, which must average from 90 to 100 miles per hour, and for reconnoisance work of short duration such as the marking of batteries, attacking weight carrying machines and use in short bombing excursions, where a single shot through the radiator of a water cooled engine would be disastrous. When engines of this type can be designed, it is evident that the Gnome type of engine with its high fuel consumption and lower efficiency is soon to be displaced.

The fixed radial or star type of engine should be attributed to Anzani. Though the external appearance of this engine is the same, the star type, in distinction from the Gnome, has stationary cylinders and a revolving crankshaft. The earliest development was a fan type, and the cylinders were all above a horizontal plane in order to avoid excessive lubrication of the cylinders. As lubrication difficulties were mastered and as vibration in the fan motor was great, the cylinders were symmetrically placed about the crankshaft. As many as twenty cylinders are now used in two sets. The modern 3-cylinder radial engine has its cylinders symmetrically arranged and its working impulses occur every 240 degrees of crankshaft revolution. By combining two such Y-type motors and using a crankshaft of two throws 180 degrees apart, a 6-cylinder engine of 45 horsepower is obtained. By combining two sets of five radial cylinders each, a 10-cylinder of 100 horsepower is produced, and similarly by doubling the 10-cylinder arrangements a 20-cylinder, two-throw crank, engine of 200 horsepower may be obtained. The Anzani engines of this type weigh 3.4 pounds per brake horsepower.

The V-type of motor adds to the advantages of the stationary cylinder engine a double use of the crankcase metal. Light weight per horsepower output is the cardinal feature of the motor, which is either the twin-four or the twin-six types. One of the latest motors still in the experimental stage is the Twin-six Packard, notable for its regularity of torque, propellor efficiency, and total absence of vibration. The cylinders are cast in blocks of three and each is proided with two inlet and two exhaust valves, set at thirty degrees from the vertical, which afford one square inch of valve opening for each seventeen cubic inches of piston displacement. This displacement is for the 100 horsepower engine. To each set of the three cylinders there is one camshaft, driven by a train of spur gears from the crankshaft. This camshaft actuates the valves through rockers pivoted on short shafts between the camshaft and the valve. This arrangement permits generous oiling of the camshaft and keeps the oil from the valve as well. A forked connecting rod of I-section is used, along the shank of which runs an oil tube carrying the lubricant to the piston pin. The pistons are die cast of aluminum alloy, the total weight of which including the piston pin and four rings is only eleven ounces. The crankshaft has three bearings and is provided with a triangular web so strong that the shaft is completely free from whip throughout the entire speed range. The carburetors feed the gas to a separate straight header from which short pipes of equal length lead out to each cylinder. Since the bend in the pipes offers resistance to the gas flow, they have been so located that they are in the same position with respect to the valves. The cooling water is circulated by means of a gear pump. Battery ignition and the starting motor are of the Delco type.

Normal piston speed is about 1,725 feet per minute, although speeds as high as 3,000 feet per minute are readily obtained. This of course necessitates a geared down propellor. At 2300 r. p. m. this motor delivers 100 horsepower with a weight per horsepower, including the cooling water and radiator, of 5.9 pounds. A 4-valve, 12-cylinder, 300 horsepower engine is now being developed by the Packard experimental department. It is to have a bore and stroke of 4 and 6 inches respectively and an angle of V of but 40 degrees.

Another motor still in the experimental stage of refinement and yet in daily usage is the Curtiss 8-cylinder V-type, made in 100 and 200 horsepower models. The cylinders are of steel and the pistons of an aluminum alloy. Reliability is promoted by the use of double ignition and two carburetors. The 200 horsepower engine is capable of 1400 r. p. m., weighs but 700 pounds, including the radiator and cooling water, about 4.4 pounds per brake horsepower. These are but two of the representative American V-motors whose increasing popularity has encouraged designs too numerous to list.

We have thus far briefly considered the four principal types of aviation engines. The stationary cylinder motor has superceded the rotary cylinder except for very high speed monoplanes like the Morane-Saulner and the Fokker. The vertical and V-type represent the best of the stationary type, surpass-

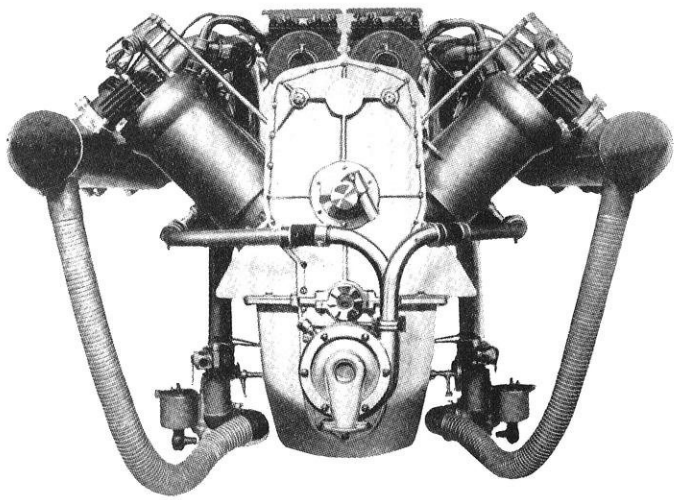

Fig. 5.—Curtiss 8-cylinder Aeroplane Engine.

ing the radial motors in accessibility, simplicity of construction, lubrication, cooling and minimization of head resistance. The V-type is superior to the vertical because of the double use of the crankcase metal as mentioned heretofore. Present practice dictates that the cylinders should be water cooled and cast en bloc. If made of steel, the barrels should be heavy enough to prevent warping. They should be placed in groups of six or twin-six, because this arrangement has the least vibration. It has been proposed to arrange them in three rows of sixes to meet the increasing demand for power, but thus far no motor of this nature has been developed. The pistons should be of cast iron, of pressed steel with cast iron rings, or of aluminum (mold or die cast) with cast iron rings also. Since lightness of reciprocating parts is desired, the latter form is to be preferred because of its weight. The valves should be cone-seated and of alloy steel. The seat should be screwed into the cylinder head to permit easy access. The two inlet and two exhaust valve system is probably the best way of obtaining maximum power for a given cylinder displacement. However, if the rotary valves, which appear so promising on paper, will only prove so in reality, a source of much trouble will be overcome in the future.

The overhead valve gear is the most advantageous as it is positive, and the single push and pull rod for inlet and exhaust seems destined to yield to one cam for each valve. In recent designs the cylinders are supplied from an independent carburetor and manifold, but for uniform gas distribution the Packard system of a main manifold and short leads seems better. Ignition should be double with two magnetos if it is convenient to place the additional plug, as tests show that ten per cent more power will be indicated by its use.

Mufflers and mechanical starters must soon be considered as standard equipment for all engines. Mufflers are desirable as they relieve the aviator of much nervous strain resulting from the roar of the high powered engines. The ingenious collector and muffler used on the latest Mercedes-Diamler apparently has solved the problem of a simple set serviceable silencer. The necessity for muffling in military operations is obvious in preventing detection. Mechanical starters are invaluable in quick "get-a-ways" in either enemy territory or for easy starting in the air or on the ground. Compressed air, either applied directly to each cylinder or to a starter geared to the engine, has given good results. However, the trend in design is toward electric starting equipment, which with its generating outfit makes lighting a future possible requirement. With greater thermal efficiency, obtainable at higher piston speeds, the question arises as to whether the propellor should be direct-connected or geared to the crankshaft. With direct connection the propellor is limited to a speed of 1200 to 1400 r. p. m. in the fast light machines, and to 900 r. p. m. in the heavy weight carrying biplanes. Thus the geared down propellor seems best, as the severe gyroscopic stresses due to the propellor are taken by a short lay-shaft rather than by the crankshaft. Advantages claimed for geared-down propellors, given by one manufacturer, include compactness, giving small head resistance, more uniform torque at the propellor, and maximum power output without sacrificing propellor efficiency. These enumerated features, however, will no doubt distinguish the aeronautical engine of the immediate future; but the changes of the past have come so rapidly that only the future can tell what new designs will be brought forth.

THE TELEPHONE IN MEXICO

T. G. NEE, e '99
Vice-President, Mexican Telephone & Telegraph Company

To appreciate the telephone situation in the Republic of Mexico, it is necessary to understand conditions within that country, and especially those surrounding the telephone industry, for telephone development is very closely associated with the social, economic, commercial and financial life of the people.

The telephone industry in Mexico and its development should be studied in connection with the size and topography of the country; climate and sanitary conditions; location and size of cities; wealth of the country; banking and money system; resources such as minerals, petroleum, soil and timber; amount of foreign and native capital invested in the various industries; industries and possibility of their future development; lines of communication and intercommunication; nature and extent of foreign and domestic trade; population, and its distribution throughout the country; classification of the people, the percentage of natives, mixtures and foreigners; percentage of illiterate and literate, their advancement, disposition, customs and other characteristics; social system, schools, churches, and organizations; form of government, laws and politics; economic conditions; and possibility of improving social, economic and financial conditions.

An understanding of the above conditions and requirements of Mexico, as well as the handicaps under which her people are working to improve them, will make it possible to study, and better understand, the history of the telephone development in Mexico and its future possibilities. But it is evident that these important matters cannot be discussed in the short space of a single article.

ORGANIZATION

The success of telephone companies and all industries depends to a large extent upon the organization, the ability of the men and the methods employed. Perhaps one of the most difficult problems in the operation of telephone properties in Mexico is the scarcity of native skilled labor. The average workman is poorly educated; few can read at all. Engineering and manual training schools, and scientific and trade literature, so common in the United States, are practically unknown. To form an organization, it is necessary first to select the men carefully and then educate them to the positions they are to fill. Mexican engineers from the best engineering schools in the United States are obtainable, but usually they have had no practical experience. Mexicans learn very quickly, but they are inclined to be more theoretical than practical.

The Mexican Telephone and Telegraph Company, the only telephone company operating in the several Mexican States, and the only one with which the writer is familiar, is the representative for Western Electric telephone supplies in the Republic of Mexico, and has access to all the specifications, bulletins and data of the American Telephone and Telegraph Company. This company has established a training school for all of its employees. Books, specifications, blue prints, and other data have been prepared in Spanish, covering all the practical and theoretical phases of telephony, and the employees are required to study and practice the parts corresponding to their particular work. Formerly, foreign skilled workmen and foremen were employed, but since starting this school they have been gradually displaced by Mexicans. The foreigners did not co-operate with the Mexicans and it was difficult to get an adequate supply of them, as a practical knowledge of the Spanish language is required before it is possible to direct the natives. Salaries of the foreigners were about three times those of the natives, so there was a considerable saving when they were displaced. There are many foreigners in charge of properties who have neither the inclination, ability nor patience to educate the Mexicans to do the better grades of work, and consequently the most economical results are not obtained.

CONCESSIONS

Formerly concessions were granted by the governors of the states which usually covered telephone plants for the largest cities, and permitted the installation of plants in other cities in the same state and their connection with toll lines. A federal concession must be obtained before interstate communications can be given. In recent years the Federal Government granted individual concessions to connect Mexico City with the large cities in the surrounding states, but the Government always retained control of these lines. All of the commercial telegraph lines of the country are owned and operated by the Federal Government, and to avoid competition, very few long distance telephone concessions are granted. Long distance service will never be very extensive, due to the great distances between important cities, and the failure of small cities to serve as feeders. The business transacted between the various large cities is small, and consequently there is little demand for telephone service. The high cost of construction and maintenance tends to make the investment unprofitable.

DEVELOPMENT

The telephone field of Mexico cannot be compared with the fertile telephone field of the United States. A sound and stable government must first be established; there must be a large immigration of thrifty, hard-working, intelligent people; capital must be interested for developing the natural resources of the country and for building industries; tourist travel, and export and import trade must be encouraged; and a better and more extensive school system must be founded. Then the people must be educated to the necessities and convenience of telephone service so as to create a proper demand for it.

In estimating the telephone development of any city or community, it is first necessary to reject about sixty per cent of the total population as non-telephone users, and to base the development study on the remaining forty per cent. The rejected part is made up of the poor, illiterate, peon class who cannot afford to pay for telephone service and really have no use for it. The population of Mexican cities does not change very much, but in estimating the development, it is necessary to determine carefully the number of people who can afford to pay for telephone service and then to base the increase in telephones, from year to year, upon the efforts put forth to induce and to educate them to use the telephone.

A telephone exchange will very rarely be found in a Mexican city of a population less than 10,000 inhabitants. There are a number of reasons for this. Cities of this size cover but a very little area, and the few people who can afford to pay for telephone service are located principally around the main plaza of the city. The distances are very short, time is no object, and then there is the ever-ready *criada* (servant) or *mozo* (porter) to carry notes or messages. These smaller cities usually have private lines connecting haciendas with the homes of their owners in the cities.

Americans have recommended and have tried to introduce the automatic telephone in Mexico. About fifteen per cent of the Mexican people, who can read and write, could operate the automatic telephone, but the remaining eighty-five per cent would be excluded, not knowing how to read numbers. The manual system is at the service of all the people, for the illiterate can inform the operators of the names of the persons with whom they wish to speak. This is only one instance of the great many unsuitable things recommended by foreigners who are not familiar with the customs, conditions and requirements of the Mexicans. Americans, in particular, show this weakness. Americans feel that every country should have all things done as they are done in the United States, while Europeans succeed in their relations and trade with foreigners because they study the desires and characteristics of the foreigners and cater to them.

OPERATION

Good telephone service depends not only upon a well maintained plant and a well trained operating force, but also upon the proper use of the apparatus by the public. Some very peculiar customs were employed by the Mexican public in the smaller cities. Just to give an idea of one of them the following is related: when a person wished a telephone connection on a magneto instrument he would ring the central, but would not remove the receiver from the hook until the operator rang back. He would then give the operator the person's name (not number) with whom he wished to speak, but before doing so, he would pass the usual friendly remarks with her. He would then hang up the receiver and go about his business until the bell rang again, when he would go to the telephone, give a long ring, remove the receiver and say "listo" (ready). It was difficult to train the public to answer the telephone promptly when the bell rang. These and many other customs tended to retard the service. But the general and correct use of the telephone by the Mexican public will come only by a gradual education of the people, and, although slow, still a continual improvement has been noticed. Many Americans have failed in Mexico by trying to revolutionize customs that have been in use for hundreds of years and which, perhaps, suited the temperament and ideas of the natives better than the foreign customs imposed upon them.

Mexican operators are faithful, courteous and obliging, and the service rendered in the large Mexican cities compares very favorably with the best service in large American cities.

MAINTENANCE

It costs no more to maintain telephone properties in Mexico than in the United States. In this country the telephone companies have the snow and sleet storms, cyclones and floods to contend with, while in Mexico there are revolutions, tropical rains and earth-quakes. Still, the losses in Mexico caused by the elements are very small. In the tropical coast cities, the great humidity and salt in the air attack everything made of metal which is not properly protected. The heat is so intense that it softens the rubber cover on the wires, causing the insulation resistance quickly to break down. The stand storms accompanying the severe "Northers" pit the wires and cables and the sand entering the jacks and other equipment causes their rapid deterioration. The Western Electric Company, in order to make moisture-proof, all apparatus, coils, relays, etc. that are to be used in the tropics gives them special treatment and materially reduces the cost of maintenance. None of these difficulties is experienced in the cities on the plateau.

CONSTRUCTION

There is no uniform class of telephone construction in the Republic of Mexico as is found in the Bell Telephone Companies in the United States. While the Mexican Telephone and Telegraph Company has adopted the specifications, apparatus and material of the American Telephone and Telegraph Company, still it is frequently necessary to deviate from such specifications to meet new conditions.

Construction work, under the supervision of German and Swedish engineers, is very often of an entirely distinct character, and quite foreign to any used in this country today. German engineers never used conduit, but instead lay the armoured cables in the earth. This class of construction is considered neither advisable, convenient nor economical by American engineers, as it is necessary to tear up the streets each time a new cable is laid, or when changes and repairs are to be made to the existing cables. Undoubtedly the first cost is less, but the cost of operation, maintenance and extensions is much greater than when conduit is used. Swedish engineers use a type of conduit construction quite different from that now employed in this country. Concrete ducts made up in single and multi-duct forms are laid in the earth without any concrete foundation or encasement. Some multi-duct sections, weighing several hundred pounds, have been laid in trenches with soft bottoms and without concrete foundations. While the various sections of duct fit together in bell-shaped joints, still it is evident how easily the sections can settle and fall out of alignment, thus making it difficult or impossible to pull cable into or out of them.

The Mexican Telephone and Telegraph Company uses the same class of conduit construction as that employed by the American Telephone and Telegraph Company, viz., vitrified clay duct laid in an encasement of concrete. When this Company was installing conduit in Mexico City, the writer had some very interesting experiences. Mexico City is located upon the bed of an old lake, and in digging two or three feet below the surface, water is encountered. In some of the trenches old Aztec idols and pottery were found, and in other trenches skeletons were very often unearthed, indicating an abandoned cemetery such as was always connected with the churches and monasteries of ancient Mexico. Foundations of solid masonry, several feet in thickness, perhaps the remains of old Aztec temples, were frequently uncovered.

None of the Mexican cities have alleys, so it is necessary to place all of the poles in the streets, which are usually narrow and winding. It is impossible to find a native wood pole that will stand the tropical conditions for any great length of time, four to six years being their normal life. The wood is spongy and soft and the decay is rapid, because the fungi having plenty of light, heat and moisture to encourage their destructive work during all of the year, there being no frost in the ground to retard their action. Wood poles have been imported from the United States and Sweden with better results, but the cost of such poles makes their general use prohibitive. The base, gains and tops of the native poles have been treated with preservatives with some success. Creosoted poles have been used with good results, although such poles are not suitable for city construction, as the oil leaching out in the hot sun ruins clothes which come into contact with them.

Due to the poor results obtained from wood poles, iron poles have been adopted in practically all of the large cities. Most of the city ordinances now specify that only iron poles shall be set in the principal business and residential sections. Iron cross-arms are generally used with iron poles, resulting in a neat and substantial construction, although the first cost is very high. Wooden cross-arms are usually treated or given two coats of paint.

Underground and aerial cable construction is about the same as that of the United States, excepting the armoured cable used by the Germans, and referred to above. Galvanized iron wire is used generally for the conductivity is not important on account of the short talking distances. Copper wire costs too much, and the temptation to steal it is so great that wherever used it is constantly being displaced. Fairly good results are obtained from the better grades of galvanized iron wire used on the plateau where the warm, dry air operates in its favor. Iron wire is also used in all of the long distance lines with good results. The principal trouble is not with the wire, but with the poor joints where wires are spliced by the workmen. Rubber covered and insulated wires are used for drop wires, bridle wires and inside installations. Copper clad wire has been experimented with, but with only a little success. Native workmen are not careful enough in handling it, and very often the copper covering is broken, thus exposing the iron beneath and resulting in a life equal to that of iron wire. Phosphor-bronze wire is also used, but only to a very limited extent.

CENTRAL OFFICE EQUIPMENT AND APPARATUS

Mexico City is the only multi-office city in the Republic. The eight principal suburbs in the Federal District all have exchanges with trunk connections with the offices in Mexico City proper. Central energy equipment is also installed in the largest cities outside of the Federal District, but magneto equipment is still used in the other cities.

The cost of labor in Mexico is from one-third to one-half the cost of labor in the United States. The cost of materials is higher, due to the duties and high freight charges for the long hauls, as all of the manufactured materials are imported. For the same class of service, telephone rates compare favorably with those in the United States, and until the revolution unsettled business and commerce, the net earnings on the investments were very satisfactory.

CONCLUSION

In conclusion it might be said, that Mexico is a virgin telephone field, full of possibilities, and of exceedingly great interest to an American. The field is a broader one than operating or constructing telephone properties in the United States, where men with expert knowledge of commercial and technical matters are close at hand for consultation, methods are standardized, skilled labor is plentiful, materials are close at hand, an enlightened and progressive people are educated to and aware of the necessities and possibilities of telephone service, and where the customs, language and laws of the country are understood.

In order to operate and direct telephone enterprises successfully in Mexico, it is not only necessary to know the telephone industry in all its details, but it is also necessary to observe closely the customs and requirements of a foreign people, and to be versatile enough to adapt new methods to meet new conditions. Freight rates and duties must be studied, and the language, laws, methods of taxation and system of transacting business must be learned. Tact must be used so as not to hurt the pride of a sensitive people, and their ideas and institutions must be respected. The public must be educated to the necessities and conveniences of telephone service, and everyone in the company's organization must be educated and trained in order that the enterprise might be operated economically and efficiently. There must be met in competition the brains and ability of foreigners from other nations, and the ability and dignity of Americans must be upheld.

SEWAGE DISPOSAL AT HOUSTON, TEXAS

E. E. Sands, c. '00, C. E. '06
City Engineer, Houston, Texas [1]

Sewage disposal as practiced in the United States is usually divided into three separate and distinct operations. The first is the clarification of sewage, which is usually accomplished by allowing the sewage to remain in settling tanks until from fifty to seventy per cent of the suspended matter is precipitated. The second is the oxidation of the organic matter remaining in the sewage after it passes the settling tanks. This is usually accomplished by the use of a filter bed where the sewage slowly trickles over the surface of a filtering medium in which there is proper environment for the growth of aerobic bacteria. The third step is the sterilization of the sewage or the destruction of any pathogenetic germs. This process is utilized only when the sewage is liable to contaminate the water supply of some other municipality. In the past these steps have usually been carried out in the following manner: the sewage was first run through an Imhoff tank; the effluent from the Imhoff tank was next discharged by means of a dosing chamber through a pipe system and nozzles onto the surface of a sprinkling filter; and finally the sewage was treated with either bleaching powder or chlorine gas to destroy the pathogenetic germs.

During the last few years a new method of sewage disposal has been studied by investigators in the United States, England and Canada. This method, known as the "activated sludge process," can more easily be understood if the original experiments leading up to the discovery of the process are briefly outlined. For many years investigators endeavored to oxidize sewage by forcing air into it by means of various appliances. Generally these experiments were failures for the simple reason that the attempt was made to oxidize the sewage by direct application of air to organic matter at normal

[1] Member, American Society of Civil Engineers and American Society of Municipal Improvements.

temperatures. Later investigations have proved that such oxidization can be accomplished only by bacterial action. One investigator, however, after continuing to aerate a bottle of sewage for several days, found that when the air was shut off after a long period of aeration, the suspended matter in the sewage rapidly settled to the bottom, the only other visible change being a slight change in color. He then drew off the clear liquor, added a fresh supply of sewage, and continued the aeration. This time it was found that it was not necessary to aerate for as great length of time as formerly and that when the air was finally shut off the suspended matter settled to the bottom quickly, the liquor in the upper part of the bottle remaining odorless and colorless. After drawing off the supernatant liquid again, a fresh supply of sewage was added. With each addition of sewage the amount of suspended mater in the bottle gradually increased, and as it increased in volume and as the length of time it had been aerated increased it was found that this suspended organic matter assumed an entirely different character. Instead of being raw organic solids, it now consisted for all practical purposes of colonies of aerobic bacteria. This organic matter, which was called "activated sludge," became itself a purifying agency and took the place of the filter medium.

Various investigators immediately took hold of this problem and attempted to design a system for operation on a large scale. Designs were prepared for both fill-and-draw tanks and for continuous flow tanks. A series of experiments were conducted at Houston, Texas, on both a continuous flow and a fill-and-draw tank, the results of which experiments are briefly outlined as follows:

In order to utilize standard blowers, a tank ten feet deep was used. The amount of sludge to be mixed with the sewage while it is being treated may be between twenty and thirty per cent. The amount of air per square foot of tank surface should be one quarter of a cubic foot per minute. The air can best be supplied to the tank through porous plates, twelve inches square, made out of a material called "Filtros."

	Crude	1 Hour		2 Hours		3 Hours		4 Hours	
	P. P. M.	P. P. M.	% Removal	P.P.M.	% R	P.P.M.	% R.	P.P.M.	% R.
Total Organic Nitrogen	5.5	2.0	64	1.9	65	1.87	66	1.8	67
Free Ammonia	6.32	2.5	60	1.44	82	0.63	90	0.32	95
Total Organic Matter	299	137	40	134	41	134	41	129	44
Oxygen Consumed	139	18	87	17	88	15	89	14	90
Dissolved Oxygen Consumed	103	3	97	2	98	2	98	2	98
Suspended Matter	253	5	98	5	98	5	98	4	98
Nitrites and Nitrates	Trace	4		8		10		11	
	Per C. C.	Per C. C.		P. C.C.		Per C. C.		Per C. C.	
Bacteria	2,800,000	176,000	93.7	118,000	95.8	117,000	95.8	116,500	

Percentage of sludge for operation, 25-30 per cent.
Tank depth, 7 ft., 6 in.
Amount of free air per minute, 3.06 cu. ft.
Area of water surface, 12.25 sq. ft.
Amount of free air per minute per sq. ft. surface, 0.25.

Amount raw sewage at each filling, 420 gals.
Cubic feet free air per gallon sewage treated per hour, 0.437.
Square feet tank surface per sq. ft. Filtros, 12.25.
Number of operations for one filling, 4.

When the design is such that one plate supplies not more than twelve square feet of tank surface, it is found that a clear and satisfactory effluent can be secured after one hour of aeration, but if the air is shut off, the clear liquid tapped off, and new sewage added each hour, the sludge will not have secured sufficient aeration to activate it thoroughly. Consequently the plan we have adopted at Houston is to aerate the mixture of raw sewage and sludge for one hour and fifty minutes. The sewage is then run into settling tanks where it is allowed to settle for forty-five minutes. The sludge that settles to the bottom is pumped out of the settling tanks by air lifts and put into tanks where it is re-aerated for two hours and forty minutes longer, after which time it is in proper condition to be mixed with the fresh sewage received at the plant. The record of a small fill and draw plant obtained at the Houston Experimental Plant is shown in the table on page 218.

Houston has a population estimated at 140,000. Running in a general east and west direction through the city is a stream known as Buffalo River, the bottom width of which is 80 ft. and which is maintained by the city at a depth of 8 feet for light draft vessels. The entire drainage area of Buffalo River is only slightly more than 300 square miles, so that for long periods during the summer months there is no perceptible flow in the channel. Consequently the sewage from the city of Houston has polluted the waters until they are dark in color and the gases arising from the surface are very offensive. The topography at Houston is such that all sewage must be pumped and part of it pumped twice. With the exception of a narrow valley along the river, the remainder of the city and the surrounding territory is very flat, the lowest elevation being 35 feet above sea level and the highest elevation 50. The larger part of the city lies between an elevation of 40 and 45 feet. The average rate of flow per person is 85 gallons per day; the maximum rate is 104 and the minimum 59. The minimum flow occurs about three in the morning and the maximum flow from ten thirty until noon. All the sanitary sewers in the city are on a very flat grade and the sewage received at the pumping plants is stale. Storm water is handled by a separate system.

On account of the construction of large mains and collecting systems prior to the time the writer was placed in charge of this work it was necessary to build two disposal plants, one known as the North Side Plant and the other as the South Side Plant. It so happens that the flow that can be diverted to the North Side Plant is almost exactly twice the volume that can ever be served by the South Side Plant. The sewage that will flow to the former is received at a pumping station located on the north side of the river close to the geographical center of the city. At this point we have installed coarse screens and a grit chamber. After flowing through the grit chamber, the sewage is pumped by three centrifugal pumps, each having a capacity of 4,100 gallons per minute. The lift is 22 feet, and from the upper end of the discharge pipe the sewage will flow by gravity a distance of 14,000 feet to the North Side disposal plant. In the south-eastern part of the city there is a pumping plant where the sewage will be elevated 25 feet to the disposal plant.

The North Side Plant will consist of four units and the South Side Plant two units, each unit being capable of handling the sewage for 37,100 persons, or an average flow of 2,190 gallons per minute. Each aerating tank is 18 feet wide and 280 feet long. After flowing through these aerating tanks, the sewage will flow across a settling tank 104 feet wide and 19 feet long. The sludge will then be returned through a re-aerating tank 9 feet wide and 280 feet long. The clear liquor will be discharged into the river without further treatment. On account of the fact that the water in the river is not used for domestic purposes, sterilization is unnecessary.

The mechanical equipment at the North Side Plant consists of three Sturtevant high pressure blowers, each capable of delivering 3,750 cubic feet of air per minute at a pressure of 5¼ pounds. Two of these blowers are sufficient for the operation of the entire North Side Plant, while the other one is used only as a spare unit. One blower is driven by a constant speed 150 horsepower motor and the second by a multiple speed motor of equal capacity, the discharge of which may be either full, three-quarters or half capacity.

The third unit is driven by 150 horsepower Standard crude oil engine. The power house is equipped with a crane to be used for the repair and handling of machinery and is equipped also with louvres and muslin screens for the filtering of air. The South Side Plant is similar to the North Side Plant except that it contains two instead of three blowers, one driven by a constant speed motor and the other by a multiple speed motor. With all the sewage pumping plants and disposal plants under full load, there will be ten electric motors in operation, the power for the operation of which is purchased at a very low rate, varying from one cent to one and two-tenths cents per kilowatt hour, depending upon the monthly demand. In order to get this low rate the city guarantees a ninety per cent load factor, the object of installing the crude oil engine being to control this factor. If for any reason it becomes necessary to operate an additional motor in one of the pumping plants or to supply more air at either disposal plant this can be accomplished by starting up the oil engine, shutting down one 150 horsepower motor at the North Side Plant, and utilizing the current thus saved at any other point desired.

The disposal plants and pumping plants are under construction at this time and will be put in operation during the month of March. It is expected that for some time to come this will be the largest activated sludge plant in the world. It is quite probable, however, that the cities of Milwaukee, Cleveland, and perhaps several others will soon build plants much larger than the one we are building at Houston. It is known that a number of cities are contemplating the use of this method. Several of these cities will have to treat from forty to fifty million gallons each day, while the plants at Houston are designed for only eighteen million gallons a day.

There are many interesting technical problems in connection with the design of such a plant. The proper distribution of the air, the correct design of the settling chambers, the disposal of the surplus sludge, the manufacture of commercial fertilizer from the surplus sludge, and numerous other problems are of great interest and some of them have not been completely solved. The particular advantage of this type of sewage disposal plant may be enumerated as follows:

(1) It can be installed in any part of the city on a comparatively small area of ground. (2) There are no nuisances around the plant, that is, no objectionable odors, swarms of flies, mosquitoes or other insects. (3) The plants can be constructed for about $20,000.00 per million gallons per day capacity, which is about half the amount required for the construction of a first-class Imhoff tank and sprinkling filter plant. (4) As compared with the use of sprinkling filters, a saving of from ten to fourteen feet of head results from the use of this process. (5) It is expected that the revenue from the sale of fertilizer will partly compensate for the cost of operating the plants. (6) Due to the fact that the removal of suspended matter is greater than by other processes, the effluent from the plant is clear and sparkling.

The cost of operating such a plant as this will be relatively large, probably nine or ten dollars a million gallons treated until the plant is running at its full capacity, when this cost should drop down to five or six dollars a million gallons. The net revenue from the utilization of the sludge should be approximately three dollars a million gallons, leaving the net operating cost as low as that of any other type of plant. If the operating cost is to be kept within reasonable limits, the capacity of a plant should not be less than ten million gallons a day.

ALUMNI LETTERS

TEN YEARS OUT

A. E. Van Hagan, e. '06, E. E. '10
Traffic Engineer, Central Group Bell Telephone Co's., Chicago

IMPORTANCE OF LETTER WRITING ABILITY

Your editors have asked me to write a letter to you based on my experiences since graduation ten years ago. To be of value to student readers such a letter should present conclusions rather than experiences, unless it is possible to present the experiences in such a way that the conclusions are obvious.

It is not easy to present experiences in such a way. Try it. Review your life to date and prepare a digest that will be helpful to some one who has not gone quite so far along the road as you have. Ten years from now you will be just as reticent about disclosing your inner thoughts to a curious world. Probably you will be more reticent, for you will have discovered then, if you have not done so now, that advice is valued at its cost.

Here is something that has been impressed on me rather forcefully. It is very difficult for a graduate of an engineering school to write a good letter. It took me about two years to learn to write a technical letter that presented a subject in a logical way, that met with the approval of the chief and the various intermediate employees, and that carried conviction to the man to whom it was addressed and to his various assistants. At times I despaired of ever writing a satisfactory letter, and it was only after two years of hard work that my letters measured up to a fairly satisfactory standard. I have compared notes with other college men and find that my difficulties with letter writing have been experienced by many. Even after ten years, it is not easy for some engineers to write a letter of three hundred words.

A young engineer in a large organization is more likely to come to the attention of the executives by his letters than by oral discussions of a subject. It behooves him therefore to learn to write. In this connection, he will derive much benefit from his college course if he has given earnest attention to the theme work in English, the written reports of the laboratory experiments, his thesis work, or work on the editorial staff of the Wisconsin Engineer.

NINE YEARS OUT

A. S. Diehl, c. '07
Engineer, Oliver Iron Mining Co., Coleraine, Minn.

ENGINEERING IN THE MISSABE RANGE

Back in 1907 when I was still an undergraduate, ten years ahead seemed a far outlook, and it is very likely that I made very little speculation as to what those ten years would bring. The first essential was a job, some place to earn a living; and since I had spent two summer vacations in field work on the Western Missabe Range, I gladly accepted the opportunity to take permanent employment with the above company.

Minnesota's great iron ore source, the Missabe Range, extends practically across Itasca and St. Louis counties, trending in a general northeast-southwest direction. The portion lying in St. Louis county is characterized by its enormous tonnages of rich ore, but the ores of the western end, largely in Itasca county, are sandy and of lower grade, in many places requiring concentration to make them marketable. Early experiments demonstrated the feasibility of improving these low grade ores by suitable washings, and in 1905 the Oliver Iron Mining Company began active development of properties in the Canisteo District. At present it is operating six open pit mines and the largest iron ore concentrating plant in the country. During all development work and continuing into the operating stage, the services of engineering crews have been in constant demand. Elaborate topographic maps were prepared; the extent and tonnages of ore bodies were determined; mining plans were developed and put in operation; railroad lines were laid out and constructed for ore and stripping haulage; and a townsite was platted and dwellings erected for the company employees. This is the greater part of the development program, and now, although the district is in the active mining stage, similar work is constantly being done. Briefly summarized, that is the writer's ten year experience.

Although the Missabe Range is a mining country, little of the extensive mineralogical, metallurgical, and chemical training of the graduate mining engineer is required. A glance at the few lines above will show the preponderance of civil engineering work. Civil engineers are doing their share of it, and Wisconsin is represented by her share of civil engineers throughout the Range.

EIGHT YEARS OUT

J. E. Gillespie, c. '08
Division Engineer, Wisconsin Highway Commission, Milwaukee, Wis.

INCREASE IN THE DEMAND FOR ENGINEERING GRADUATES

My attention was recently called to the series of letters from alumni now appearing in the Wisconsin Engineer and I was invited to join the list of autobiographers and to tell about myself, my family and my work in addition to discussing my general impressions of the engineering profession and other matters of that character. It would be better to dispose of the question of my family at once by the announcement that there are no new faces to be introduced and, with the exception of a nine year increase in age, the family remains very much the same as in 1908. As for myself, I have been in the employ of the Wisconsin Highway Commission for the past five years, and at present I am located in the Stephenson Building, Milwaukee. My work consists of supervising this section of the state, for the Commission, and the state aid road and bridge work. In order to take care of the necessary surveys and plans we have an organization at this point consisting of four engineers, all of whom are Wisconsin men. Previous to going to work for the State Department I was with the Chicago & Northwestern Railway Company for three years, one-half year of which was spent in South Dakota and the remaining time in Wisconsin. While in South Dakota I had the good fortune to run across Mike Hayes, '08, and to spend a night at the Hayes Brothers construction camp on the Belle Fourche Dam. I frequently meet Walter Buetow, Herb Kuelling and Bill Ryan of the '08 crowd, owing to the fact that they are connected with the State Highway work—Buetow as division engineer at La Crosse, Kuelling as highway commissioner of Milwaukee county, and Ryan as a contractor.

As to my views regarding engineering work, I think it can be safely said that the prospects for the young engineer are brighter than they have been for some time. For the first time that I can remember since 1907 the demand for engineers in practically all kinds of work is greater than the supply. Although the salary standards in the engineering profession have not done much more than to keep pace with the general increase in other work, a young engineer who has just completed his engineering course can get a position today without any trouble whatever and at a salary which is relatively better than the average of a few years ago. The entrance of the states into the field of road and bridge construction has created a pressing demand for civil engineers, and now that the National Government has taken up the work we may be assured that highway engineering will soon claim a large percentage of the engineering graduates each year. Although the need for engineers in greater numbers will sooner or later result in an increase in the proportion of students who choose the engineering profession, I believe that the present scarcity in the engineering market will continue for some time and that it will soon result in a favorable readjustment in the rates for engineering services.

SEVEN YEARS OUT

F. A. De Boos, c. '09, C. E. '15
Manager, Johnson Service Co., Kansas City, Mo.

ROUTINE WORK, BUSINESS EXPERIENCE, AND CHARACTER

The average graduate can expect to settle down to a more or less routine existence after graduation. A reply to a recent inquiry sent out by one of our college organizations rather covers my case. The inquiry was: "What are you doing for your country?" The answer: "Eating three meals a day, giving the furnace 'Hail Columbia' every morning and night, working eight hours each day (sometimes), going to a 'movie' once or twice a week, and sleeping seldom (two babies in my family)."

At college a student's hours are arranged by schedule. He has certain set tasks, and having completed them, moves on to other problems, on schedule. He has a certain definite objective before him—graduation. Having graduated, he enters into a new life. There is no regular schedule of advancement, and the average student may look forward to a real settling down period. I do not mean that he should let himself fall into a rut, but that he should nerve himself to the daily routine which may require several years before his energy and ability produce results.

Another thing which has impressed me is the fact that a very considerable number of the engineering graduates will have but little use of their engineering knowledge. It will undoubtedly serve them as a foundation, but their occasions to draw upon specific engineering facts accumulated while at college will be few. This is because a great many do not enter strictly engineering work. One thing most all of them will have need of is a knowledge of business and business methods. It is my opinion that our college courses should include more of a training along business lines and that the students themselves, during summer vacations, or at any other available time, should endeavor to get actual experience in some kind of business. Good business experience is the one biggest asset a college graduate can have.

Another thing the college student should bear in mind is that he is in the habit forming stage, and habits formed previous to his graduation will be hard to change afterward. This applies of course to habits both good and bad. So, entirely apart from the technical side of engineering education and training, any student may build himself a good foundation in character and habits. Moreover, if he can also develop his business ability, he will find that when he takes stock of himself upon graduation, he will have a higher rank in those qualities making for success than if he had applied himself entirely to the technical problems. To form some basis for a comparison of these qualities which make for success, it might be well to study the report of the Committee on Engineering Education of the American Society of Civil Engineers which has made an interesting attempt to ascertain the essentials of a successful engineer and how they are measured. The committee is assisting the Carnegie Foundation in this investigation, and Professor C. R. Mann, of the latter organization, made a short talk before the annual meeting of the association at its meeting in New York recently. Last spring, in response to questions on these points sent out to practicing engineers, 1,500 replies were received. These were carefully studied and from them were compiled the following composite opinion of the relative values of the attributes. Before accepting this rating, however, another set of questions will be sent out which will either confirm or refute the figures already obtained. These figures from the Engineering Record are:

1. Character, including integrity, responsibility, resourcefulness, initiative	41.0	
2. Judgment, including common sense, scientific attitude, perspectve	17.5	
3. Efficiency, including thoroughness, accuracy, industry	14.5	
4. Understanding of men, executive ability	14.0	
	——	87.0
5. Knowledge of the fundamentals of engineering science	7.0	
6. Technique of practice and of business	6.0	
	——	13.0

As Professor Mann pointed out, if technical ability is worth only 13 per cent, technical education should be radically changed.

The exceedingly great importance placed upon character is another matter of note. It is rated as great or greater than any other two attributes.

SIX YEARS OUT

W. F. LENT, e. '10, E. E. '11
Engineer, Cutler Hammer Mfg. Co., Milwaukee, Wis.

NARROWNESS IN ENGINEERING

If a freshman or sophomore in an engineering course would ask me for advice, I would say to get all the "culture" study you can; if a junior or a senior, get all of the commerce training you can; if a new graduate, get the idea out of your head that you are a finished product.

The product of the engineering school is all too narrow; he knows a little of Ohm's Law or has a smattering of the properties of superheated steam, but what does he know of the principles of political economy or economics or business? I believe that what electives are offered to members of the first two classes can well be chosen in the College of Letters and Science and of the last two in the School of Commerce.

The modern engineer is being called upon more and more to exercise more than purely technical functions. Hence the broader his training, the greater his chances for success; the greater his knowledge of the fundamentals of business, the more successfully can he cope with his problems. The technical training of the engineer should be on fundamental principles and general application to the subject. There is time enough for specialization later.

The recent engineering graduate should realize that he is prepared by his college training only to *learn* to be useful to his employer. The sooner he realizes this, the more quickly can he increase his usefulness and hence his earning capacity. Much latent ability has been retarded in its development by a failure to appreciate this fact.

FIVE YEARS OUT

B. E. MILLER, e. '11
With Railroad Commission of Wisconsin, Madison, Wis.

THE IMPORTANCE OF THE PROPER SELECTION OF ONE'S POSITION

The greater part of my "five years out" has been spent in close contact with the student body and younger graduates. I am convinced from the conversations and the correspondence which I have had with the latter that too many of them are dissatisfied with their positions. I would not say that the majority are dissatisfied, but there are too many that are. In practically all of the cases which I have observed the graduate had been a fair to a good student and was from all appearances capable of handling the position he occupied. There was a lack of interest, however, on his part, which usually developed into indifference or utter disgust for his work. As many of these cases have occurred among our better students, I am lead to believe that it is a case of a man at the wrong job. Too many of our seniors fail to place themselves on the "box" in an effort to determine whether they are adapted to the position under consideration. Too often the man is influenced by a slight advantage in salary or the word of some fellow student or instructor. I have in mind a senior who had all the "ear marks" of an excellent salesman; but influenced by an attractive initial salary he accepted a position in the traffic department of a large telephone company. His duties have to do with the routine work of telephone operators. It is not necessary to comment on the fact that he is disgusted with his work. Another student, one of the best men in his class, a leader among his classmates, and with all the characteristics of an executive, accepted a position in the statistical department of a large organization. Should we be surprised when he says that he is looking for a real job? I wish to say to all seniors in regard to prospective positions—go slow, and be sure that you are adapted to the position you accept.

FOUR YEARS OUT

ELMER E. BROWNING, JR., e. '12
With the American Telephone & Telegraph Co., New York City

IMPORTANCE OF ENGLISH TO ENGINEERS

Immediately after leaving college I secured a position as apprentice in the traffic department of the American Telephone and Telegraph Company. The apprenticeship course covered six months, during which time I was given experience in several different branches of the business, such as in pole line construction, central office equipment, installation and maintenance, telephone operation, and the preparation of the various traffic reports. After completing the course, I was assigned to the Cincinnati office as assistant to the district traffic manager of the Cincinnati district.

This was the first real job I held with the company, and in conection with it I can say with strictest accuracy that I was initiated into the work with fire and water, the district headquarters having been burned out twice during the first month of my assignment to the office, and the Ohio floods of March, 1913, having occurred during the third month. The company seemed satisfied that I had passed the "acid test" creditably and I was transferred in May, 1913 to a similar position in the Chicago office. I held this position until March, 1915, when I was then transferred to a supervisory position in the division headquarters in New York. My work at the present time is of an administrative and supervisory nature.

It has been my observation during the past four years that advancement to executive positions in the larger business organizations depends fully as much on broad general knowledge as on technical knowledge of the fundamentals of a business. For this reason I would advise any young man who pursues an engineering course at a university to pay particular attention to the acquirement of general knowledge of English, economics, business management, and commercial law. Technical knowledge is important in that it constitutes the basis for acquiring engineering sense, but there is a tendency on the part of engineering students to subordinate all other branches of learning to the technical work. This, I feel, should be guarded against. For this reason the six year course has, in my opinion, decided advantages over the four year course in preparing students to reach the higher executive positions. Much can be done, however, by students in any four year course by making judicious use of their time and taking more seriously certain courses now included in the curriculum.

I have included English in the list of general subjects because it has been my experience that a good working knowledge of English is of prime importance. This is true especially in large organizations where ideas are of little value until passed upon by superiors and one of the first steps in putting an idea into effect must, of necessity, be to reduce it to writing. Thus, engineering students should not make the mistake of belittling the study of English but should, rather, bend every effort toward acquiring the ability to express their thoughts in clear, accurate and concise English.

These thoughts have been emphasized again and again in my business experience, and I cannot commend too strongly their careful consideration by undergraduates.

THREE YEARS OUT

S. D. Wonders, c. '13
Statistician, A. M. Byers & Co., Pittsburg, Pa.

THE FUTURE FOR ENGINEERS IN BUSINESS

The line of demarcation that once existed between the professions of engineering and accounting is no longer clearly marked. The new science of industrial management has opened a field where accountants with an engineering training and engineers with a knowledge of accountancy are equally valuable. The increasing drift of young engineers away from the work that they studied in college proves that business men are endeavoring to avail themselves of the services of technically trained employees.

A statistical study of the present occupation of the 1913 class of civil engineers brings forth these facts: out of thirty-nine men, twenty-six were listed as engineers in the 1916 directory, four as salesmen, three as teachers, and one each as contractor, editor and efficiency engineer, with the occupation of three unknown. These figures show that three years after graduation, about sixty-seven per cent. are still following civil engineering. Statistics for other classes covering longer periods demonstrate that this percentage tends to decrease with the length of time after graduation.

Several factors lead to the success of the engineer in business. Perhaps the most important of these is breadth of vision. College training, if it has done for him as much as it should, has given him proper perspective and has stimulated his imaginative powers. Judgment, perception, and the ability to think clearly and accurately are other characteristics he must possess. Finally, his knowledge of mathematics and the principles of drawing enable him to present data clearly and graphically to his employer.

In the attempt to supply the demand for properly trained men, a number of engineering schools are now giving courses in industrial management from which much good is undoubtedly derived. The important thing, however, is not the studies that are pursued in college, but the qualities of mind that the graduate pcssesses. The instructor who can help to remove the narrowness of mind and the *clannishness* that exists among so many engineers toward outsiders with whom they come in contact, will do more for his classes than the man who drums into them an exact knowledge of some certain phase of engineering.

TWO YEARS OUT

C. M. Osterheld, e. '14
Superintendent, Municipal Electric Light System, Stoughton, Wis.

VERSATILITY IN ENGINEERING

You probably think that you are kept out of mischief by the constant efforts of untiring profs; your predecessors thought so too, but we find that there is a lot of work to be done off the campus; and there's lots of joy in doing it too.

Since leaving school the writer has been in charge of a lighting system that now supplies a thousand meters, each of which demands that current be supplied at all times just as your prof endeavors to keep you humping while in his class room. One of the things the old guard noticed in the engineering college was that no matter how faithful a man was, nor how well he handled his work, he always felt there were some frayed ends to be gathered up. We used to feel that our work was never done; that as soon as we properly satisfied the demands in one class room we went immediately to another where we again had to give good work of an entirely different nature. This is as it should be; the training in versatility is what we need. This marks the difference between the capable man and the "sweat." On a large job one of the boys quit the other day because another boss in the same firm asked him to do a little job for him. "Too many bosses," he replied as he put on his sweater and took his time. We believe no Wisconsin engineer will ever come out with a disposition like that.

In regard to my own work I wish to say that central station work appeals to us greatly for there is always a demand for one's best effort and an opportunity to advance. Last fall we put in two new dams with tainter gates, making it possible in this way to control the water more easily, while formerly a flash board dam was unable to care for the water in a flood. We also had an interesting problem in street lighting. Due to the relatively small capacity of our machines the 50 KW single phase constant current transformer caused bad phase unbalancing on our three phase lines. If the phases were balanced for ordinary times they would be decidedly unbalanced on moonlight nights when the arcs were off. This difficulty was finally overcome by using multiple nitrogen lamps with commercial transformers. The lamps were lighted by having the current turned on by means of automatic switches which were connected to the old arc circuit. Thus all the lights came on at once and the load was carried on all three phases.

Another thing that an undergraduate does not appreciate is that if he is a mechanical engineer he should take a good hard course in electrical engineering, and vice versa. Also when he first gets out he will hear a lot about the practical man. The fact that you had theoretical training should make you more practical. Never give up theoretical investigation altogether. If you do, you're a dead engineer. If any of you remember "Ostie" accept his best; and if any of you are hard up for a thesis subject drop down and we'll talk the matter over.

ONE YEAR OUT

MICHAEL AGAZIM, m '15

STICKING TO ONE POSITION

In answering your request to represent the class "one year out," I do not presume to state correctly the feelings of my classmates, but must give more or less my own impressions and observations. It is only impressions and observations which I can record, since interesting experiences, that is, experiences connected with the task of earning a living, have been very, very few.

For most of the one-year men, the time since graduation has been spent in absorbing good solid knocks, for although a few were lucky enough to step into fairly good positions, most of them have started at the bottom of the struggling heap, a few, I suppose have been able to obtain a fairly good share of the "golden harvest," while others have been content to sacrifice some of their money to obtain that indispensable requirement known as experience. One of the hardest things to assimilate at first is the apparent fact that one is obliged to start in on the same plane as the untrained man, when one feels himself capable of handling much larger things. Some have remained in their original positions, hoping to earn promotion by loyal steady service, while others have improved their condition by changing from one job to another. Although changing positions is advantageous as concerns the acquirement of new and varied experience, this practice may become very detrimental if carried too far since, as we all know, there are certain ethical standards in this matter which are rigidly upheld by the average employer.

There cannot be a much more pleasant experience than to run into a classmate unexpectedly. To meet a Wisconsin man is always a pleasure, while meeting a classmate is like running into a long-lost brother.

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EDITORIAL

When a course is taught by a professor, the correctness of his teaching principles are very rarely questioned. Nevertheless, when a subject is taught merely by lectures, without recitations or text-book, without quizzes or reports bearing directly on the subject at hand, without even reference books—merely lectures which are to be followed *without* notes—and then a comprehensive exposition on the subject matter covered in the months of October and November is wanted on the final examination, who is to blame for the low grades that inevitably follow? To give one a final grade based entirely upon the final examination is a most acrimonious showing of narrow-mindedness, of unfairness and dogmatism, so detrimental as to refuse either explanation or further discussion. Such courses should not exist. A course given under such lax management should not be tolerated. When there are no textbooks, no notes, no reports, no recitations, merely lectures on a subject of supposedly wide scientific application, there is something radically wrong. There is need for a decidedly thorough overhauling.

* * *

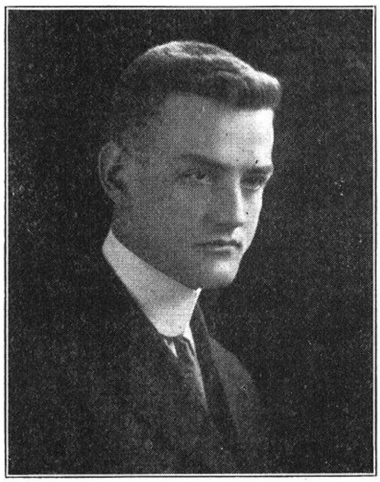
It has been the policy of one of our machine design courses to grade a problem entirely upon the final answer and avoid consideration of the method of calculation. Each succeeding class has denounced this policy most thoroughly and has brought up the question of the intrinsic purpose of this procedure.

Accuracy in engineering, far more than in any other field, is extremely important. Consider the effect on a designer's reputation of a crankshaft built with a factor of safety of seven-tenths instead of seven, simply due to a misplaced decimal point. Consider the value of the correctness of method relative to final results in quantitative analysis. Carelessness in computation is merely a habit, and it is in appreciation of the importance of accuracy that the Department of Machine Design does pursue this policy. If several other departments in the engineering school were to appreciate the value of accurate careful work the graduate would find that he has acquired a most valuable asset for future work.

MATHIAS J. KLINE

December 10, 1890–October 27, 1916.

An acute attack of erysipelas caused the sudden death of Mathias J. Kline C '14, in a hospital of Marquette, Michigan. The deceased was twenty-six years of age. He was born in Kaukauna, Wisconsin, December 10, 1890, and lived in that community up to the time of entering college. Upon graduating from St. Mary's parish school he entered the Kaukauna High School, graduated with honors with the class of 1910, and then took a two years civil engineering course at Lawrence college, Appleton. He further pursued the study of engineering here at Madison, receiving the C. E. degree at the completion of a three years course in June, 1914.



After graduation he visited at his home for several weeks and on August 1, 1914, began working for the United States interstate commerce commission in the estimation of the physical valuation of the railroads of the country. He was engaged in this work when the fatal illness overtook him. Mr. Kline's many friends mourn his death as they saw in him a young man of promise, who by reason of his native ability and education seemed to have before him a bright future, which death cut short.

LEO RICHARD WHEELER

February 25, 1893—August 30, 1916.

Leo R. Wheeler, c '15, eldest son of Mr. and Mrs. John Wheeler of Geneva, Illinois, died at the Colonial Hospital on the morning of August 30, 1916, after an illness of four days. News of his death comes as a severe shock not only to the relatives, but to the large circle of friends of this estimable young man. Several days before his death he went to Geneva from Maywood, where he had been working on the staff of the State Highway Engineers, stating that he was ill and needed medical attention. His illness was at once diagnosed as appendicitis and an operation was performed the next day. He rapidly grew worse however and a few days later complications set in which resulted in his death.

Leo Wheeler was born in Chicago twenty-three years ago but soon afterwards his family moved to Geneva where practically all of the remainder of his life was spent. He graduated from the Geneva High School with the class of 1910 and entered the University the next September. Upon graduation he assisted his father on a number of construction jobs including several large concrete bridges and during the last few months prior to his death had been employed on the staff of civil engineers for the state of Illinois.

That the life of a young man of Wheeler's capability should be taken just at the time when his life plans were beginning to materialize, seems almost unfair, and it is with remorse that the class of 1915 pay their last respects to Leo R. Wheeler.

CAMPUS NOTES

On Wednesday evening, January 17, Professor Kahlenberg gave a lecture before the Wisconsin Section of the American Chemical Society on the results of some of his studies of cellulose. He has found that an exceedingly concentrated solution of ferric chloride obtained by melting the salt in its crystal water acts as a solvent for cellulose. Hydro-celluloses are first formed which are then gradually converted into glucose. Ferric chloride solutions of this nature readily dissolve the simple celluloses like paper and cotton; starch, however, is practically unattacked by this reagent, which gives the possibility of separating starch from cellulose. Quantitative investigation of this separation is now in progress.

So far as the compound celluloses are concerned, as we have them in various woods, straws, and other vegetable fibers, the solvent extracts the cellulose, leaving an insoluble residue. This has made possible the determination of the cellulose content of these compound celluloses. Professor Kahlenberg presented a large amount of data on the various woods, straws, nut shells, and other materials, showing the cellulose content. Thus far the barks of woods examined have indicated that they contain no cellulose. Further study of the insoluble residues from various compound celluloses is being conducted in the laboratory.

* * *

Commercial Mechanical Engineering 103 will be offered in a somewhat modified form this semester. The procedure in the promotion, organization, and operation of an imaginary engineering industrial organization will serve to co-ordinate a series of synopses dealing with economic and technical subjects contributory to such development. Among these may be noted: preliminary engineering reports, financing of new enterprises, the relation of such interprises to banks, forms of organization, manufacturing sites, physical layout and routing, efficiency methods, remuneration of labor, and housing. Lecturers from outside the engineering college will be secured when desirable and possible. The course is elective, and will be given by Professors Callan and Mack.

* * *

Mr. Kennedy has resigned his position as instructor in Mining and Metallurgy to become associated with John A. Salvage & Company of Duluth, mine operators and shippers of iron ore. Mr. Kennedy will become assistant to the general manager.

* * *

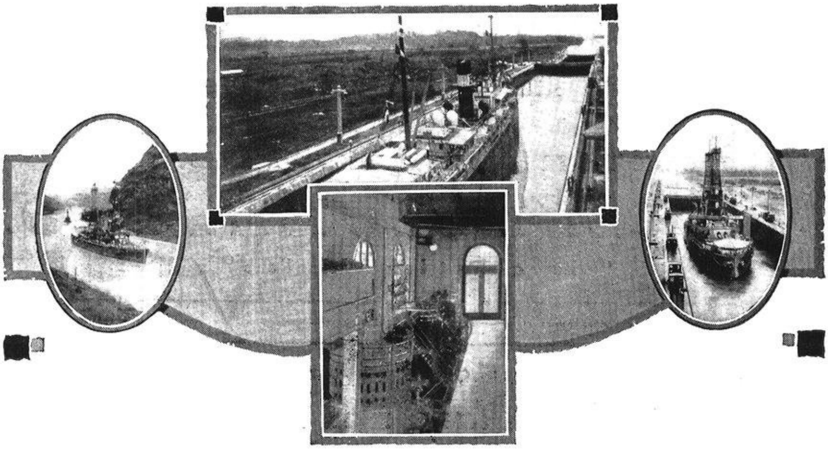
Mr. E. O. Lange, instructor in Electrical Engineering, married Miss Jessie Thompson of Fond du Lac, January 1.

* * *

Professor D. W. Mead on Tuesday, January 16, gave a lecture upon the problem of flood control. Professor Mead has given a great deal of attention to this subject, particularly with reference to the conditions at Dayton and those of the famous Yellow River in China.

* * *

Mr. Charles R. Underhill, engineer for the Acme Wire Company, gave an interesting lecture, January 18, on the electromagnet. Mr. Underhill's work has covered everything from the design of bell windings to that of lifting magnets, which are now so widely used in handling ferrous metals.



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