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KNIGHT MOTOR ADVANTAGES.

ROBERT B. WHITE, '18.

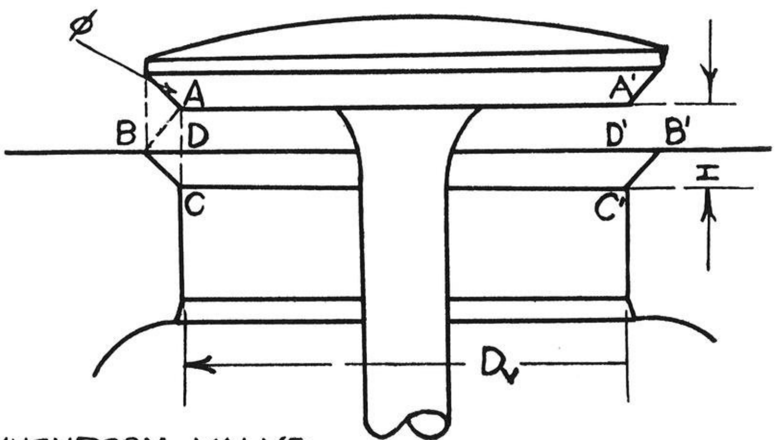
Readers of THE WISCONSIN ENGINEER will remember Mr. White's article in the March, 1915, issue, on the advantages of the eight cylinder motor, an article which was very timely, in view of several announcements of motors of this type. This article follows the announcement of the adoption of the Knight motor by two of the large American car manufacturers, and will therefore be of especial timeliness— EDITOR.

With the remarkable advancement in popularity of the sleeve valve motor the question frequently has been raised as to the actual advantages of this type of motor construction over the poppet valve motor. This question has been made especially pertinent by the adoption of the Knight motor by the Willys-Overland Company and by the announcement of the new Stearns-Knight-Eight. The writer shall endeavor to prove in successive steps, certain advantages, which are substantially as follows: a larger valve-port capacity, higher velocity and positive character of the valve-actuation, thermal and volumetric efficiency gains through the medium of the hemispherical combustion chamber, and the smoothness and the silence of the motor as a whole. These advantages result in a far greater power output and a steeper power curve for a given piston displacement.

In a comparison of the relative valve capacities of the sleeve valve motors and the average poppet valve motor, it may be of value to depict a motor whose port capacity may be calculated and to find the equivalent valve orifice diameters of a poppet valve motor of equal bore. Inasmuch as the exhaust-and-intake area graphs of the sleeve valve motor are known to be practically isosceles triangles, the legs of which are equivalently convex and concave, we may assume that the average height of exhaust port opening is .205 in. if, as in the new Willys motor, the port height is .410 in. Bearing in mind that the circumferential exhaust port length is 3.75 in. and that the exhaust port opening extends throughout 225 degrees of crankshaft travel, the valve port capacity may readily be computed, thus:

$$3.75 \text{ in.} \times .205 \text{ in.} \times 225^\circ = 172.96 \text{ square-inch-degrees.}$$

In order to learn the valve orifice diameters which would be necessary to equal this port capacity, several assumptions must be made. As is customary in the design of valves, the lift should be assumed to be approximately one fifth the diameter of the valve throat, and we may also assume that during the 225 degree period of valve opening the valve is actuated with constant acceleration and deceleration through 85 degrees of the crankshaft travel, leaving only 140 degrees duration of full



MUSHROOM VALVE.

opening. Under these conditions, therefore, the area of the valve opening must be 172.96/140 or 1.735 sq. in.

To continue in the derivation of the valve diameter of a motor of this kind, let us next derive a formula for the opening area of the ordinary mushroom type of valve. By referring to the diagram, it will be recognized that

$$AB = AC.\cos BAD = H.\cos \phi \quad (1)$$

and that $$BD = AB.\cos ABD = AB.\sin \phi \quad (2)$$

whence $$BD = H.\cos \phi.\sin \phi \quad (3)$$

and also that $$BB' = D_v + 2\,H \cos \phi \sin \phi \quad (4)$$

Then with the formula for the lateral area of a truncated cone the opening area, (A_c), will be found by substitution, thus:

$\pi[BB' + AA']/2.BC = \pi[2D_v + 2H.\cos\phi \sin\phi]/2.H \cos\phi$

Then $A_c = \pi[D_v.H \cos\phi + H^2 \cos^2\phi \sin\phi]$ (6)

$A_c = \pi[D_v.H.707 + H^2.353]$, when $\phi = 45$ degrees. (7)

As aforesaid, H is equal to $D_v/5$, which when substituted in equation (7) becomes

$$A_c = \pi[D_v^2/5. .707 + .353\, D_v^2/25] = .484\, D_v^2$$

Known A_c, the diameter of the valve may readily be derived with this equation known, in this manner

$$.484\, D_v^2 = 1.735$$

$$D_v = \sqrt{1.735}/.484 = \sqrt{3.59} = 1.90 \text{ in.}$$

In like manner, with the intake valve of this motor timed for 218½° of opening, with induction ports of .393 in. bore and 4 in. circumferential length, it is found that the port capacity is 171.7 square-inch-degrees. By the methods employed above and by substitution in the formula for valve opening area, the valve diameter of a poppet valve motor of 218½ degrees intake opening, and a valve lift equivalent to one fifth the valve throat diameter, can be derived as before, and we get:

$$D_v = 1.92 \text{ in.}$$

From the foregoing calculations, it is manifest that the sleeve valve motor actuates with a greater valve port capacity, for we know that few automobile motors contain poppet valves of such large diameters and resultantly high lifts.

Most important in this consideration of the advantages of the sleeve valve motor is the form of the combustion chamber. The mechanical power of a motor is derived from the chemical potential energy of the gasoline vapor through the heat evolution during the reactions, and it follows that the cooling of the gases should be prevented until the completion of their work. But from physical considerations the walls must be kept much cooler than the gases. Then it is obvious that the smaller the amount of the hot gases which comes in contact with the relatively cold combustion chamber walls, the higher will be the thermal efficiency of the motor. Theoretically this would call for a spherical combustion space, since the sphere has the smallest surface for a given volume. To put this theory into practice is practically impossible, due to the fact that even were the compression space a perfect sphere it would cease to be so at the instant that the piston started down on the induction or expansion strokes. Nevertheless we may approximate this spherical formation by the use of sleeve valves such as in the Knight motor or by overhead valves in combination with a concave piston head. Under these conditions a gain will be made in the thermal efficiency which can be attained in no other manner. With the sleeve valve motor, however, the flow of the exhaust and intake gases is unrestricted, these flowing directly through the ports in the sleeves without passing around valve heads to the center of the combustion chamber, and are scavenged, in time, in a similar manner through the other corresponding exhaust port. Although this resistance to the gaseous flow set up by the valves and their throats and passages may seem to be negligible, it is indeed quite important when one considers that it has been proven that the speed at which a charge flows into the cylinder depends directly upon the resistance to the gas flow, as well as to the inertia of the gas column in the filling of the passage.

A secondary series of advantages of this form of combustion chamber is introduced by the higher compression which is attained thereby. Not only does this form of compression space increase the velocity of flame propogation throughout the charge by the elimination of the side pockets in the cylinder wall but it also increases this velocity in another manner. With higher compression, the normal mixture induced in the cylinder becomes more homogeneously mixed, or in other words, the molecules of the gasoline and air constituents are in far more intimate contact, allowing them to burn at a greater rate than the molecules of the stratified charges of a low compression motor.

Another advantage of the Knight motor is the spark plug location, which is necessarily in the center of the compression space. Let us study the conditions existing in the center of the combustion chamber in order that we may then see the advantages involved by this location of the plugs. In order that the oxidation of the gasoline vapor to carbonic acid gas and water vapor take place with extreme speed, it is obviously essential that the flame be propagated throughout the charge in a direction opposite to those gases whose tendency is to expand from the downward travel of the piston. Now if that layer of gases at the extreme end or pocket of the cylinder (as in the "L" or "T" head motors) or at the cylinder head be ignited, the heat of combustion would tend to increase its volume and to expand that volume of gas between the piston and the initial point of oxidation. But the piston then starts on its downward travel and as a result the spark flame would have to propogate itself throughout the escaping strata of gases. Not only does this result in a slow burning of the charge but also in the cooling of the charge through expansion. From this, it is evident that if ignition of the charge could occur next to the piston there would be an increase in the power output and R. P. M. Although this may be only a theoretical consideration of the existing conditions, it is manifest that the Knight motor can make the best possible approximation of the initial point of spark propogation and hence will derive a slightly greater amount of power through its influence.

Perhaps the greatest innovation of the Knight motor and the universally admitted advantage is the total elimination of noise in this type of construction. In the non-poppet valve motors, any sounds created by the valve tappet striking the valve stem, by the valve striking its seat, by worn valve guides, by noisy cams or cam driving gears are totally foreign and in their place no other noises are substituted. On this point is based the remarkable silence and the durability of these motors and largely for this reason depends the success of the non-poppet valve motors in some of the leading European cars. But that we obtain a thorough understanding of the reasons for this silence, let us consider the conditions under which the poppet valve camshaft acts.

For every revolution of the camshaft the cam, in lifting the tappet and valve against the valve spring, passes through one period during which the reactive tendencies of the valve spring push down upon the cam in attempt to drive this part ahead of its regular motion. In this manner the driving mechanism of the camshaft receives the action of that force during an exceedingly small interval, but sufficiently great to cause the camshaft to become a driving member of the gear train. When the forward motion and inertia of the driving gear is great enough to eliminate this backlash between the gear teeth, it is indeed practicable to meet this condition, *if* the period occurring as the drive is reversed does not extend through too great an interval of time, and the spring effort is sufficiently great. Not only does this cause the teeth of the driving spur to come into direct and sharp contact with the camshaft gear if the clearance is of any appreciable magnitude, but it also causes a pronounced chatter in the timing gears and subsequent wear on the teeth faces. Nor is the silent chain camshaft drive free from this alternation of efforts on the gears or pulleys, for this type of drive has the undeniable tendency to vibrate, to stretch, and to contract from the explained reason of the gear chatter. Furthermore, if the distance between the driving pulleys is of any considerable length, if the motor is run at high speed, and if those vibrations of the uneven camshaft torque are synchronized with the aforementioned vibrations the noise is exceedingly displeasing. In fact, herringbone gears, spiral gears or any other form of drive are equally susceptible to this alternation of efforts on the poppet valve motor, each causing in the end some characteristic and eminently disagreeable sound.

The sleeve valve motor is exempt from all such difficulties, from the noises created by the worn valve guides, tappets and tappet rollers, from the valve being abruptly hammered into its seat, and in place substitutes a valve action which is positive, efficient, and simple, which shows practically complete absence of wear on those surfaces which provide the permanent and tight closing of the combustion space, and yet which is simple, as seen by the limited number of parts. Still another disadvantage of the non-poppet valve motor has been its ability to preserve for an indefinite time tight valve seats. In this respect, the Knight has undoubtedly proven its superiority, because the tight closing of the valve is practically uninfluenced by the amount of service that the motor may be required to render. Very little has been done in the evolution of poppet valve motors to render the valve tight for any length of time. It is to be admitted that valve diameters have been decreased to diminish sound and warpage, and that selection of such material as tungsten alloys has been made to minimize these valve troubles. Self-seating valves such as the Adler type of valve head have been tried, and even four valves per cylinder have been used, but the Knight valve actuation is still superior.

As with any other fundamental improvement of the internal combustion motor, many questions have come up in regard to its lubrication, its cooling efficiency, or for example, the power consumption by the sleeve valves. Let us next consider these questions in the above order. Probably the greatest problem found in this type of motor construction is effective yet efficient lubrication of the oscillating sleeves. These difficulties, however, have been overcome by the milling of helical oil grooves in the surface of the sleeves, by drilling oil holes in the sleeve skirts to facilitate the passage of oil from one surface to the other, or by raisable oil troughs, so that in the present stage of advancement this question is practically answered. As to cooling efficiency or the question of the danger of burning the edges of the ports by the tremendous heat of the exhaust (1150 F.) it may be conclusively stated that both aspiration and induction ports are amply covered by the junk ring, at the moment of expansion and thereafter, and that their edges are never exposed to the maximum temperature occurring within the cylinder. In fact no trouble of this nature has ever been experienced in Knight motors. In regard to the power consumed by the sleeve movement, conclusive evidence is the test conducted on a 75 B. H. P. motor, which demonstrated a power loss of 2.66 % for the sleeve oscillation.

In summary, we see first the greater valve capacity of the Knight motor, the inherent gains in power and speed through the hemispherical combustion chamber, a gain in the velocity of flame propogation, lack of resistance to the gaseous flow, and improved scavenging of the exhaust gases, then the silence of the motor with its concomitant elimination of camshaft periodicity, its ability to preserve a permanent and tight closing of the valves for indefinite time lengths, and lastly its positive and improved valve actuation. Beyond doubt there does not exist today a poppet valve motor which could rightfully claim such a culmination of fundamental advantages, such high efficiency combined with the softness, the stamina, and the silence of the standard sleeve valve motor.

THE PHYSIOLOGICAL EFFECTS OF ELECTRIC SHOCK.

I.

H. W. Rusch, '15.

Asphyxiation, i. e., cessation of respiration, may be looked upon as the ultimate cause of all deaths, including those by electric shock. The different ways in which the electric current causes asphyxiation and a study of the variables involved in this article pave the way for a similar detailed discussion of resuscitation in case of shock to be published in the November issue.—Editor.

The physiological action of electrical shock upon the human body is a rather vague subject in the mind of the average electrical engineer. At first thought this subject seems to be of interest and importance only to the medical profession, since the victim is usually; as soon as possible after the accident placed in the care of some competent physician. The engineer may be well informed as to the routine methods employed in the treatment of shock, yet a knowledge of the physiology involved cannot fail to aid him, if judgment is called for.

The physiological effects resulting from electric shock caused by lightning were investigated as early as the 18th century, but interest in death by the electric current was first shown by physicians and pathologists in 1882. Up to this time only a few serious accidents had resulted from electric currents, since electrical machinery was not then very well developed nor widely used. As the development and use of electrical generating apparatus progressed, and higher voltages were produced, the number of accidents and deaths continued to increase until it is estimated, at the present day, that 200 persons are accidentally killed yearly in the United States alone by electric currents. With an increase in the number of deaths caused by the electric current, the desire among physicians and pathologists to determine the actual effect which the electric current has upon the human body also grew. Consequently many experiments were performed, for the most part upon animals, the dog, cat, guinea-pig, and rat being the chief victims. The results obtained were quite uniform for given currents, but the conclusions in a few cases did not agree with the general opinions. Many of the conclusions reached during the earlier experiments still form the foundation of present-day theories.

Among prominent experimenters, whose investigations have been regarded as being of exceptional value in determining accurately the physiological effects of electric shock, a few may be named, such as Cunningham, an English anatomist, Weiss and Zacon, two German pathologists, and Prevost and Battelli, two French pathologists. Cunningham, Prevost and Battelli issued accounts of their experiments and conclusions in the year 1899. The experiments and conclusions of Weiss and Zacon were not published until 1911.

Of the many experiments undertaken, those performed jointly by Prevost and Battelli are probably the most conclusive, since they were the most carefully made. Exact measurements not only of voltage employed and of current, but also of blood pressure and respiratory movements were made. Prevost and Battelli also varied the electrical conditions of their experiments more widely than any other experimenters did. Direct and alternating currents were employed and dogs were used as the victims. In many cases the dogs were connected into the circuit by placing one electrode in the mouth and the other in the rectum. Other methods, however, were also used in which the electrodes were placed at different points upon the body.

Naturally, the method of procedure was to impress a low voltage first and then gradually increase it. The first pressure applied between mouth and rectum was five volts, alternating. This was found to be painful, but showed no effect upon the respiration or upon the action of the heart. However as the voltage increased, the results found began to change, so that at ten volts impressed for two seconds, death was almost certain. During the period of current flow, respiration ceased, but resumed its normal operation for a short time after the current was shut off, after which death occurred. During the time of passage of the current, the body was thrown into a condition of general muscular stiffening, known technically as tentanus. As higher voltages were used, other effects upon the animal were very marked. High voltages might produce injury to the nervous system, they might cause general convulsions, or might upset the respiratory movements for a half hour or more, with loss of sensation and reflexes, and the severity of the nervous symptoms was more or less in proportion to the voltage and to the length of time for which the current was applied. No such phenomena affecting the central nervous system were noticed up to 120 volts.

The experiments performed by Cunningham brought forth the same conclusions as did those of Prevost and Batteli. Cunningham, however, worked with etherized dogs, and his experiments and those of Weiss and Zacon bring out the fact that the use of anaesthetics does not affect the physiological results obtained. In these experiments Cunnningham used 115 volts, direct, and determined the current which could be passed through the body with impunity. He made record of the fact, during the experiments, that the size of the dog did not seem to be a determining factor in the current which the animal could carry, since a Newfoundland dog was killed at 300 milli-amperes, while a small shaggy terrier survived 700 milli-amperes. To accord with the findings of Prevost and Batelli, Cunningham found that with a high current value (1.6 amperes) passed through the brain, deep inspiration was caused, accompanied by a cessation of the respiration while the current flowed. The heart continued to beat and the blood pressure rose to values two or three times the normal, returning to normal again when the current was cut off, after which respiration began again. If, however, the current was allowed to flow for four to five minutes the heart gradually stopped.

Weiss and Zacon performed their experiments upon dogs anaesthized with chloral. The electrodes, just as in other experiments, were placed either in the mouth and rectum or upon the head and leg. The results of these experiments show that death could be caused by seventy to one hundred milli-amperes, alternating, traversing the thorax, with the heart in the path of the current. Direct currents took, roughly speaking, 300 milli-amperes.

With small currents general muscular tetanus set in which resulted in asphyxiating the animal. While thirty-five to forty-five milli-amperes were too small to produce direct failure of the heart, after ten minutes application, death was produced by tetanus and asphyxiation. Four hundred milli-amperes could be passed through the head with comparative impunity; the heart continued to beat, though rather irregularly, and respiration ceased during current flow.

The above experiments as given showed only the external effects, which have led to the formation of certain definite conclusions as to the mode of death by electric currents. However, the determination of the exact cause of death, whether it depended upon failure of the heart, upon action on the nervous system, or upon muscular stiffening, was a matter which required considerable study and systematic experimentation, and a complete analysis of many cases was made only through the aid of post-mortem examination. The results of experiments and post-mortem examinations have led to the firm conclusion that the sudden death of an animal, which is subjected to electric current, may be the result of one or more of three main physiological effects, namely:

1. Cardiac fibrillation.
2. Paralysis of the central nervous system.
3. Muscular tetanus.

The first, cardiac fibrillation, is a condition in which the muscle fibres of the heart do not act co-ordinately or in unison. In other words, each muscle fibre functions separately. The appearance of the heart in this condition may be likened to a mass of angleworms, which have just been thrown from a bait can. Each angleworm moves for itself and the mass does not seem to have any definite motion other than that of each individual worm. As a result of fibrillation, the heart cannot function properly and hence the blood pumped from it is not sufficient for the maintenance of life.

The second effect, paralysis of the central nervous system, produces very severe nervous disorders. The nerves are no longer able to transmit stimuli to the respiratory muscles, and in consequence of the fact, the respiration is checked and the victim dies. However, if proper methods of artificial respiration are used upon the victim for a period of time after the accident, the respiration can be aided, and the nervous system caused to recover from the state of paralysis.

The third effect, muscular tetanus, is a condition in which the muscles of the body are paralyzed and stiffened. This condition does not permit respiration, because in inspiration those chest muscles which elevate the ribs contract simultaneously with the muscles of the diaphragm, causing an enlargement of the thoracic cavity. With an increase in chest size a vacuum is produced, which causes a rush of air to the lungs. Hence when the muscles of the chest become paralyzed, the lungs may be left in a state of inspiration or expiration without the least chance of resuming operation.

Brief mention may be made here of a fourth cause of death. This is direct injury to some important organ. Examples of this are burns, or destruction of tissue, and may be severe enough to produce death after a period of a few days or weeks by causing complications to set in.

Of the above causes of death, cardiac fibrillation could not be determined from the external appearance of the animal, although the blood pressure tracings showed a stoppage of the heart action and fall of the blood pressure to zero. To determine the exact cause of this phenomenon it was necessary to have recourse to post mortem examinations. These showed conclusively that cardiac fibrillation occurred under certain electrical conditions. The electrical conditions necessary for any one of the above physiological effects are shown by a more detailed study of the experiments reviewed above.

With alternating voltages, the results of the experiments were as follows: Very low voltages, for instance, less than ten volts, may produce muscular tetanus, which, if prolonged for a sufficient period, may cause death in the animal. With voltages below 240 volts, fibrillation alone was the cause of death. At pressures from 240 to 600 volts, the heart was arrested in ventricular fibrillations, and the respiration was stopped simultaneously. The animal invariably died. With pressure between 1,200 and 4,800 volts, the ventricles of the heart continued to beat vigorously, although the auricles were paralysed, and respiration ceased. Hence the conclusion was that at high voltages, death is caused by asphyxiation, at intermediate voltages it is caused by both asphyxia and cardiac fibrillation, and at very low voltages by cardiac fibrillation alone.

A very interesting fact brought out in these experiments was that when fibrillation was caused by the low voltages, the high voltage could be used to overcome this fibrillation and to restore the heart to its normal condition again. Fibrillary contractions of the heart were found to be almost invariably fatal in dogs. Life could, however, be preserved for a short time by massage of the heart and artificial respiration, but death followed upon the cessation of these manipulations, since the heart could not be made to perform its functions properly again.

The experiments performed with direct currents showed the following interesting facts:

Fifty volts, direct, was found not fatal to dogs in five seconds. This is to be contrasted to ten and fifteen volts, alternating, which were fatal in two seconds. From fifty to five hundred volts, direct, the injury to the dog was uniformly fatal, causing incurable fibrillations; artificial respiration was useless. Voltages above 550 were not available, but it was thought that the effect would be the same as for high alternating voltages; namely, the heart would act normally again, but the respiration would cease. These experiments go to show that, at least for dogs, rabbits, guinea-pigs, and rats, the low direct voltage is less harmful than the low alternating voltage.

In addition to the data gathered from experimental study upon animals, information secured from autopsies upon criminals and upon persons accidentally killed has been recorded and is available. This is the most reliable information which we have regarding the action of the electric current upon the human body, because direct experimentation upon human beings is too dangerous to be carried on systematically. The results of autopsies, although exact in a general way, are far from being as systematic as experiments and hence they do not disclose all the facts. However autopsies are not without value, and so a few cases may be of interest.

In 1885 a man was instantaneously killed at the Health Exhibition at London. Forty hours after death he was examined, and it was found that *rigor mortis* (stiffening of the muscles) was marked, and extreme fluidity of the blood was observed. It was then thought that the vital spots at the base of the brain are in such case markedly implicated. This seems to be logical conclusion, since if the base of the brain, technically known as the medulla, which contains the respiratory center, is affected, the respiration will be checked and death will be caused by asphyxiation. The extreme fluidity of the blood is also a characteristic condition resulting from asphyxiation. However, *rigor mortis* does not show anything definite as to the probable cause of death, outside of a possibility of its being a result of general muscular tetanus, since *rigor mortis* is experienced sooner or later in all deaths, and may only have been hastened through the intense nervous strain produced by the action of the current upon the medulla.

An autopsy which was performed upon a criminal electrocuted in the State of New York is very interesting, because it was performed, in this case, for the purpose of determining whether death in such electrocutions was really caused by the electric current or by the surgeon's knife afterward during the post mortem. The results found are as follows: The superficial veins of the extremities, especially those of the arms, were empty and collapsed. Nearly all of the blood in the body had been driven into the head and the upper part of the chest and neck. Some of the over-distended veins had ruptured and allowed the blood to pass between the tissues of the body. This blood was found to be congealed. An incision of the abdominal walls showed the tissues to be bloodless. Removal of the skull cap and puncture of the membrane covering the brain showed that dark and slightly congealed blood filled the cranial cavity. This was caused by a rupture of the blood vessels of the brain. A clot of congealed blood was found at the base of the brain, which in itself would be sufficient to cause death. The lungs appeared normal, although in some places the blood had been forced into the tissues. The heart walls were thin and flabby and blood retained in the cavities was dark. The vessels of the intestines, especially those of the small intestines were distended with blood. The liver was normal but engorged with blood. The kidneys and spleen were normal. The abdominal aorta was empty.

This autopsy seems to offer conditions which are not usually found in post-mortem examinations. Here the blood was congealed, whereas, in general, the blood had been found to be fluid. This discrepancy may be due to differences in power expended and time of current flow in the different cases. In the New York case, the current was eight amperes, applied for fifty-seven seconds, at 1780 volts. This was an expenditure of 225.4 watt-hours of power, and coagulation was there probably caused by the heating of the blood. In deaths caused by industrial currents, the current is undoubtedly very much less than eight amperes, and hence the heat produced is not sufficient to coagulate the blood.

This examination also shows that hemorrhages may be caused by electric currents, and that the victim may die as a result of these internal hemorrhages. Hemorrhages have not been commonly found in persons killed by the electric current, and hence are probably not important enough to be called a common cause of death.

A third case may be cited, which happened in 1892. The victim was a man who came in contact with 2450 volts, alternating. Upon receiving the shock, he fell back and uttered a cry for help. Ten minutes later he was found to be livid, his pupils dilated, and blood stained mucous issuing from his nostrils. Artificial respiration was performed; the man inspired slightly three times and then died. In forty minutes the body became quite rigid. A post mortem examination was performed thirty-one hours later, and it was found that *rigor mortis* was still marked, the blood was liquid and dark, the brain was congested, and the spinal cord was congested but healthy. In this case asphyxia was most likely the immediate cause of death, on account of the agreement of symptoms.

The possibility of further complications, if death does not result from the shock, is brought out very clearly in an accident, to which the writer happened to be an eye-witness. The person involved had accidentally placed his head near a copper tube bearing 44,000 volts. Fortunately for the victim, the floor was made of concrete as was also the third floor of the building, and hence no direct connection existed. The amount of current which he received is, of course, unknown. When he was removed from danger his body was limp and apparently lifeless. It could especially be noticed that his body was extremely warm. Artificial respiration was immediately performed and in a few minutes the victim began to groan as if he was in great agony. This groaning continued during the whole time of the artificial respiration, but seemed to subside more and more as the patient began to show life. Finally his eyes opened and he looked blankly about. Consciousness did not return until four hours after the accident. Since the accident, the injuries have healed up surprisingly well, but other developments have occurred. Both eyes have developed cataracts, an opaque condition of the lens of the eye. This formation gradually hardens, and the lens must be removed before the victim can be made to see with the aid of glasses.

The physiological effect accompanying the shock was undoubtedly a checking of the respiration, which probably was due either to nervous disorders or to tetanus which may have existed in the respiratory muscles. The power arc which existed at the instant of the accident seemed very large, and probably enough current was received to cause the paralysis of the central nervous system and hence a stoppage of respiration.

In regard to the formation of cataracts in this instance no explanation can be given. The heat which was developed in the body could have been caused entirely by the I^2R loss, but was probably due largely to the action of the electrically stimulated muscles.

From the brief consideration made thus far, it can be seen that a large amount of confusion existed, and before any definite conclusions were reached, a thorough study of all conditions was necessary. The results of post mortem examinations point to one direct cause for death, and that is asphyxiation. This term, as commonly used, suggests a cutting off of the air supply to the body and is applied mainly to external respiration. Asphyxiation, as used here, applies to internal respiration chiefly, and means that the lungs become inoperative, and are no longer able to furnish the blood with oxygen. Hence the oxygen supplied to the numberless cells of which the tissues are composed is insufficient to maintain the life of these cells and as a result death occurs. The cells of the nervous system are the most sensitive to the lack of oxygen, and hence die first thereby causing a destruction of the nervous system. However asphyxiation may be looked upon as the ultimate cause of all deaths, and hence it really becomes a question as to what physiological effects resulting from the electric current cause asphyxiation.

As a result of experiments and autopsies, asphyxiation may be regarded as being due to one of several causes; namely,

1. Cardiac fibrillation, which causes asphyxiation by not permitting the heart to function properly.

2. Paralysis of the central nervous system, which causes asphyxiation by stopping the sending of stimuli to the respiratory muscles.

3. Prolonged muscular tetanus, which causes the asphyxiation through the inability of the respiratory muscles to function properly.

Whatever may be the pathology of the problem, it is possible to determine with fair accuracy the end effect of different electrical variables. This determination is possible with the aid of experimnetal data, since it can be assumed that any variation in the conditions has relatively the same effect upon man as upon animals. However, a total separation of these variables is not possible and really should not be attempted, but remembering the close relationship existing between the variables, it is possible, within limits, to consider them separately. Among these variables may be mentioned:

1. The magnitude of the voltage.
2. The strength of the current.
3. The type of current, whether D. C. or A. C.
4. The path of the current.
5. The resistance of the electrode and contacts.
6. The frequency of the supply.

First of all consider the voltage. With alternating currents death has occurred at voltages as low as sixty-five, and a good many instances of death from voltages of 100 and 120 volts have been recorded. With such low voltages, the resistance of the body and of the contracts determines entirely the danger. A rise in voltage increases the ease in which fatal current is sent through the victim. For this reason, more deaths are experienced with higher voltages used in industrial work.

But here comes a paradox. From experiments which have been performed upon animals, it would appear that if good contacts are made, the currents at high voltages become less dangerous to man and probably for the same reason, namely, that incurable fibrillary contractions do not set in. A number of instances have been recorded in which men have received industrial currents at 10,000 volts without being killed at once, and yet the contacts were good, and the current received undoubtedly high.

However, if the victim makes a poor contact so that the current received is very small, he may be killed by cardiac fibrillation. Hence it is apparent that the question of how much voltage a person can stand cannot be readily answered because of the many variables.

The strength of the current is probably the most important variable. No certain knowledge regarding the amount of current which a human being can withstand is available. Yet certain scientists have reasoned that it is about seventy or ninety milli-amperes. Dixon Mann, an English pathologist, showed experimentally that alternating currents of from fifteen to thirty milli-amperes sent through the chest do not affect the heart action. Trotter, another English scientist, found that direct current up to thirty-five milli-amperes, sent from the hands to the feet, was insupportably painful, but not fatal.

When very large currents are sent through the body, we again meet with a paradox. Small currents may kill instantaneously, while large currents are much less fatal. As an example, it can be stated that in certain American electrocutions, a current of five to eight amperes have been passed for many seconds through the body without causing permanent arrest of the heart or respiration.

From this it is plain then that currents of a fraction of an ampere may cause death by throwing the heart into fibrillation, whereas large currents provide better chances of recovery. The point of transition between fibrillation and the permanent effect upon respiration is not known.

A curve showing the danger of various currents may be of interest at this point, and will show in a measure certain facts which seem to be quite firmly established. This curve has suggested itself to the writer, and is in no sense exact. The ordinate chosen is the danger to life, and the abscissa is the current. No values have been ascribed to either co-ordinate, since the data necessary for such exact construction are not available. OA represents the size of current which can be taken with impunity. ABC is that part of the curve where fibrillation may exist alone. CD shows the part in which fibrillation, a paralysis of the central nervous system may exist simultaneously. Beyond D is the region of the stoppage of the respiratory system.

The co-ordinates of the points determining the curve will depend upon the time, since it has been found that currents which were ordinarily too small to produce fibrillation of the heart, could be made to produce these fibrillations if applied for a longer period. The different types of currents, alternating or direct, seem to possess characteristics which make one more dangerous than the other under certain conditions. Industrial alternating currents are, other things being equal, more dangerous than direct currents. From experimental data available it

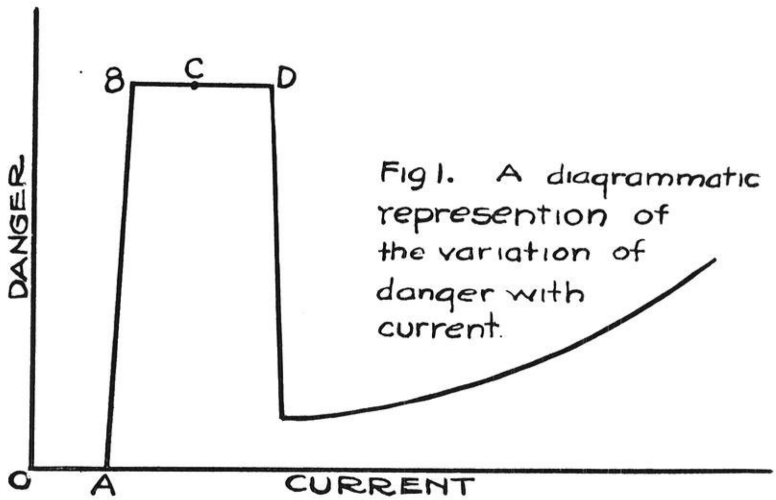


Fig 1. A diagrammatic representation of the variation of danger with current.

would appear that direct current must be two or three times as strong as alternating to kill a human being. Yet in cases which are not immediately fatal, the after effects produced by direct current make it more dangerous than alternating current, because of the electrolysis effect that direct current has upon the tissues of the body.

The path of the current or the position of the electrodes during shock is of the utmost importance. It is thought that a man receiving current into one leg and out the other can withstand enormous currents without any apparent effect providing the amount of current which might pass through the heart is negligible. The most dangerous position of the electrodes is that which places the heart in the direct path of the current.

The resistance of the points of contact is also of importance in reducing the current. The skin, especially when dry, provides the greatest resistance of the body, and hence if the contact is between the skin and the electrode is not made good the total resistance will be increased materially.

The effect of the resistance at the electrodes and in the body in determining the results of the current is shown in the following table, in which it is assumed that the current traverses the thorax on its way through the body.

TOTAL RESISTANCE OF BODY ASSUMED TO BE	RESULTS OF BRIEF EXPOSURE TO A.C. AT		
	100 volts	1000 volts	10000 volts
VERY LOW: CONTACTS GOOD 1000 OHMS	CERTAIN DEATH SLIGHT BURNS	PROBABLE DEATH MARKED BURNS	SURVIVAL: BURNS AND OTHER SEQELAE SEVERE
HIGHER: ABOUT 10,000 OHMS	PAINFUL SHOCK NO INJURY	CERTAIN DEATH BURNS PROBABLY SLIGHT.	PROBABLE DEATH SEVERE BURNS
HIGH: CONTACTS BAD 100,000 OHMS	SCARCELY FELT	PAINFUL SHOCK PROBABLY NO SEVERE INJURY	CERTAIN DEATH BURNS SLIGHT IF RESISTANCE REMAINS HIGH

An item of interest in alternating current work is the frequency. The frequency of the current when taken over a wide range may influence the results very materially. From experimental results, it has been shown that the most dangerous frequency is 150 cycles per second. As the frequencies increase the currents become less dangerous, as is clearly shown by some experiments performed by D'Arsonval. He worked with frequencies between 400,000 and 1,000,000 cycles per second and found that he could take currents of three amperes through the body. This is at least thirty times as great as can ordinarily be taken. He also found that there was no painful sensation, no burning of the tissues at the point of contact, and no muscular tetanus.

PATENTS.

SAM ROTH, '15.

The student engineer, and no doubt the practicing engineer will do well to file away the following pages of solid information on the patent law and procedure. This was one of the best of recent senior conference papers.—EDITOR.

The subject of fundamental patent law may, at first thought, appear to be of interest only to a certain class of lawyers, but for many reasons it is essential that engineers have at least a general knowledge of the rudiments of our patent system. Almost every engineer will at some time in his career come into contact, in one way or another, with the patent office. If he should perfect an invention, the patent records will enable him to determine, within limits, whether the invention is new; they will help him to avoid existing patents; they will give him material assistance in the design of the machine or article invented. Moreover, engineers are very often called upon to do expert work in the valuation of patents, or to give expert testimony in suits wherein patents are involved. At such times it will be his knowledge of the patent records and patent law that will make his work or testimony valuable. Then, too, in his work for others, the engineer often has to co-operate with a patent attorney; that their joint work may have the greatest value to those for which it is done the engineer must have some conception of the basic patent law.

Like many of our basic institutions, the patent system was adopted, with modifications, from the British system, which had its beginning about 1617, during the reign of James I. Until the foundation of the British patent system the crown granted monopolies on the necessities of life, but this practice came to be irksome and distasteful to the people. Lord Coke in about 1605 rendered a decision, based upon the ancient common laws, that all such monopolies were illegal, except those granted for limited times on inventions. This resulted in the Statute of Monopolies in 1623, which made all monopolies illegal, except such as were granted by Parliament for new inventions or manufactures. This statute is the foundation upon which the British patent system rests. The patent record, however, begins in 1617, and is probably based on the early decision of Lord Coke.

In this country a few of the colonies granted patents, the earliest known being in 1646 by Massachusetts Bay. The framers of our constitution considered the encouragement of invention of sufficient importance to provide in the constitution for the granting of patents. This was indeed a wise provision, for it is obviously essential that patents issued shall be valid throughout the country. The basis of our patent system is therefore Section 8 of Article 7 of the Constitution of the United States, which reads: "Congress shall have the power * * * to promote the progress of science and useful arts by securing, for limited times, to authors and inventors, the exclusive right to their respective writings and discoveries."

In accordance with the power thereby granted Congress has passed many statutes relating to patents, and it is indeed remarkable that the laws passed by our early congresses have needed so little revision during all the years of our country's existence. The first patent laws, drafted in main by Thomas Jefferson, were passed in 1790. The granting of patents was entrusted exclusively to the Secretary of State, Secretary of War, and Attorney General, two of whom could grant a patent to anyone who reasonably satisfied them that they had a new and useful invention. The grant was limited to fourteen years and during the four years from 1790 to 1795, sixty-seven patents were granted. Thomas Jefferson, who was himself an engineer of no little ability, examined all of these applications with great thoroughness. In 1793, much in opposition to Jefferson's wishes, the patent statute was changed. The grant was made a mere ministerial act, aliens were discriminated against, and practically no examination for novelty was required. This statute was revised in 1800 to include resident aliens. The evils of this system were very great and to a certain extent cumulative, so that a thorough revision of the patent laws was made in 1836. By this act the patent office was established, and a commissioner of patents appointed. This patent office, which was a bureau of the Department of State, was the real beginning of our present Patent Office. In 1849 it was made a part of the Department of the Interior. By the act of 1836 the patent grant was for a period of fourteen years, but in 1861 this was increased to seventeen years. Extensive revisions have been made in the patent laws at various dates, but they remain the same in essential features as the laws of 1836. By these revisions the original powers of the Commissioner of Patents have been developed from those of a mere clerical nature to those of a high judicial nature; with the growth of the office and the powers of its head, there have come examiners of training, skill, and character in no respect inferior to the judiciary which administers our laws.

The most important statutory provision relating to patents was that established by the act of 1870, and by two amendments, one in 1896, and the other in 1897. It is found in Section 4886 of the Revised Statutes and reads as follows: "Any person who has invented or discovered any new or useful art, machine, manufacture, or composition of matter, or any new or useful improvement thereof, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than two years prior to his application, and not in public use or on sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may upon payment of fees required by law, and other due proceeding had, obtain a patent therefor."

This section provides for the granting of a patent, but does not render the patent effective. It merely says that a patent may be granted for specified classes of inventions, and if the law stopped there we should have absolutely nothing of value. However, Sections 4920 and 4921 of the Revised Statutes give the patentee the right to invoke the power of the Federal Courts to protect his monopoly. In this way the patent is made effective. There is a popular idea, that a patent is a sort of magician's wand or stuffed club. This is an extremely erroneous conception, for a patent creates nothing that did not exist before; it is, after all, only a special warrant to sue for redress for the commission of infringing acts.

A patent consists of a deed signed and sealed by the Commissioner of Patents granting to the inventor the exclusive right for seventeen years to make, use, and sell the invention, and referring to attached specifications and drawings for a disclosure and definition of the invention. As is seen from the preceding discussion this exclusive right to make, use, and sell the invention gives in legal effect the inventor only the exclusive right to prevent others from making or using the invention. In return for this absolute monopoly, the invention is described in public record as an aid to others, and at the end of seventeen years becomes public property.

In the statutory provision quoted, the following type of invention may be patented, subject to limitations as to novelty, etc., of the statute.

1. A machine.
2. A manufacture.
3. A composition of matter.
4. An art.
5. An improvement.

For the final decision as to whether the invention will fall into one of the above classes or not, whether it is novel or not, whether the patent granted is valid or not, we are dependent upon the decisions of the Federal courts. It is these courts that interpret all congressional measures and it is to their records and their decisions that we must go for our patent law. After many years of court procedure the following definitions have come to be generally accepted:

A Machine is an artificial organism governed by a permanent artificial rule of action, receiving crude mechanical force from the motive power, and multiplying or transforming it according to the mode established by the rule.

A Manufacture is an instrument created by the exercise of mechanical forces and designed for the production of mechanical effects, but not capable, when set in motion, of attaining by its own operation to any determined result.

Even though these definitions are widely different it is by no means easy to discriminate sharply between a machine and an article of manufacture. Compare these common devices: An ordinary pen, a fountain pen, and a typewriter. It is evident that an ordinary pen is not a machine but an article of manufacture; its mode of action does not reside in the pen; one must not only apply force to it but must direct that force; one must dip the pen in the ink and form the letters by the mechanism of the hand in order to make it write.

With a typewriting machine one simply applies force. The law of the machine is that, when one strikes a certain key a corresponding character will be printed on paper. Here we have a true machine. Moreover, the typewriter is composed of a number of machines. But how about a fountain pen? As a pen, it is simply a pen, a tool, an article of manufacture. But it does not have to be dipped into ink. It contains a mechanism whereby ink is carried down to the pen. That is the law of the device, that the ink shall flow to the pen, when pressure is applied to the point. It is therefore a machine, not a machine for writing, but a machine for supplying ink to the pen.

A Composition of Matter is any mixture or composition of chemical elements, solid, liquid, or gaseous, like soap or steel. However, when considering the purchase of a patent on some composition of matter, one must exercise extreme care. Suppose an inventor offered for sale a patent on a machine for making an artificial stone, and another patent on the stone itself. The patent on the machine may be valid, but if the artificial stone is of the same composition as a true stone of its kind, the patent on the composition of matter is most certainly invalid.

An Art, as applied to patent law, may be any process, or series of processes, steps or operations for accomplishing a chemical or physical result. The Bell telephone patent contains a claim for the art of transmitting messages by undulatory currents. Another example of a process or art patent is one that was issued for a process of casting car wheels, which consists of causing a jet of molten metal to enter the mold in a tangential direction to give the metal a whirling motion, so that the heavy, sound metal will flow to the rim of the wheel, and thus prevent the cinders and bubbles from occurring in the rim. From this it is seen that the patentability of a process does not depend on the appliance with which it is carried out, for in the case cited the apparatus was all known, but the process was new.

An Improvement is any change or addition to an invention which tends to simplify the operation or widen the scope of the machine, art or article patented. An improvement is in itself patentable, but the patentee of an improvement has no right to make the thing improved upon if it is patented and the patent still in force. Nor will the original patentee have any right to the improvement because he hold a dominant patent.

All patentable things have been enumerated and it may also be of value to note those to which the courts say no patents shall be granted.

A mental conception of a device is not patentable. It must be reduced to practice before it can be made the subject of a patent grant.

A force of nature is not patentable. Morse sought to monopolize the electric current as a force of nature for transmitting information, but this claim was not allowed.

Scientific principles and properties of matter may not be patented. This was shown in the "Lead Pipe Case," wherein it was endeavored to obtain a patent on the principle that lead, if melted at low temperatures and high pressures, could be made so to flow as to form lead pipes, traps, etc. This was a discovery of a scientific principle and property of matter, and neither are patentable, but the machine for accomplishing this or the process might be patentable.

A result or function is not patentable. It is for the discovery or invention of some practicable method of producing a beneficial result or effect that a patent is granted, not for the result or effect itself.

For an aggregation of parts each of which is used for an old process no patent may be granted.

For the duplication of a patented article it is obvious that no patent is allowable.

For the simplification of a patented article or process no patent can be granted, except in exceptional cases. Then it will be found that by this apparent simplification a new device or process has really been evolved.

A double use of a device already patented cannot be patented, as, for instance, the use of a coffee mill for grinding spices.

The transposition of parts, since it is not an invention, is not patentable.

An immoral object may be new and ingenious, but it would be detrimental to public morals and general welfare, and so would lack one of the requisites of the statute; usefulness. It would therefore not be patentable.

So far we have analysed the first or positive part of Section

4886 of the Revised Statutes. After this part come the following negative requirements:

1. Not known or used by others in this country before his invention or discovery thereof.

2. Not patented or described in any printed publication, in this or any other country before his invention or discovery thereof or more than two years prior to his application.

3. Not in public use or on sale in this country for more than two years prior to his application.

4. Not abandoned.

Upon these four statements are based all the decisions of the Patent Office and the Federal courts in their determination of the novelty of that art, machine, or article for which a patent is sought. Novelty, if determined in strict accordance with the statute will mean absolute novelty, for under the law an American who finds himself denied a patent because of a prior description of his invention in a Chinese record cannot plead ignorance of the language and literature of the land. The inventor must think out beyond all that has been done and known in the country and out and beyond all the publications of the world.

Let us consider in detail each of the above negative requirements.

First: Prior knowledge or use of in this country by others prior to his invention. This limitation must necessarily be put upon a device or art for which a patent is desired, although the courts in their decisions have set limits to the application of this part of the statute.

Second: Prior patent or publication in any country, (a) before the inventive act, (b) more than two years before application.

(a) A patent or publication before the inventive act makes a device absolutely unpatentable, but the patent or publication, especially if a foreign patent or publication, must disclose the invention so completely that it may be practiced without invention or further experiment.

(b) The provision that allows two years to elapse between invention and application gives the inventor a considerable length of time to perfect his device after he has first conceived it.

Third: Public use or sale more than two years in this country.

The two year limit in this case is absolute. The two year limit gives the inventor ample time to perfect his device but the application must be filed not a day over the two year limit.

Fourth: Abandonment. Loss of the right to obtain a patent or the right to obtain the monopoly of a patent already granted by abandonment differs by the loss by public use or sale more than two years before application is filed in that it may occur at any time, before application, after application, or even after patenting. It differs also in that it is something arising from the intent or the conduct of the inventor, and is not merely a statutory limitation.

It is generally thought that if the requirements as to novelty, etc., are fulfilled, that all one has to do to obtain a patent is to secure a few forms, have some drawings made, and then sit back and wait for the Patent Office to grant a patent. This method may do in some cases, for the Patent Office generally will see to it that one dces not claim more than he should, but the Patent Office is absolutely unconcerned as to whether the patent is protected. The drawing of a patent application is, therefore, a matter not for an engineer or inventor, but for a skillful patent attorney, because the strength of a patent is directly as the skill with which the application is drawn. By the rules of the Patent Office, based on sections 4888 to 4892 of the Revised Statutes, the complete application for a patent comprises:

1. A letter of transmittal.
2. The first fee of $15.00.
3. The petition.
4. The oath.
5. The specifications.
6. The claims.
7. The drawings.
8. The model, when required.

1. The letter of transmittal, though not required, usually accompanies the application and gives the name of the applicant, title of invention, and form in which the fifteen dollar fee is being sent.

2. The fee of $15 is the first fee. A second fee of $20 is required when the patent is ordered to issue, making a total government fee of $35, unless complication of appeals arise.

3. The petition is a communication addressed to the Commissioner of Patents, setting forth matters of citizenship, residence, post-office address, and asking for the grant of a patent upon the invention named and set forth in the accompanying papers. The petition usually contains a clause giving to a designated person the power of attorney. This empowers the person to whom it is given, whether he be an attorney or not as long as he is a registered solicitor, to prosecute the application, make alterations, amendments, arguments, and receive the patent when issued.

4. The oath or affirmation, if desired, follows rather closely the wording of the statutes and states that the inventor verily believes himself to be original, first, and sole (or joint) inventor of the device or process described.

5. The specification is a technical description of the invention for which application is made for a patent. Properly speaking, the specification covers and includes: (a) preamble, (b) general statement of object and nature of the invention, (c) brief description of views or drawings, (d) detailed description, (e) claims, (f) signature of the inventor, (g) signatures of two witnesses. The part that is commonly known as the specification includes the first four of these items and is described as follows in Section 4888 of the Revised Statutes: "The specification is a written description of the invention or discovery and of the manner and process of making, constructing, compounding, and using the same, and is required to be in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which the invention or discovery appertains, or with which it is most nearly connected, to make, construct, or compound and use the same."

6. The claims, while mentioned under the specifications, are usually treated under a separate head. The claims are described in the Revised Statutes as follows: "Before any inventor or discoverer shall receive a patent for his invention or discovery he shall * * * description of specification * * * and he shall particularly point out and distinctly claim the part, improvement or combination which he claims as his invention or discovery." The claims are the most vital part of the patent.

Regardless of what may be described in the specification, this is of no protective value unless covered by claims.

7. Section 4889 of the Revised Statutes says in regard to the drawings: "When the nature of the case admits of drawings, the applicant shall furnish one copy signed by the inventor and his attorney in fact, and attested by two witnesses, which shall be filed in the patent office, and a copy of the drawing, to be furnished by the Patent Office, shall be attached to the patent as part of the specification. The making of Patent Office drawings is a special part of the draughtsman's art, and it is enough to say that the drawings must conform to several set rules. It must be kept in mind that Patent Office drawings must be kept as general as possible, that the drawing does not need to be a working drawing, and that all parts do not have to be to scale, as exact relative proportions are immaterial as regards the principle of the device represented.

8. In earlier days models were required to be filed with the application. This requirement was abolished many years ago, due to the difficulty of housing the growing collection, and to the general increase in the knowledge of mechanical drawing. Upon rare occasions at present a model may be required if the examiner finds it necessary to explain the working of the invention.

The actual obtaining of a patent may occupy a few months or several years. The course of procedure would be somewhat as follows:

Suppose A makes what he believes to be a patentable invention. His best course is to place the matter in the hands of an experienced patent attorney or solicitor, for in addition to the larger experience of the solicitor, the fundamental principle of checking prevails, namely that a second person has a better perspective than the person who did the work, and who is therefore too close to it for the best view. Some kind of a "novelty" search is usually desirable. This may vary from the study of the Official Gazette, which one of limited experience in such matters may make for himself, through the $5.00 search of the classified Patent Office records, to a thorough novelty search, made by experts through the records of different countries and technical literature, for which a fee of $200 or more may be charged.

Even the briefest search may find a flat interference, in which case the result is conclusive. In the absence of such a finding, however, the results are negative, for even after a most exhaustive search one cannot say absolutely that an interference does not exist somewhere and that it may not be discovered later.

If it is decided to proceed with the application, the attorney prepares all necessary papers and drawings, which he submits to the applicant for suggestions. Upon final approval and signing by the applicant, the application is forwarded to the Patent Office with the first fee of $15. The Patent Office immediately acknowledges receipt, noting general information in papers and drawings, if there be any. The former may require correction before formal action is taken. Informalities in drawings are often passed until action is taken in the case. For the receipt of acknowledgement the applicant is given a serial number, date of filing and the title of invention, which should be used in all future correspondence regarding the application.

From two weeks to many months may elapse before the application is examined and reported back to the attorney, the difference in time depending upon the crowded condition of the class into which the application falls. The first action of the examiner may be one or more of the following: (1) Allow, (2) Allow in part, reject in part, (3) Reject all claims, (4) Require corrections, (5) Require explanations or a model, (6) Require division, as into an application for the machine and an application for the process, (7) Declare interference with another application.

When a claim is rejected for lack of novelty the examiner gives brief and specific reasons for the rejection, with reference, so that data may be located. If patents, either U. S. or Foreign, are cited, the class, date, number, title, and patentee are the references given. If the rejection is based on other printed information, that reference is given. Upon notice of the rejection of one or more claims, the applicant, by his attorney, has rights of reconsideration, amendment, substitution, correction, or revocation.

After the second rejection upon substantially the same subject matter and for similar reasons, the applicant has the right of appeal from the primary examiner to the examiner-in-chief. The fee for this appeal is $10. From an adverse decision from the examiner-in-chief, an appeal may be taken to the Commissioner of Patents, for which a fee of $20 is required. If he also should render an adverse decision, an appeal can be taken to the Court of Appeals of the District of Columbia.

If no answer regarding an action by the Patent Office is returned by the applicant, or his attorney, within one year of the receipt of the same, the application is held abandoned. This one year clause is sometimes purposely used to prolong the pending of the application by taking the time limit for a reply, which reply will require further action, etc. This prolonging the time allowance may be due to legitimate reasons, as for example the invention may be such that a market has to be developed, in which case the seventeen year life beginning at a later date will be more valuable. This appears to have been the basis for the delay in the Selden Patent, which was filed in 1879 and issued sixteen years later.

Delays, however, give rival inventors an opportunity to file patents, and although the patent itself offers small protection, in most cases the holder of the issued patent is possibly in a stronger strategic position that the one who delays, although interference proceedings may be brought against issued patents.

After all differences are adjusted between the applicant's attorney and the examiner, and certain claims have been allowed, notice of allowance is received. Six months is allowed for the payment of the final government fee of $20, making the total fee, if no appeals are taken, $35. After the final fee is paid, the patent is issued, bearing a number and date.

Our patent system has been the subject of much criticism, some probably just, some decidedly unjust. Bills are continually being introduced into Congress to change it, but as compared with foreign systems, it seems to be the fairest and best in existence.

BALL BEARING STANDARDS AS RECOMMENDED BY THE S. A. E.

H. C. ANDERTON, m '15.

The Ball and Roller Bearing Standards Committee of the Society of Automobile Engineers as early as 1910 began the enormous task of standardizing all ball and roller bearings, which work has covered a period of nearly four years and at least five elaborate reports have been prepared and submitted after innumerable consultations, arbitrations, and compromises between the manufacturer and the user. The fifth report was finally accepted in January of the current year.

In the ball bearing standards as adopted the principal specifications and tolerances may be summarized as follows:

1. Outside race diameter.
2. Inside bore, or shaft fit.
3. Width of bearing.
4. Eccentricity of the races.
5. Axial freedom of the bearing.
6. Chamfer of outside and inside corners.

It was recommended that the sizes adopted by the annular ball bearing producers, which are metric standards, should be recognized as standards for ball bearings as to bore, outside diameter and width.

The series are listed as light, medium and heavy, and numbered series 200, 300 and 400 accordingly, all series differing in bore, outside diameter, width and diameter of balls. The carrying capacities are also listed for each bearing, and are based upon all bearings manufactured by suitable workmanship, and suitable material and running at a uniform speed, and uniform axial load, not exceeding 500 r. p. m. It could not be expected that all conditions would be covered by the loads given and hence for conditions of shock, axial thrust, or a combination of the two, a greater factor of safety must be used.

Now in determining the proper tolerances, the commercial side of the problem bore considerable weight, for the reason that a standard could not be adopted that would raise the manufacturing cost because of its exceedingly close limits, and especially when the entire article was not being manufactured under one management as is often the case. It is easily discerned that different concerns having different working standards would greatly confuse the purchaser should he attempt to compel a single standard from all of them.

Taking up each of the tolerances in order, as adopted by the Society, some interesting items will be noticeable.

1. The outside race diameter should have a plus tolerance of 0 and a minus tolerance varying from .0006″ to .0012″ according to the size and type of the bearing.

2. The bore should have a plus tolerance of .0002″ and a minus tolerance varying from .0004″ to .0007″ according to the bearing.

3. The width should have a plus tolerance of 0 and a minus tolerance of .002″ for all bearings.

By the width of a bearing shall be known the distance between one end of the outer race and the opposite end of the inner race, measured parallel with the axis of the bearing.

The tolerances just stated include the extreme for all makes of bearings as indorsed by the manufacturers. It has been the practice of some ball bearing manufacturers to work only to minus limts, while others work to tolerances on both sides of the exact nominal size as to zore. Where greater accuracy than specified by the tolerance given above is required the dame should be specified by the purchaser.

4. The eccentricity of the inner race is that lack of running truth noticed upon the stationary outer race when rotating the inner race and balls upon true centers. It may vary from .0008″ in the bearings of smaller bore to .0012″ in the larger sizes, with a mean of .0010″ in the medium bores.

The eccentricity of the outer race is that lack of running truth shown upon a suitable indicator during the rotation of the outer race and balls upon the inner race fixed upon a stationary arbor. It varies from .0012″ to .0018″ with a mean of .0016″ for the sizes of bearings as classified above.

5. The total axial freedom varies with the size of ball used and was specified as follows:

3/16″ to 7/16″ ball to have total axial freedom of from .005″ to .01
1/2″ to 11/16″ ball to have total axial freedom of from .008″ to .015
3/4″ to 1 1/8″ ball to have total axial freedom of from .010″ to .020

In the absence of a standard method of measuring axial freedom, it has been later recommended that definite figures for the allowable amount of the axial freedom be eliminated from the recommended practice of the Society.

6. The corners at the bore of the inner race shall vary from 1 to 3 mm. (.04″ to .12″) in radius, according to the bearing size. The corners of the outside race shall be chamfered the same as the inside. A 45° chamfer ground true, both with the bore and the outside diameter was recommended by the Committee.

The question of chamfers has been the most vexing problem confronting the committee and the above seems to be a fairly agreeable size. It is the almost universally used by the foreign manufacturers. Some engineers wish to fit a bearing against a large shoulder with a large fillet and hence desire a large chamfer. A washer placed back of the bearing improves the situation by rounding the inner corner of the washer to fit the fillet and the outer corner to fit the chamfer of the bearing. This has been used especially in wheel work.

THE POSITION OF THE ENGINEER.

ABSTRACT *of Address given at the Sixth Annual Convention of Triangle*

BY IRA OSBORNE BAKER, *Doctor of Engineering, Professor of Civil Engineering University of Illinois.*

I was truly glad to accept the invitation of the committee to speak to you tonight, because of my interest in Triangle, and also because of a desire to say a helpful word to promising young civil engineers. For more than forty years I have been especially interested in civil engineering students and graduates; and I do not know where one could find a more promising group to whom he might bring a message of encouragement.

There are not lacking those who claim that the engineer does not occupy the position in his community to which he is entitled by virtue of the time given to his professional preparation or because of his intellectual ability. It is often claimed that engineering is a learned profession; but it is said that the engineer does not occupy as high a position among his fellows as does the lawyer, the doctor, or the preacher, members of the other learned professions. The usual requirements for admission to a collegiate engineering course, and also for graduation, are higher than is generally required for the lawyer or the doctor, and the engineer's education is usually more than that of some influential preachers; but nevertheless these professional men occupy a position of greater distinction in the community than does the engineer. It is seldom that an engineer takes a leading part in the discussion of questions relating to municipal franchises for street railroads or electric lighting, even though these are engineering matters; nor is it usual that the engineer has as prominent a position in the discussion of questions relating to city water supply or sewage disposal as the physician, even though these matters are in the field of the engineer. Again, the engineer is not as prominent in the discussion of moral and civic questions as is the preacher, although the engineer ought to be interested in public affairs.

Again, who makes the laws for the city or the state? I think you will all agree that the engineers are not represented in such work in proportion to either their numbers or their intellectual ability. If time permitted, it would not be difficult to show that in many cases state legislation has been unfortunate in that it has not been guided by sound engineering wisdom. It will be sufficient to cite one or two examples. In the cities of Illinois the law permits the owners of abutting property to decide upon the kind of paving material to be used in the adjoining streets, but makes the city responsible for the maintenance and renewal of the pavement; and consequently the property owners, at least frequently, select the pavement of least first cost regardless of the efficiency and ultimate economy of the pavement. Numerous more glaring errors could be cited in several states concerning highway legislation; and similar examples could be cited in municipal ordinances concerning public utilities and public improvements.

It is also claimed that the engineer does not rise to the higher administrative positions as often as his training and experience would warrant, or as often as his professional services are really required. In how many states are there engineers on the railway commissions or in the public utilities commissions? Not many railway engineers rise to the higher administrative positions, at least not in proportion to their own numbers and to the number of such positions.

Of course, there are noted individual exceptions to the claim that the engineer does not receive his proportion of the higher administrative positions, and there are also noted examples of engineer's organizations rendering valuable aid in public affairs; but nevertheless I think the views I have stated are substantially correct for the representative engineer and engineering organization.

The public realizes reasonably well the need of an engineer in certain lines; but usually regards him as being well versed in technical matters only, and does not regard him as a man whose opinion has weight in non-technical matters. Too often he is simply a tool of others.

It is worth while then to inquire why the engineer does not have a more prominent position among his neighbors, and why he does not more often rise to the higher administrative positions.

In the first place, this lack of influence is not because of lack of education, for the usual requirements for admission and graduation for enginers are at least equal to those ordinarily required for lawyers and doctors. Further, that the engineer does not occupy these positions, is not because of lack of need of his services, for many of the public positions demand the qualities of mind and the experience possessed in a large degree by engineers. Again, it is not because of lack of intellectual ability that engineers are not influential in their community.

The failure of engineers to acquire a position worthy of their professional training and intellectual ability is partly because many of them work in isolation. For example, an engineer may spend two or three years in an uninhabited region in constructing a water-power development or in driving a tunnel through the mountains, and thus be deprived of the opportunities to mingle with his fellows or to participate in public affairs.

But I am persuaded that the chief reason why the engineer does not attain to the position in the public estimation which he might occupy is because of wrong ideals. The representative engineer magnifies the importance of technical matters. In college he is insistent upon acquiring a so-called practical education, that is, he desires to specialize and to take only the subjects immediately connected with his chosen profession. As a consequence, he lacks breadth of view and is weak in knowledge of non-professional matters. Too often he has sought to perfect himself in technical details to the neglect of a knowledge of political procedure, of business methods, of labor conditions, or of social problems. Further, he is often seriously deficient in the ability to use correct and forceful language.

What then can the engineer do to improve his position in society, or rather what can you do, my young friends, to prepare yourselves for a wider usefulness and a larger success. I have several definite suggestions:

1. Conserve your health, be strictly honest, and keep your heart pure. Considering my audience, I need not say any more on these matters.

2. By continual care and practice, cultivate the ability to express yourself in writing and in oral speech in clear, concise, correct English. There is nothing more necessary to the young engineer who desires to attain more than a mediocre success.

3. Extend your horizon by reading and study of industrial and political history, political and social science, economics, labor problems, principles of banking, rate regulation, and other vital subjects that will suggest themselves. There are numerous volumes on any of these subjects that are intensely interesting and instructive.

Reading along these lines will be of inestimable value in widening your horizon and in increasing your knowledge; but such study may also easily be made of greater importance as intellectual training. Thus far you have devoted nearly all of your time to the study of absolute truth. The facts have been placed before you, and you have been expected to acquire a comprehension of the principles and to apply them to stated examples. Heretofore you have been dealing with the science of necessary conclusions; but hereafter you will deal with problems to which you can find only probable answers. In many of the problems with which you must deal in the future, the principles to be employed will not be stated, and it will be necessary for you to discover the fundamental relations for yourself. Further, you will find that there is conflict between some of the factors, and you will be called upon to discriminate as to the weight to be given to the various elements of the problem. This will require accurate observation, close analysis, and careful judgment. A study of the subjects I mentioned will afford you stimulating intellectual exercise along new lines. Many problems arise in practical life in which the principles involved are not stated with anything like the clearness of the problems that you have confronted thus far. In a sense your training has unfitted you for the solution of these newer problems, since you have not usually been accustomed to discover the fundamental principles, nor to weigh the factors, nor to harmonize discordant elements. I am sorry that I can not take time to discuss this point more fully.

4. Be careful in selecting your associates. A leading American civil engineer who was just getting started in his professional career once said that he could not afford to go to the annual convention of the American Society of Civil Engineers because he wanted to join a certain club, the leading club in the city in which he lived, for which the entrance dues were $600.

He said that he wanted to make the acquaintance of the men in that club, for they virtually controlled the commercial affairs of that metropolis. Do not misunderstand me. This man did not entirely neglect technical societies, but he did join the club referred to, and now he has an annual salary of $50,000 and gets some large fees besides. The initiation fee to the club was not wasted; and his success was not simply luck. I am glad to know that two promising young civil engineering friends of mine have recently joined that same club.

5. There is a radical change that comes when a man leaves college, which many graduates fail to understand. Before graduation, the chief object of those who have affected your life most, your parents, your teachers, your friends, has been to serve you; and your sole purpose has been to receive. But after graduation, the chief object of your life must be to serve others. Before graduation your chief ambition was to know, but after graduation your chief duty will be to do. The change of attitude from being continually expected to receive, to one in which you are expected to give, is very great; and not unlikely will cause you to make some unconscious mistakes. For example, if a few weeks or months after graduation your work has ceased to be instructive, you may not ask your employer to change it solely to enable you to secure more valuable experience, for it is your duty to put his interests above your own. Young graduates frequently fail to appreciate the difference in relationship to them of the professor and the employer, and do not understand the difference between their own relationship to the college and to the company. Further, the employer is likely to be more exacting as to attendance and promptness, and to demand more as to compliance with instructions than the college professor; and it is usually necessary that he should be more exacting. These matters may seem to be small, but a proper understanding of them is necessary for success if one works for others.

6. Do not become a man of technical details nor a man of books to the exclusion of a knowledge of affairs. In the first place, the successful engineer must buy materials; and therefore he must have a knowledge of market conditions and of business methods. These come only by close observation. Notice that I do not say they come by experience. Of course, they come

through experience; but experience alone does not give the necessary knowledge. They come only through thoughtful observation and careful analysis. In the second place, a successful engineer directs the labors of others; and therefore he must know much of the motives that influence men, and must understand the point of view of organized labor, and should have at least some knowledge of the advantages and disadvantages of the different methods of payment. In the third place, an engineer is frequently called upon to report upon projects; and therefore he should be able to foresee all the industrial, commercial, and financial conditions involved in the project, and should be able to accurately discriminate as to the relative importance of the various conflicting factors. In the fourth place, the engineer writes specifications and makes contracts and therefore he should know something of the intricacies of the law. In short, the successful engineer must have technical knowledge, but he must also be a man of affairs, knowing men and business methods.

7. Participate in public affairs, not only to discharge your political and social duties, but also because of the development and breadth of view that will come to you.

I was pleased to hear incidentally this afternoon that the civil engineering students of Purdue University held a proportionally large number of the college political offices, which is instructive as showing their interest in public affairs, and also their ability for leadership.

8. Finally, be courageous, have an ambition for a large success and then work hard to attain the goal. May abundant success crown your efforts, and real joy attend you through a long and useful life.

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EDITORIALS.

For the twentieth time the Wisconsin Engineer extends its greetings to the students of the College of Engineering in particular, and just as particularly to the alumni of the College, who have made it what it is. We can not improve on the old wish for a most successful year. Nothing succeeds like success anyway.

We'd like to steal just a little space to ask every engineer, whether he is still an undergraduate or has left the campus, for his sincere support. We have the temerity to believe that we deserve support. We know that we have the goods to deliver and no excuses to offer. Our last year was successful. We gave you the best we had then. We are ambitious, and therefore we are saying now in black and white that we are in the field to give something still better this year, just so that we will have something of a promise to you to live up to.

The position of you alumni is well nigh impregnable. We can not force you to help us unless you so desire. You do not have the time to be a subscription rustler. Nor a news gatherer, as such. Nor anything at all, if you choose. But a little hint to the other grad in town about the ENGINEER. A little jog in the memory that will spread the news, through us, of his marriage perhaps, or even his "raise." It's the little things that count. We certainly are grateful for your earnest support thus far, and only hope for a continuation of grace.

What we would like to say to the students is that there is always room for one more on our staff, provided that you do not expect to be carried along as dead weight. There is work to do right now. Drop in and have a talk. Ask for a job.

* * *

At the University of Wisconsin there are, as all learn sooner or later, sundry traditions, varying widely in importance and character. It is a tradition that a Freshman may not smoke on the campus. Also green caps. Sometimes a freshman forgets about engineering steps.

It is no less a tradition that the College of Engineering shall give the Big Minstrel Show every other year, and under this tradition this year should see a return engagement. Shall the Engineers have a Minstrel? We've got to decide soon in order to get favorable passage by the Student Interests Committee. This time the whole mass of the College, down to the very last molecule, has got to show the enthusiasm or we won't get by.

* * *

The question of material should not be a very vexing one, in view of recent concerts on the Engineering Building steps. May the mere passage of a few months of vacation not dim the memory of those regular sings. Nor dampen the enthusiasm.

"Gentlemen, be seated."

CAMPUS NOTES

There will be few new faces among the faculty for the coming year, and at present writing, less than two weeks before the opening of the semester, two of these are not yet publishable.

To the Steam and Gas Department comes Mr. J. G. Callan as the head. Mr. Callan is a consulting engineer of wide experience and should bring a wide fund of extra-curricular information with him. Professor Callan comes from Boston.

Not one of us but will regret the resignation of Professor J. G. D. Mack, who has accepted an excellent position with the State Railroad Commission. Mr. Mack has been vitally interested in everything connected with student life and has given himself heartily to their interests, and does not even mind being called Father of the Engineer's Club, which recently celebrated its Twentieth Anniversary. The WISCONSIN ENGINEER will lose in him a valuable advisor. But certainly we wish him every possible success in the new position which he assumes.

There have been several promotions in title among the faculty. Associate Professorships have been given to four Assistant Professors: Corp, Withey, Van Hagen and Kinne.

* * *

Prof. Edward D. Kingman, who has been handling the field work in railway location for the past two years, has resigned. He has been spending the summer with his people in the east.

* * *

Mr. Leonard Francis Boon, who has been appointed instructor in railway engineering, is a Wisconsin graduate and a member of Tau Beta Pi. He received his B. S. degree in 1910 and the degree of C. E. in 1912. Mr. Boon's railway experience covers a period of six years between 1903 and 1909 and includes location and construction work with the Chicago and Northwestern, the Wisconsin Central and the Chicago, Milwaukee and Puget Sound Railways. For the past five years he has been a member of the joint engineering staff of the state tax and railroad commissions which position has afforded him exceptional opportunities to become familiar with railway regulation and valuation work.

* * *

The field work in the course in railway location and construction, which is taken by the junior civil engineering students during the first semester, will, as usual cover the survey and location of a two mile line of railway from a point near the engineering building to a connection with the Illinois Central Railroad, south of University Heights. This line affords an ideal problem in location. The line swings out of the Illinois Central main line and rises to a summit on the saddle between University Heights and the cemetery where it crosses the track of the Southern Wisconsin Railway. From there it curves through the gap and winds down the north slope on a stiff grade to a crossing with the Chicago, Milwaukee & St. Paul Railway. Thence across the flats to the edge of the lake where it skirts along the hillside to the desired terminus.

The field parties are organized as is customary in railway work and the students are "rotated in office" so that everyone has an opportunity to fill the responsible positions and to display, or acquire to some degree, the capacity for handling such parties.

The work this year will be under the supervision of Prof. Van Hagan assisted by Messrs. Boon and Hopkins.

* * *

The course in Railway Valuation this semester will be given by Mr. Boon.

* * *

We suspect that even the old grads will be interested in the new sill at the front door of E. B. After millions of shoes had worn the sandstone sill into a small Culebra Cut, just when it was getting to be a sort of land mark, it has been removed, and a very prosaic concrete sill substituted.

How about the minstrels?

If you are not under compulsion to visit the Steam and Gas Lab this semester, drop in the gallery and take a look at the new units. Notice also the crowded condition, which indicates that we are getting the best equipment that can be given. Mr. Black is certainly equipping a regular laboratory.

Freshmen ought to watch the bulletin boards of the various engineering societies on the second floor. You will be wanting to enter an engineering club sooner or later, or you are not cut cut for a good engineer, and you will profit my making your choice, and getting in the swim now.

ALUMNI NOTES

Alumni news is hard to get in the summer, when this first issue is gotten ready. We are out of touch. Hence what we give in this issue is very scattering, and is not a fair sample of what will follow.

We have an interesting little story in itself of the Wisconsin Colony which has recently been founded at Dayton, Ohio. The official name of the colony is the Wisconsin-Dayton Club, and was formed at one of the regular Saturday afternoon luncheons with twenty men present. Mr. Upson is president, A. A. Ort, vice-president, and H. A. Anderton, secretary. Fifteen of the twenty men are engineers connected with the Delco Plant and the Miami Conservancy District. Out of about sixty men on the staff there are fourteen Wisconsin men with the District.

Professor Mead is a member of the Board of Consulting Engineers, and is acting Chief Engineer.

Professor Corp is conducting the experimental work.

Mr. Weidner, of the Hydraulic Department, is connected with the channel experiment work.

The other men are Mr. A. Elmendorf, of the Mechanics Department, C. P. Conrad, '15, who returns to Madison, Byron Bird and A. B. Clement, c e '15, A. A. Ort, c e '12, I. H. Doolittle, K. B. Bragg, S. H. Seelye, H. H. Wesle, and Myron Cornish, all c '15.

H. A. Anderton, m '15, and R. H. Grambsch. e '15, are in the repairing and testing departments, respectively, of the Delco plant.

The Miami Conservancy district work is to cost in the neighborhood of $20,000,000 and will last four to five years.

The following card has just been received from Chicago:

Ray Palmer, formerly commissioner of gas and electricity of Chicago, announces that he has resumed his consulting engineering practice and is prepared to advise about or undertake general supervision of re-organizations, valuations, rates, lighting and other public utility or industrial problems requiring expert engineering and accounting service.

Mr. Palmer graduated in 1901 from the Electrical Engineering course. He is a Fellow of A. I. E. E. and Member of W. S. E.

When the class of 1915 left school we take it that not many were situated, or were very reticent about their positions. The following is all the information we could glean from the records:

Walter H. Steimke is with J. F. Dornfield, 2148 Washington Blvd., Chicago, but the nature of the position is not disclosed.

Jack Edwards is with the Illinois Zinc Co., Peru, Ill.

Jake Trantin is in the Inspection Department of the Lackawanna Steel Co.

Roman Schmid is with the Patton Paint Co.

H. R. Parker is with the Laclede Gas Company, St. Louis.

W. R. McCann has taken the position of Secretary of the State Public Utilities Commission of Illinois, at Springfield.

Gerry Wells thought last June that he would be a salesman with the Wagen Electric at St. Louis. Can some one enlighten us?

Even Pardee says his position is to horizontal.

D. F. Schlindler is with the Johnson Zinc Smelter, Keokuk, Iowa.

Arch Case tells us in his flowing hand that he is to be on New York Subway Extension work.—flourish.

Cuthbert Conrad is to be Fellow in the College of Engineering this year.

T. Reyes is to be in the Philippine Government employ.

Hoy Clayton is inspecting Roads and Pavements for the City of Milwaukee.

Gilman Smith is going to do graduate work at Boston Tech.

Les Rogers is on Concrete Tunnel Lining work at Glacier, B. C., with the Bates-Rogers Company.

Carrington H. Stone is with the American Carbon Company of St. Louis. He will be building them a wireless, we dare say, before he leaves.

V. J. Vallette is with the Superior Ladder Co., Goshen Ind.

Bill Zachow signs as Fireman on the Soo Line, but we have it from Tommy of the Steam and Gas Lab, that his term as fireman only lasted through three apprentice runs, and that he is now at work on cost reducing.

E. J. Connell is with the Llewellyn Iron Works, Los Angeles, Cal.

Ernie Lange is taking the graduate course at Westinghouse.

Skinner deserves a new line, but is doing the same.

Harry Hersh is in the Commercial Department of the Milwaukee E. R. & L. Co.

We have just received word of the death of F. C. Hencke, c '10, of Wautoma, Wis. The date and details have been as yet unattainable.