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OF THE

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FARRAR PETRIE HAMILTON

PROCEEDINGS

OF THE

LOUISIANA ENGINEERING SOCIETY

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EDITORIAL NOTES AND COMMENT

President Hamilton. Mr. Farrar Petrie Hamilton, elected to the presidency of the Louisiana Engineering Society at the annual meeting in January, was born in Hinds County, Mississippi, in February, 1878.

He was educated at Pantops Academy in Virginia, and at Washington and Lee University, where he received his engineering degree, graduating from the latter institution in 1899.

Mr. Hamilton acquired his early practical experience in various lines of engineering activity in and about Jackson, Mississippi, over a period extending from 1899 to 1904.

In 1906 he was employed as resident engineer on the New Orleans Great Northern Railroad. From that work he went to St. Louis, where he was located for the next four years.

Having been superintendent of street paving for the Gulfport Creosoting Company during the latter part of 1910, Mr. Hamilton then engaged for the next four years in the business of wood block paving, having been consecutively salesman, superintendent, district manager and vice-president of the Creosoted Wood Block Paving Co., of New Orleans.

From 1915 to 1917 he was paving engineer for the Southern Pine Association of New Orleans. This was followed by some railway and asphalt paving experience until the beginning of 1918, when he joined the office force of the Creosoted Materials Company, occupying successively the positions of salesman, sales manager, vice-president and finally president, which office he now holds.

Mr. Hamilton is an Associate Member of the American Society of Civil Engineers, member of the American Wood Preservers' Association, and a resident member of the Louisiana Engineering Society since 1915.

He has served the Society as Director and as Vice-President, and, therefore, comes to the President's chair thoroughly imbued with the best traditions of the Society and with that spirit of loyalty to its interests which is so characteristic of the membership of the Louisiana Engineering Society. This spirit coupled with Mr. Hamilton's own well-known energy and initiative insures for the Society in advance an interesting and profitable season for the year 1926.

Official Staff for 1926. In addition to Mr. Hamilton as President, elected at the annual meeting were Mr. Edward S. Lanphier, Vice-President, and Professor Frederick H. Fox to serve for three years as member of the Board of Direction. Mr. Frank A. Muth was re-elected Secretary and Mr. Walter B. Moses, Treasurer.

A special meeting of the Board of Direction was held January 9, 1926, in order to elect two members to fill the unexpired terms of Mr. Lanphier and of Mr. O. P. Adams, the latter having moved away from New Orleans. This resulted in the election of Mr. John L. Porter to serve one year and Mr. W. L. Fey to serve two years.

New Members. Since the publication of the last issue of the Proceedings the following members have been elected to the Society:

Resident Members.

Alexander Allison, Jr., Office Engineer with Sewerage and Water Board.

Chester W. Carr, Manager, E. W. Carr, Inc.

Lloyd G. Frost, Hedrick and Frost, Consulting Engineers.

Joseph J. Krebs, Principal Assistant Engineer, City Engineers' Office.

Walter J. Manion, Consulting Marine Engineer.

Thomas M. McCarroll, with Board of State Engineers.

Howard N. Moody, Consulting and Contracting Engineer.

Benjamin J. Oliveira, Assistant Engineer, Sewerage and Water Board.

Adloe Orr, Consulting Engineer.

Patrick H. Quinlan, Assistant Engineer, City Engineers' Office.

Grover C. Rackerby, with Board of Commissioners, Port of New Orleans.

Russ F. Wills, Terminal Engineer, Southern Pacific Railroad.

Non-Resident Members.

James A. Barksdale, Gulfport, Miss., Consulting Engineer.

Edward G. Freiler, Kentwood, La., Consulting Engineer.

Associate Member.

William H. Garges, Specialty Salesman with J. Watts Kearny & Sons, New Orleans.

Resident Junior Member.

Robert V. Markey, Draftsman.

Transfer from Student to Junior Member.

Francis A. Landrieu, with Board of Commissioners, Port of New Orleans.

Student Members.

Philip H. Campbell,
William H. Creighton,
Robert J. Dreuding,
Fernando Ensenat,
William W. Hay,
Frank E. Johnson,
G. Elmer May,
William O. Mascaro,
Leal C. H. McLean,
Eugene H. Miazza,
Walter W. Oser,
Pascal Pareti, Jr.,
Hartwell J. Rosson,
Ben Z. Segall,
David Stayer,
Lucien T. Vivien, Jr.,
Stephen J. Wallbillich.

All Senior Engineering Students in Tulane University.

The Annual Smoker. The word **annual** is used advisedly here, because, by common consent, the smoker has come to be the standard form of entertainment for the members of the Louisiana Engineering Society at the close of each annual meeting in January. And if their strength, both physical and mental, will survive the strain of furnishing the "pep" and entertainment for this annual function, we shall hope to see Mr. Ole K. Olsen and Mr. Walter B. Moses appointed as a perpetual standing committee on the Smoker.

Held this year in the main dining room of the Chess, Checkers and Whist Club the smoker was a great success with an unusually large attendance, plenty of noise and spirit(s), and all the other good things that go when a bunch of good fellows, like the engineers, get together.

Mr. Allen T. Dusenbury was the toastmaster and he conducted the affair in his usual spirited manner, not permitting any of the speakers to become either prosy or prolix.

The professional part of the entertainment, while of a decidedly Semitic flavor, was certainly not lacking in that quality which is supposed to be the criterion of a properly cooked beefsteak. In fact, some parts of it were so rare that they might be considered as rather underdone or raw.

But who should worry? Anthony Comstock did not seem to!

The honored guests of the evening were Attorney General Saint, Col. C. McD. Townsend, Commandant H. A. McClure, Major H. S. Bennion, and our one and only Honorary Member, Sidney F. Lewis.

The Diesel Engine. Under this title Mr. James M. Todd contributed a very interesting paper to the exercises of the Society at its meeting of December 14, 1925. The paper traces the early history and development of the internal combustion engine, and explains the contrasting features of the principles of operation of the Diesel engine and the ordinary gas or gasoline engine.

The inventor of this type of engine, dating from 1892, was Dr. Rudolf Diesel, a German engineer, while the first design of its type to be built in this country was designed and constructed by Adolphus Busch, of St. Louis, in 1898. This was a 60-horsepower engine, and so rapid has been the development of the type that figures for 1925 show the year's output to be 1,500,000 horsepower.

Mr. Todd's paper was illustrated with a large number of lantern slides. As it was not practicable to reproduce these illustrations in the Proceedings, the paper as printed in this issue necessary omits a considerable portion of the descriptive matter.

Report of Special Committee to Re-establish a Geological Survey in Louisiana. Louisiana has never had a geological survey, which functioned as an independent organization. As far as I have been able to deduce from records, between about the years 1898-1908 a geological division was attached to the old Louisiana State Board of Agriculture and Immigration in cooperation with the Geological Department of Cornell University and the United States Geological Survey. Splendid geological work was commenced and accomplished under the competent part-time work and supervision of Prof. G. D. Harris, of Cornell, and Mr. A. C. Veatch, of the United States Geological Survey, and others.

From compiled statistics of the year 1921, I find that there was then in existence in the United States organizations functioning as geological surveys in forty-one of the forty-eight States. This ratio has probably been further reduced since that time, therefore it may be readily seen that Louisiana is one of the few or only State in the entire United States which does not have a geological survey.

At the present time, we are completely surrounded by States having State geological surveys, namely, the States of Texas, Oklahoma, Arkansas, Mississippi and Alabama. In round numbers Texas spent almost a quarter of a million dollars on the State geological survey.

A few of the reasons why I believe a state geological survey should be established:

I. In her mineral resources, Louisiana is potentially one of the richest States in the Union. Millions of dollars of outside capital is yearly invested in the exploitation and winning of some of these resources, such as oil, gas, sulphur and salt. And additional yearly millions would in all probability be invested if we had a comprehensive survey of all of our metalliperous and non-metalliperous deposits. Throughout the entire year the Geological Department of the Tulane University, and I am certain the same is true of Louisiana State University, is receiving letters of inquiry from individuals and corporations in regard to Louisiana's mineral resources. I have here a typical letter which I received less than a month ago and which I will read. Exhibit 1.

II. To date less than one-eighth of the topography of Louisiana has been surveyed and mapped. This may be readily seen by referring to the United States topographic index map of Louisiana.

III. We have no area maps showing the distribution of soils according to their fertility or suitability for certain agricultural crops.

IV. We have no atlas of index fossils, which is almost the sole criteria for correlating the stratigraphy of our beds which is so essential in differentiating between productive and non-productive horizons.

In conclusion I desire to state that at the present time other societies within the State are now working on this very problem. And since this committee commenced its work on the drafting of resolutions I have received letters from the secretary of the Louisiana-Arkansas Division of the Mid-Continent Oil and Gas Association and from the president of the Louisiana Section of the American Association of Petroleum Geologists assuring us that we will receive the cordial cooperation of their societies.

Resolution presented by committee:

WHEREAS, we believe that a geological survey in the State of Louisiana would be of the greatest value in solving many of the economic, agricultural and engineering problems of a nature peculiar to our State by supplying necessary maps, bulletins, and general information,

RESOLVED, That the State geological survey should be reestablished.

Signed:

R. A. STEINMAYER,
E. T. PAYNE,
ALF. F. THEARD,
Committee.

PAPERS AND DISCUSSIONS

THE ENGINEER IN PUBLIC LIFE.

Address of the Retiring President,
MARCEL GARSAUD.

To write of the engineer in public life is to write of him as a public servant. Sound engineering training, the bedstone on which all engineering practice is founded, cannot but fit the engineer for a life of service; to think of him in any other light but that of serving mankind would be to think of him as engaged in a pursuit foreign to his chosen profession.

Most people, even including engineers, once thought that for an engineer to become a public man, or a public servant, meant his entrance into politics. It must be admitted that our system of government, national, state, and municipal, and the condition of our polities in years previous, were ground enough for this belief. Up to a recent period, our country, our states, and our cities, advanced scientifically and progressed economically, not merely because the forces leading and controlling science and economics were at work, but because our country was so new, and growing so fast, that the march onward was irresistible, and was taking place quite frequently unassisted by the administrators of government.

We have now come to the point where civic leadership and political command must be trained. The public is being rapidly educated to the view that it is not sufficient for the thinking, the planning, and the execution of its construction works to be in the hands of engineers; the administrative and legislative functions of our government are so closely and intimately related to the science of engineering, that control and guidance must no longer be obtained through the channel of politics, but this control and guidance must be directly in the hands of men who have trained themselves for that purpose.

If any proof is needed to demonstrate this new public realization of the engineer's true place in public life, there is but need to mention a few significant facts which have taken place in this country in the past five years.

In our national government we behold as Secretary of Commerce a man who is an engineer. During the past few years, in this department of our federal government, an engineer has demonstrated so ably, and so irrefutably, the qualifications of the engineering profession for the mapping out of sound governmental doctrines that, today, Congress and the President look to that department for advice and guidance in constructive thought.

Examine the question at issue between Chicago and the rest of the country bordering on the Great Lakes, which question has really assumed an international aspect between the United States and Canada, involving the withdrawal of water from Lake Michigan. We find a Board of Review of some twenty-five men, nationally known, chosen for the specific purpose of studying this problem and arriving at some definite recommendation. This is a question which not only involves engineering knowledge but affects commerce and industry as well.

This Board of Review, composed of twenty-five men, is composed of twenty-five engineers. The same holds true of several other just as important and vital issues ,which recently have also assumed international proportion.

The governing of cities by the old form of aldermanic government has given way to the new form of government by commission council. This in turn is being replaced by the form of municipal government known as "City Manager." Under this system, the Mayor and Commission Council act as the legislative branch of the city government, but all of the executive and administrative duties usually performed by the Mayor and commissioners are in the hands of one man known as City Manager. This system is proving very efficient and popular, and some of our largest cities, Cleveland, Ohio, for instance ,have adopted and are satisfied with its operations.

Let us examine the list of city managers who have been in office for some time, and who have demonstrated ability, good judgment, and who have contributed very largely to the success of this form of government; we find on this list the names of men whose names we find also on the roster of our best engineering societies.

The proper place of the engineer in public life has been established in the past few years through a sheer demand for that sort of service. The engineer is becoming the administrator of the public will, not so much of his own wish, but rather because the services he can render are so badly needed by all forms of community activities that he has in reality been drafted into service.

We can well ask ourselves whether the profession, in its misplaced modesty, has kept faith with its duty to this country.

I am not speaking now of the brazenness and forwardness which we find in all professions, but I am speaking rather of the assertiveness, borne of knowledge of the right and of self-confidence, which, I believe, the engineer should exercise more frequently, and with greater insistence.

When I say that, I have not in mind the advancement or aggrandizement of the engineer, but I have in mind the welfare and progress of the cities and states. That the work accomplished by an engineer for the public will gain him recognition, even in spite of his own efforts to dim his accomplishments, is well illustrated by the recent election in our own city of an engineer as Commissioner of Public Property by the votes of three different political parties. Of course, it seems obvious that an engineer should be elected as the head of a department of public property, the work of this department involving so many engineering features, and so much construction work; but a little thought would soon convince us that exactly the same principles apply, and the same reasons exist, why other departments of city government should be headed by an engineer.

The Department of Public Utilities is one in which the head of it must of necessity deal in engineering problems. There is no question presented to him, no solution that he can work out, without bringing into play principles of engineering.

Public utilities go toward creating not only comfort and convenience for the public, but, what is more important, go toward creating and operating the agencies which enable the public to work and to live. Transportation, power, fuel, drainage, sewerage and water involve the transformation of the products of nature for use by mankind, and this transformation takes place by reason of the efforts which the engineer brings to the accomplishment of science. Even public safety today has reached such a stage as to put it beyond the realm of any one but the engineer to find a solution so that the movement through our public streets cannot only be expedited but made safe.

The attempt has been made thus far to establish the irrefutable fact that public service demands efficient and disciplined training, and that such training is best supplied by the engineering profession. The next thought that arises, naturally, is what will the public demand of the engineer as a public man.

Up to this time, the services of an engineer have been obtained on the same basis as those of any other hired employee, and the nature of that service has been purely technical, and, one might say, advisory. Our communities today are groping in the dark and are seeking more than technical advice; they are badly in need of disciplined administrative leadership. Our people have awakened, and the day is breaking when our citizenship will recognize that their civic leaders must primarily possess engineering qualifications; it is not too hopeful to say that these civic leaders of tomorrow will be engineers.

What are those engineers who have been placed in public life by opportunity, or who are about to be so placed, doing to fit themselves for the new work and reconcile themselves to the new conditions. Too much emphasis cannot be placed in the statement that, if the engineer in public life depends solely on his engineering training to carry him through, and on his ability to dispense his services to the community to the best advantage, he is doomed to disappointment.

The transition from political leadership to trained leadership cannot be made without the sacrifice by both of some of the doctrines and tenets of the political leader and of the engineer. The political leader is clever and shrewd, and will be the first one to adjust himself to his new status. The engineer, however, has been trained in a school which teaches doctrines diametrically opposed to some of the beliefs held by men who now occupy the field which he is seeking to enter. The trained man, therefore, must be prepared to understand the dogmas of the old system of government, and he must be prepared to exercise wise judgment and sound discretion in dealing with the eradication of such of those dogmas which should be eradicated.

No doubt this will require sacrifices on his part; sacrifices, not in the abandonment of principles, but in the postponement of their application. If the field of governmental administration is worth invading by the engineer, the value of this step is commensurate with the big things that may thereby be accomplished; to bring about the fulfillment of his ideas and his aims, to do big things, the engineer who enters public life should be willing, patiently and diplomatically, to attempt to mold the actions of his new coworkers very much in the same way in which he has been taught to mold the forces of nature and cause them to bend at his will and wish.

If the engineer undertakes in his profession to deal with the new problems with which he is being confronted, it must be solely for the attainment of the public good and the public welfare. He must submerge himself, as it were, and forever keep in mind the public weal; otherwise, failure in his new field awaits him.

There is still another factor which must be touched upon in an address of this kind. What are our schools and colleges doing to prepare their young graduates for the new civic branch of the profession? It is obvious to those who have stepped forward and undertaken the new work that the demand for technical men as administrators of government will in the very near future exceed the supply of those who are willing, and have been able to fit themselves by training, to accept the assignment. We will need young men who can be taken from schools with a rudimentary knowledge of this new branch of the profession, men who can thus grasp the difficulties encountered without having to go through so many long years of the valuable but, in these modern days, entirely too slow school of experience.

Therefore, we must look forward and we must encourage our engineering colleges to include in their curriculum courses in business principles, and courses in the administration of government in its most important phases.

The University of Paris, France, seems to lead the way by its recent adoption, through presidential decree, of a School of Higher Civics and Public Administration, intended for the training of city officials and city planners.

The writer can conceive of no nobler work which could be done by the Louisiana Engineering Society than if it devoted its best efforts for the next few years to a policy of assisting our two universities in preparing some of their engineering graduates for a public life, and also to devise ways and means whereby the Society's own activities would place the best talent within its membership at the service of the community when the need arises.

THE DIESEL ENGINE.

By James M. Todd.

Read Before the Society, December 14, 1925.

The internal combustion engine has developed so rapidly in the last few years that we hardly realize the important position it occupies in our commercial life and the vital place it holds in our national life.

Without the internal combustion engine in types ranging from the gasoline engine to the large full Diesel engines our progress would be greatly limited. While the development and use of the internal combustion engine during the past ten years has been rapid, the next ten years will show even greater progress.

This progress will be along the lines of greater simplicity and the selection of finer materials to resist heat and power stresses that will allow longer life at a lower maintenance than any other type of prime mower.

The economy of the Diesel engine over steam has fully justified its preference for ship propulsion and in many cases for stationary plants.

It is interesting to note that an internal combustion engine was built long before Watt constructed his atmospheric steam engine. Due, however, to defects of operation in the early forms of internal combustion engines, the steam engine took precedence, and it was only during the latter part of the nineteenth century that the internal combustion engine came into commercial favor.

It had often been suggested that gun powder be used as a source of power, exploded in a closed vessel. Huyghens in 1680 appears to be the first successful builder of an internal combustion engine; and he employed the gun powder principle. His engine, however, was not very successful, and the internal combustion motor was then practically ignored until 1791.

At this time, John Barber, an Englishman, built an engine which made use of gas distilled from coal as a fuel. His machine was in reality a gas turbine, rather than a gas engine, and effort is still being made to develop a prime mover along these same lines.

The first successful marketable engine was developed by Lenior in 1860, and employed the double acting principle, with valves of the flat-port type, somewhat along the lines of steam engine practice, being operated by eccentrics. This engine employed pressure as high as seventy-five pounds, and hundreds were built and placed in commercial use. The gas consumption was very high, and the efficiency only about 4 per cent, which did not give very economical operation.

In 1862, Beau de Rochas, a Frenchman, proposed the cycle which is used by the majority of gas engines today. He never actually built an engine, though his proposed cycle has lived. His is the familiar suction, compression, ignition and expansion, and discharge cycle of the modern automobile motor.

In 1866, Otto, in Germany, designed a vertical engine with a free piston, employing a rack and clutch to revolve the crankshaft. This engine did not, however, meet with much success. Otto was not a quitter though, and the present Gas-Morten Frabrik Deutz, a German engine building company, was formed by Otto and Langen, and they brought out an engine known as the "Otto Silent" which made use of the de Rochas cycle. This engine created quite a furor at Paris in 1878. It was so superior to all engines developed to that date, that thousands were sold all over Europe, and many are sold at the present time. In 1921, the sales of these engines aggregated some 533,000 horsepower.

During this development, the New World was not asleep. A few years previous to the design of the "Otto Silent," George Brayton, a Philadelphian, secured patents on an engine along entirely individual lines. This engine burned either liquid or gaseous fuel, and burned it at constant pressure by means of a pilot light arrangement. This Brayton Cycle has much to commend it. It was the most efficient of all cycles, operating between the same temperature limits. However, for equal power, it required much larger cylinders than the Otto, so it was abandoned in favor of the much simpler machine.

About this time, the Clerk engine was developed. It operated on the two-cycle principle, and was th eforerunner of the modern two-cycle engine. It made use of a charging cylinder and flame or hot-bolt ignition. This engine, too, was not so favorably received, as it was not as simple as the "Otto Silent." Subsequently, however, many engines have been built using this two-cycle principle, but with compressing by the under side of the piston, in or about the crank case, in preference to a separate charging cylinder as was used by Clerk.

The pioneer of the hot-bolt or "surface ignition" engine was then developed by Charles Ackroyd Stuart, an Englishman. This engine was built by the Hornsby Company in England under the name of the "Hornsby-Ackroyd" Engine, and by the De La Vergne Machine Company in America under the name of the "H. A. Type." This machine operated on the four-stroke-cycle principle and ran a compression pressure seldom in excess of sixty pounds per square inch. Later development of this type used compression as high as 250 pounds per square inch, and attained satisfactory results.

In 1892, Dr. Rudolf Diesel, a German engineer, designed an engine to operate on the Carnot Cycle. This engine is based on the principle of heat addition at the highest temperature, and heat exhaust at the lowest temperature. Dr. Diesel proposed the use of coal dust as a fuel, with some form of explosive agent for the starting stroke. He constructed an engine on this principle, but wrecked it in his initial explosion. This caused some experiment, and a water-cooled engine, admitting heat at constant pressure instead of constant volume, was developed. The first of these engines ran very nicely, but was never able to carry any load. Further experiment converted this machine into a practical possibility, and in 1897 a practical engine of twenty-five horsepower, of vertical cross-head design, was produced.

This was the first European Diesel. The first American engine was built by Adolphus Busch, of St. Louis, in 1898, and was of sixty horsepower, two-cylinder, A-frame design. The first Marine Diesel was built in France in 1903, for use on canal boats, and worked on the four-stroke principle. In Russia, by virtue of the larger demand for marine engines, the development was greatest, and in 1908 Nobel Bros., of Petrograd, installed the first Submarine Diesel.

From this modest beginning the internal combustion engine has grown in favor by leaps and bounds. The uses and development of gas and gasoline engines are, no doubt, familiar to all, and the general use of the automobile engine has done much to remove the fear and dread of successful operation. We will pass on to the most recent advancement of this type of prime mover, the Crude Oil or Diesel Engine for discussion. In this country alone from sixty horsepower constructed in 1898 it has reached a total of 70,000 horsepower in 1922, and the latest authentic figures for 1925 place the year's output at 1,500,000 horsepower.

One of the interesting facts obtained by the study of the Diesen engine is the continuity of service afforded by this class of machinery. Many engineers hold decided views against crude oil engines, basing their prejudice on the statement that the Diesel engine does not stand up in service. To the contrary, no other prime mover can show such a record of continuous service. Out of a total of some 500,000 horsepower investigated, less than 8,000 horsepower are no longer in service, and some 2,000 horsepower of the discarded engines were installed in plants destroyed by fire, from causes other than those arising primarily from the engines.

Another phase of the development of the Diesel engine is the question of cylinder size. In the earlier types it was thought advisable to hold the cylinder sizes below 150 horsepower. The past few years, however, have seen the development of Diesel engines for both marine and stationary work in cylinder sizes as large as 750-950 horsepower for commercial purposes. There has been constructed by Sulzer Bros. in Switzerland, an experimental, simple-cylinder engine of 2,000 shaft horsepower, at 115 R. P. M. with bore of 39.4 inches and stroke of 43.3 inches. This engine gave very satisfactory results.

The uses to which the Diesel engine can be put are increasing rapidly. It finds its greatest fields, of course, in central station, oil pipe line and marine uses, but its scope is fast increasing to include refrigeration plants, mines and quarries, water works, pumping plants, railway locomotives and general industrial power.

In marine operation, the Diesel horsepower has reached some 1,700,000 total, and in submarines the installed horsepower will total above 200,000. This submarine figure is open to controversy because the navies of the world do not release these figures for authentic publication. At the present time 35 per cent of the world's new ship construction is having Diesel power as compared with 1.8 per cent in 1914.

I am assuming some familiarity on your part with the various types of Diesel engines which may be generally referred to as four-cycle and two-cycle—and either may be single acting or double acting, provided with either air injection or mechanical injection of the fuel, and of horizontal or vertical construction.

It is generally understood that a Diesel engine is that type of combustion engine in which ignition of the fuel is brought about by the heat of compression.

The manner in which this principle is carried out in an actual engine is best shown by an indicator card. Examination of such a card will show that the order of events is the same as in any four-cycle gas or gasoline engine. Here, however, the compression instead of being from 65 to 70 as in the case of gasoline engines, or about 120 as is used for natural gas, is around 500 pounds. The air, if taken in at say 60 degrees F. will by the time it is compressed reach a temperature of from 800-900 F. The exact temperature will vary with the ratio of the cooling surface of the cylinder walls to the total volume of aid and somewhat with the amount and temperature of cooling water being used. The clearance volume for a pressure of 500 pounds is only about 7 per cent of the cylinder displacement as compared with from 20 per cent to 30 per cent for the lower compression pressures just referred to. Just before dead center and when the compression has reached practically 500 pounds, the fuel is injected and immediately ignites due to the high temperature. It burns as the piston moves forward and is supposed to be entirely consumed by the time the piston reaches a certain point at which the gases then expand until the exhaust valve opens and the gases leave the cylinder exactly as in any other internal combustion engine.

A theoretic Diesel card would show a straight line at the top and the expansion curve would fall slightly more rapidly at the beginning of expansion. That it does not do so is due to the fact that not quite all of the fuel is consumed during the first part of the stroke.

It is mathematically proved and it is confirmed in practice that the efficiency of an internal combustion engine depends upon the compression pressure. The higher the compression, the less the amount of fuel required per B. H. P. hour. This explains to a very large extent the high efficiency of the Diesel engine, the compression being considerably more than double that of any other type of engine. The efficiency also varies with the length of cutoff, being greater the shorter this cutoff. This further explains why the efficiency of a Diesel engine does not fall off greatly at low loads, the thermal efficiency in the cylinder increasing with reduction of the load. The efficiency of the engine is also increased by the fact that pure air only and not a mixture of fuel and air is taken into the cylinder on the suction stroke.

These then are the essential features of the Diesel cycle. Compression of pure air to about 500 pounds, injection and burning of the fuel oil at this point and expansion of burnt gases from, followed by the exhaust and suction strokes, the latter two exactly as in the gas engine. The operation of this cycle in an engine requires a pump for delivering and at the same time measuring the oil; a compressor for furnishing the air with which to inject the oil and a spray valve to which both the air and oil are conducted, in which the air mingles with and atomizes the oil and through which the mixture sprays into the cylinder.

In the case of mechanical injection, the compressor is omitted and the atomization and delivery of the oil into the cylinder is accomplished by the pump and spray valve alone, the former working with increased pressure and the latter modified in design and functioning in a somewhat different manner.

In the case of air injection, compressed air delivered usually by a three or four stage compressor at 750 to 950 pounds is used to properly atomize the fuel and inject it into the power cylinder. Engines using mechanical injection instead of compressed air have fuel pumps somewhat similar in principle for both types but operating against pressures of from 1,500 to as high as 4,000 pounds.

In the air injection type the fuel valve is actuated by a cam while in the mechanical type the fuel valve is opened by the pressure produced by the pump.

These three mechanisms, the spray valve, the air compressor and the fuel pump are the features wherein a Diesel engine differs from other internal combustion engines.

These pressures to which we refer, the compression pressure, the spray air and the working pressure of the oil, may sound high and possibly alarming to anyone unaccustomed to the comparatively low pressures of steam practice, but the question is simply one of designing for these pressures, together with the careful selection of the proper grade of iron and other materials, and, equally important, accurate machine work and assembling.

(Note: The continuation of Mr. Todd's paper was a running commentary upon a number of illustrations of the details of construction of Diesel engines, shown by means of stereopticon slides. It was not practicable to reproduce these illustrations here.—Editor.)

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NON-RESIDENT MEMBERS.

JAMES R. ADAMS, (1911), Lake Providence, La.
FELIX L. ALCUS, (1922), with W. T. Alcus & Co., Ltd., Pearl River, La.
LEWIS SCHERCK ALCUS, (1922), 7445 Maple St., New Orleans.
JAMES ALLEN BARKSDALE, (1926), Assistant City Engineer, Box 691, Gulfport, Miss.
JOHN H. BATEMAN, (1925), Louisiana State University, Baton Rouge, La.
JOSEPH P. BERANGER, (1915), Chief Engineer, West India Sugar Finance Corp., 129 Front St., New York City.
M. A. BERANGER, (1918), General Manager, Bernard Lodge Central, Orange Lane, Jaimaica, B. W. I.
MERRILL BERNARD, (1917), Civil Engineer, Crowley, La.
JOS. M. BING, (1917), Consulting Engineer, 53 Hamilton Terrace, New York City.
R. W. BRINGHURST, JR., (1912), Commissioner Parks and Streets, P. O. Box 706, Alexandria, La.
FOREST LEROY BUCKLEY, (1923), Resident Engineer with J. W. Billingsley, Harrisonburg, La.

JACOB THOMPSON BULLEN, (1925), Caddo Parish Engineer, Box 772, Shreveport, La.
JOHN CALLAN, (1918), 1533 Felicity St., New Orleans.
H. F. CAMERON, (1914), Public Service Company of Oklahoma, Tulsa, Okla.
THEO. F. CHENET, (1922), Resident Engineer, New Smyrna, Fla.
L. C. DATZ, (1906), Newman, Saunders & Co., Inc., 506 Olive St., St. Louis, Mo.
JOHN J. DAVIDSON, (1918), care Avoca P. O., Morgan City, La.
GEORGE H. DAVIS, (1909), Member Ford, Bacon & Davis, Inc., 115 Broadway, New York City.
WILLIAM F. EBLEN, (1016), Houston Light & Power Co., Houston, Texas.
L. P. ELBERSON, (1911), Superintendent, Louisiana Irrigation & Mill Co., Crowley, La.
S. WALLACE ELBERSON, (1911), Engineer with A. M. Lockett & Co., Crowley, La.
FRANK E. EVERETT, (1914), Civil Engineer, Crowley, La.
CHARLES H. FENSTERMAKER, (1914), Chief Engineer, Industrial Lumber Co., Engineer, Road District No. 5, Allen Parish, Elizabeth, La.
FRANCIS T. FOOTE, (1909), Lumber Business, Kaplan, La.
JAMES McC. FOURMY, (1916), Consulting Engineer, Hammond, La.
A. A. FRASER, (1922), Engineer, The Building Products Co., Summit and Sandusky Sts., 350 Woodruff Ave., Toledo, Ohio.
EDWARD GEORGE FREILER, (1926), Drainage Engineering, Kentwood, La.
WILL S. GUEDRY, (1925), Assisant Engineer of Construction, Louisiana Highway Commission, Box 774, Monroe, La.
FLOYD HAMILTON, (1919), Lake Charles, La.
JOHN LOVEJOY HENNING, (1919), 525 Kirby St., Lake Charles, La.
FREDERICK McH. HILL, (1919), Monroe, La.
SAMUEL A. HONAKER, (1922), Civil Engineer, Box 357, Sacramento, Calif.
GEORGE P. HOPKINS, (1922), Contractor, Gulfport, Miss.
ANDREW W. JACKMAN, (1913), Sales Engineer, care Miramar Hotel, Miami, Fla.
CHARLES L. JACOB, (1911), 600 Kerlerec St., New Orleans.
E. S. JARRETT, (1909), President, Jarrett-Chambers Co., Inc., Contractors, 30 E. 42nd St., New York City.
JULES A. LORIO, (1921), Geismar, La.
L. A. LOUSTALOT, (1913), General Contractor, Hammond, La.
R. S. McCORMICK, (1922), District Maintenance Engineer, Louisiana Highway Commission, Napoleonville, La.
HERBERT H. McGEHEE, (1920), 432 S. Boulevard, McComb, Miss.
RUFUS S. MANLEY, (1912), President, Texas Creosoting Co., Orange, Texas.
ERNEST J. MEAD, (1922), Forest Engineer, 2220 North St., Beaumont, Texas.
HENRY A. MENTZ, (1915), Consulting Engineer, Lock Drawer 929, Hammond, La.
JULIAN DUNBAR MONETTE, (1921), Project Engineer, State Highway Department, Meridian, Miss.
J. D. MURPHY, (1922), Civil Engineer, Mandeville, La.
CHARLES W. OKEY, (1911), 807 McCall Bldg., Memphis, Tenn.
WILLIAM C. OLSEN, (1914), Consulting Engineer, Raleigh, N. C.
GUY OSBORNE, (1913), Gable, S. C.
BOYKIN W. PEGUES, (1907), Professor of Civil Engineering, Louisiana State University, Baton Rouge, La.
H. N. PHARR, (1908), Sugar Planter and Manufacturer, Olivier, La.
H. A. PHILIPPI, (1912), Civil Engineer and Superintendent of Construction, 316 Audubon St., New Orleans.
FREDERICK F. PILLET, (1922), Associate Professor, Civil Engineering, Louisiana State University, 613 St. Mary St., Baton Rouge, La.
OTTO F. REISZNER, (1916), Reiszner & White, Civil Engineers, Lecompte, La.
FRANK LOUIS REYNOLDS, (1919), Construction Superintendent, Todd, Robertson, and Todd Engineering Corporation, 347 Madison Ave., New York City; residence, 476 Clinton Ave., Brooklyn, N. Y.
W. B. ROBERT, State Highway Engineer, Baton Rouge, La.
FRANK L. ROE, JR., (1920), Omega, Madison Parish, La.

JOHN A. SALMEN, (1911), Vice-President, Salmen Brick & Lumber Co., Ltd., Slidell, La.
T. H. SAMPSON, (1900), Ambarwood Manufacturing Co., P. O. Box 138, Helena, Ark.
REGINALD McC. SCHMIDT, (1915), Junior Engineer, 4th District, Mississippi River Commission, 1923 Leontine St., New Orleans.
HOBART D. SHAW, (1917), City Engineer and Chief Engineer, Harrison County Road Protection Commission, Gulfport, Miss.
ELMER E. SHUTTS, (1918), Lake Charles, La.
JOHN A. SILSBEE, (1915), Consulting Petroleum Engineer. Okmulgee, Okla.
JULIUS SLOVENKO, (1924), 1834 S. Millard Ave., Chicago, Ill.
T. BAKER SMITH, (1919), Houma, La.
JOHN Y. SNYDER, (1918), Engineer, 1211 City Bank Bldg., Shreveport, La.
IRA W. SYLVESTER, (1901), Consulting Engineer, Rapides Bank Bldg., Alexandria, La.
ROGER I. TANNER, (1921), Abbeville, La.
STEWART TICHNOR, (1922), Standard Oil Co., Shreveport, La.
WM. F. TRIGGS, (1914), Operating and Maintenance Engineer, E. Fifth St., Crowley, La.
THOS. H. TUTWILER, (1898), President and General Manager, The Memphis Street Railway Co., also President, Memphis Power and Light Co., Memphis, Tenn.
WM. VON PHUL, (1908), Ford, Bacon & Davis, Inc., 115 Broadway, New York, N. Y.
J. LESTER WHITE, (1920), Reiszner & White, Civil Engineers, Lecompte, La.
W. S. WHITE. (C. M.), Box 44, Sulphur, La.
A. A. WOODS, (1911), Chief Engineer, Maintenance of Ways and Structures, Southern Railway System, Lines West, 506 Southern Railway Bldg., Cincinnati, Ohio.
D. F. WOODS, (1922), Lutcher, La.

ASSOCIATE MEMBERS.

JOHN A. ABELE, (1922), Manager, Industrial Iron Works, 428 Whitney-Central Bldg., Locomotive and Crawling Tractor Cranes, 3215 Palmyra St., New Orleans.
RAYMOND P. BASSICK, (1923), Manager, New Orleans Blue Print & Supply Co., Inc.; 826 Union St., New Orleans.
R. H. BAUMBACH, (1911), Manager, Eugene Dietzgen Co., 316 Camp St., New Orleans.
JOSEPH BRENNAN, (1920), General Contractor, The Brennan Co., 1805-07 Market St., Dallas, Texas.
E. C. BROWN, (1915), Sales Engineer, 3820 St. Charles Ave., New Orleans.
LEWIS McCLELLAN DALGARN, (1921), 1517 Nashville Ave., New Orleans.
H. W. FLETCHER, (1913), Treasurer and General Manager, The Clyde Co., Inc., 309 Magazine St., New Orleans.
WILLIAM HENRY GARGES, (1926), with J. Watts Kearny & Sons, 5623 Milne St., New Orleans.
GEORGE B. GIBSON, (1921), 2103 Painter St., New Orleans.
PAUL JOSEPH GILBERT, (1925), Sewerage and Water Board, 2566 N. Rocheblave St., New Orleans.
GEORGE J. GLOVER, (1916), General Contractor, 1032-1035 Whitney Bldg., New Orleans.
JULES GODCHAUX, 1899), 221 Godchaux Bldg., New Orleans.
EDWARD R. GREENLAW, (1925), President, Greenlaw Truck and Tractor Co., 6831 West End Blvd., New Orleans.
WALTER F. JAHNCKE, (1920), Secretary-Treasurer, Jahncke Service, Inc., 814 Howard Ave., New Orleans.
HENRY M. LICHTENSTEIN, (1925), with E. W. Carr, Inc., 5917 Laurel St., New Orleans.
JOHN McINERNEY, (1920), Construction Superintendent. Detroit Free Press, Detroit, Mich.
EDWARD T. MALLOY, (1920), 1211 N. Hagan Ave., New Orleans.
JOHN J. STEADHAM, (1912), Supervisor, Bridges and Buildings, N. O. & N. E. R. R. and N. O. T. Co., 308 Newman St., Hattiesburg, Miss.
F. W. STEVENS, (1909), Manager, New Orleans District Sales Office, Allis-Chalmers Mfg. Co., 710 Maison Blanche Bldg., New Orleans.
WILLIAM LOUIS STEVENS, JR., (1925), with W. Horace Williams, Inc., 88 Fontainebleau Drive, New Orleans.

HARTWELL JOHN ROSSON, 1322 Elysian Fields St., New Orleans.
JOSEPH HENRY SAUCIER, 2616 Ursuline St., New Orleans.
BEN ZION SEGALL, 4209 S. Rocheblave St., New Orleans.
S. B. SCHWARTZ, Superintendent, Maginnis Cotton Mills, New Orleans.
LEWIS MONROE SHELTON, 4915 Baccich St., New Orleans.
DAVID STAYER, 8314 Jeannette St., New Orleans.
JOSEPH F. THOMSON, Care of General Electric Co., Schenectady, New York.
LUCIEN T. VIVIEN, JR., 1519 Broadway, New Orleans.
STEPHEN JOSEPH WALLBILLICH, 4027 Delgado Ave., New Orleans.
JOHN MORT WALKER, JR., 6039 Prytania St., New Orleans.
O. P. WALKER, 5918 Chestnut St., New Orleans.
CHARLES CARROLL WIGGIN, JR., 3203 Napoleon Ave., New Orleans.
CHARLES LAFAYETTE WRIGHT, JR., Romeville, La.
ALBERT G. WYLER, 530 Jackson Ave., New Orleans.

SUMMARY.

Honorary Member	1
Resident Members	219
Non-Resident Members	75
Associate Members	22
Non-Resident Associate Member	1
Junior Members	27
Non-Resident Junior Members	9
Student Members	49
Total	403

MINUTES OF MEETINGS AND BUSINESS OF THE SOCIETY.

Minutes of the Board of Direction, December 14, 1925.

The meeting was called to order by President Garsaud, the following members were present: Messrs. Adams, Hamilton, Robert, Moses and Muth.

The minutes of previous meeting were read and approved and bills on hand were ordered paid.

The grade of membership of Mr. Eugene Gravely was changed from Non-Resident Junior to Resident Member.

Mr. A. W. Jackman was reinstated and grade of membership changed from Resident to Non-Resident Member, effective January 1, 1926, as requested.

Mr. R. P. Rordan was reinstated, effective January 1, 1926, as Member.

The resignations of the following were accepted with regret: Messrs. John H. Walsh and W. P. Brandin.

It was with regret that the following members were dropped for non-payment of dues or failure to reply to communications: Messrs. Charles F. Akins, J. F. Ross, Fred E. Smith, R. A. Pierpont, Jack Harris, W. L. Sizemore and Walter Cooke.

Communication was read from Prof. John H. Bateman relative to the organization of a Baton Rouge Section of the Louisiana Engineering Society. After interesting discussion of the details of such an organization, on motion duly seconded it was voted that the Society send the Treasurer and the Secretary to Baton Rouge to confer with Professor Bateman and others interested in the matter at some convenient date in the near future.

The following applications, upon motion duly seconded, were ordered to ballot:

Resident Members.

Alexander Allison, Jr.,
Chester W. Carr,
Lloyd Garner Frost,
Joseph J. Krebs,
Walter J. Manion,
Thomas M. McCarroll,
Howard N. Moody,
Benjamin J. Oliveira,
Adloe Orr,
Patrick Henry Quinlan,
Grover Cleveland Rackerby,
Russ Faulkner Wills.

Non-Resident Members.

James Allen Barksdale,
Edward George Freiler.

Associate Member.

William Henry Garges.

Resident Junior Member.

Robert Vincent Markey.

Transfer from Student to Junior Member.

Francis A. Landrieu.

Student Members.

Philip H. Campbell,
William Henry Creighton,
Robert Joseph Drueding,
Fernando Ensenat,
William Wallace Hay,
Frank Emil Johnson,
George Elmer May,
William O. Mascaro,
Leal C. H. McLean,
Eugene H. Miazza,
Walter K. Oser,
Pascal Pareti, Jr.,
Hartwell John Rosson,
Ben Zion Segall,
David Stayer,
Lucien T. Vivien, Jr.,
Stephen J. Wallbillich.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

Minutes of the Regular Meeting of the Society, December 14, 1925.

The meeting was called to order by Colonel Garsaud, President; F. A. Muth, Secretary, and present forty-one members and guests.

Minutes of the previous meeting were read and approved.

Professor Steinmayer, Chairman of Special Committee to report on the reestablishment of a Geological Survey in Louisiana, submitted an interesing report of the findings of his committee. On motion duly seconded it was voted to authorize the President of the Society to appoint a committee of such number of persons as he deems best to draft a bill for the Legislaure for the reestablishment of the Geological Survey in this State.

The President then read copy of a letter written by him as President to the President of Tulane University inviting attention to the importance of having a qualified civil engineer to collaborate with the architect in the checking of the design of the proposed Tulane Stadium, also the reply to that communication prepared by Professor Douglas Anderson, Dean of the Engineering College, and Chairman of the Stadium Committee, which reply was prepared at the request of the President of Tulane University. On motion duly seconded it was voted that the Society go on record as approving the letter of Colonel Garsaud, President of the Society, and that a copy of the letter be spread upon the minute book as a record.

The Annual Smoker was announced and President Garsaud stated that the members of the Entertainment Committee are: Messrs. Ole K. Olsen and Walter B. Moses. The Smoker was announced for January 9th, and on motion duly seconded it was voted to leave the details of the Smoker to the committee.

The President announced that in line with the discussions held during the year on the subject of the present law for licensing of engineers that he would soon appoint a committee to prepare the draft of a bill of extension of the law to include professional engineers not covered by the existing law.

Nominations for officers for the ensuing year were then in order and the following is a resume of the ballots:

President.

Hamilton	32
Olsen	2
Lanphier	1
Garsaud	1
Total	36

Vice-President.

Lanphier	27
Adams	1
Young	3
Nelson	1
Elliott	1
Porter	2
Olsen	1
Total	36

Member of Board.

Fox	24
Young	2
Gregory, Jr.	3
Porter	2
Olsen	1
Scott	1
Converse	1
Nelson	1
Anderson	1
Total	36

Treasurer.

Moses	36

Secretary.

Muth	36

On motion duly seconded the Treasurer and Secretary were both unanimously nominated.

As a result of the above ballots the following officers were nominated to serve for the year 1926:

F. P. Hamilton, President.
E. S. Lanphier, Vice-President.
W. B. Moses, Treasurer.
F. A. Muth, Secretary.
F. H. Fox, Member of the Board to serve for three years.

The technical exercises of the evening were then held. These exercises were under the auspices of the Local Chapter of the American

Society of Mechanical Engineers, Prof. James M. Robert, Chairman. Mr. James M. Todd gave an interesting address on "The Diesel Engine," using many lantern slides in connection with the paper. Interesting discussion of the paper followed, and upon conclusion a rising vote of thanks was tendered the speaker.

The Society then adjourned to the collation served in Pitre's Restaurant.

F. A. MUTH, Secretary.

Minutes of Board of Direction, Annual Meeting, January 9, 1926.

The meeting was called to order by President Garsaud, the following members were present: Messrs. Hamilton, Moses, Muth.

The minutes of the previous meeting were read and approved and the bills on hand together with the bills for the Annual Smoker were ordered paid.

The grade of membership of Mr. A. L. Black was changed from Non-Resident to Resident Member.

The grade of membership of Mr. C. A. Ives, Jr., was changed to Non-Resident Member.

Mr. Andre C. Duval was reinstated.

The resignations of Mr. Robert W. Wolcott and Mr. Geo. R. W. Lewis were accepted with regret.

Mr. Frank E. Everett was dropped from the membership of the Society with regret.

Report was made from Mr. John T. Eastwood, Chairman, Committee on Publications, Division B, also reports from Mr. R. R. Baumbach and Mr. Raymond Bassich, members of the Employment Committee. These reports were ordered referred to the Editor to be printed in the Proceedings.

The annual reports of the Treasurer and Secretary were read and approved and ordered referred to the Society.

The resignation of Mr. O. P. Adams, member of the Board ,was accepted with regret.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

Minutes of the Society, Annual Meeting, January 9, 1926.

The meeting was called to order by President Garsaud, F. A. Muth, Secretary, and thirty-eight members and guests present.

Minutes of the previous meeting were read and approved.

The annual reports of the Treasurer and Secretary were read and were ordered printed in the Proceedings.

The annual report of the Board of Direction was approved and ordered printed in the Proceedings.

Ballots were canvassed for new members, there being seventy-seven formal ballots and three informal ballots, and the following members were declared elected:

Resident Members.

Alexander Allison, Jr.,
Chester W. Carr,
Lloyd Garner Frost,
Joseph J. Krebs,
Walter J. Manion,
Thomas M. McCarroll,
Howard N. Moody,
Benjamin J. Oliveira,
Adloe Orr,
Patrick Henry Quinlan,
Grover Cleveland Rackerby,
Russ Faulkner Wills.

Non-Resident Members.

James Allen Barksdale,
Edward George Freiler.

Associate Member.

William Henry Garges.

Resident Junior Member.

Robert Vincent Markey.

Fransfer from Student to Junior Member.

Francis A. Landrieu.

Student Members.

Philip H. Campbell,
William Henry Creighton,
Robert Joseph Drueding,
Fernando Ensenat,
William Wallace Hay,
Frank Emil Johnson, Jr.,
George Elmer May,
William O. Mascaro,
Leal C. H. McLean,
Eugene H. Miazza,
Walter K. Oser,
Pascal Pareti, Jr.,
Hartwell John Rosson,
Ben Zion Segall,
David Cooper,
Lucien T. Vivien, Jr.,
Stephen J. Wallbillich.

Ballots were also opened for officers, there being eighty-nine formal ballots with no informal ballots cast, and the following officers were declared elected for the ensuing year:

President........F. P. Hamilton
Vice-President........E. S. Lanphier
Treasurer........Walter B. Moses
Secretary........F. A. Muth
Member of Board to serve three years........F. H. Fox

The President referred to the progress the Society had made during the year both financially and with increase in membership.

He also thanked the members for the work they had done in assisting the Board and the Officers in carrying ont the work so successfully during the year.

The new President, Mr. F. P. Hamilton, was then conducted to the chair by Prof. Douglas Anderson. Mr. Hamilton made a few appropriate remarks in thanking the membership of the Society for the honor conferred upon him.

The President then announced the personnel of Committee on Registration of Engineers, also Committee on Reestablishment of a Geological Survey in Louisiana.

There being no further business the meeting then adjourned to a most enjoyable Smoker which was held at the Chess, Checkers and Whist Club.

F. A. MUTH, Secretary.

Special Meeting of the Board of Direction, January 9, 1926.

A special meeting was called to order by Colonel Garsaud, President, and the following members were present: Messrs. Hamilton, Moses, Muth.

This meeting was held after the annual meeting of the Society.

The following new members of the Board were elected to fill the unexpired terms of Messrs. Lanphier and Adams as follows: Mr. John L. Porter to serve one year, Mr. W. L. Fey to serve two years.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

ANNUAL REPORTS

ANNUAL REPORT OF THE BOARD OF DIRECTION.

Year 1925.

New Orleans, La., January 9, 1926.

To the Members of the Louisiana Engineering Society:

Gentlemen: Your Board of Direction begs to report that during 1925 ten regular meetings and two special meetings were held for the transaction of the business of the Society.

Our Technical Papers Committee has given us a varied program of very high-grade papers.

Our Library Committee has done very excellent work and a number of new books, suggested by the members, have been added during the year.

The Employment Committee has been most energetic and has done splendid work in placing of men in employment, which has been a satisfaction not only to those employed but to the employers seeking assistance.

The Membership Committee has also done excellent work. During the year there have been a number of resignations and adjustments, bringing the net increase to twenty-five members, although fifty-one members were taken in by election and reinstatement.

The Committee on Publications, Division B, has been very active during the year and has added several substantial advertisements which have enabled the Proceedings Reserve Fund to show a gain for the year 1925 amounting to $184.56. It is very necessary that in order to have the high grade of our Proceedings maintained that we have additional advertisements. This is due to the fact that the cost of publishing the Proceedings has increased in the last few years and the cost of preparing cuts for properly illustrating the papers has also increased.

The Publications Committee has given us a most interesting journal during the year. The journal has an increasing circulation which is much wider than one would be led to believe. The influence of this journal is very far-reaching. There is no question but that the Proceedings is the most important activity of our Society, and the thanks of the Board and of the Society go forth to Prof. Douglas Anderson, Editor, who maintains the Proceedings as such a high-grade journal.

Attention is invited to the financial condition of the Society. Our Investment Fund shows a gratifying increase and has a balance of $3,805.72. The General Reserve Fund shows a balance of $4,343.72 and the Proceedings Reserve Fund a balance of $1,311.97. The Treasurer's report shows a cash balance of $1,416.33.

During the year work has been done by special committees appointed to submit reports on the Reestablishment of the Geological Survey in Louisiana and the Registration of Professional Engineers.

Reestablishment of Geological Survey in Louisiana. The Society has recently received and approved the report of a committee appointed in conformity with a resolution of the Society on the advisability of the reestablishment in this State of a geological survey department.

Louisiana is one of the four states in the Union having no such department, and it is deemed most essential that a geological survey department be reestablished.

A committee has been appointed to draft a bill for introduction in the Legislature next May, and the Society will be asked to endorse this legislation.

Registration of Engineers. The act requiring the registration of civil engineers practicing their profession in the State of Louisiana has been in force since 1908.

It is te opinion of those who have been most closely connected with the operation of the law that its effect has been all that was expected of it.

While there has been some criticism in several isolated cases, there can be no doubt that it has protected the public from the incompetent and that it has been of some benefit to the engineering profession.

Outside of one or two of all the states which have registration laws, Louisiana is the only State which registers only civil engineers. Other states register professional engineers, including civil, mechanical and electrical engineers.

The operation of the law in states registering all branches of the profession works very satisfactorily, and in the exchange of reciprocal relations between Louisiana and other states, Louisiana is handicapped by the fact that it registers only civil engineers.

For that reason the Louisiana Engineering Society has taken up a movement to introduce a new registration act in the Legislature next May covering the registration and licensing of all engineers.

A committee has been appointed to draft the proposed law, and it is intended to submit this draft of the bill to the Society for its approval at two consecutive regular meetings.

The Board of Direction urges that the Society stand behind this movement and give it whole-hearted support.

Organization of a Baton Rouge Chapter of the Louisiana Engineering Society. Baton Rouge is fast developing into a center of engineering activities due to the location there of so many agencies dealing in construction work, thus bringing together in Baton Rouge a large number of engineers.

There is a sentiment at the State capital that there should be a closer relation between the individual engineers and a closer contact with the Louisiana Engineering Society. The suggestion has been made that there be established at Baton Rouge a local chapter of this Society, and the Board of Direction has by authority of the Society taken steps to work out the preliminary details by the appointment of a committee of two, whose members are to visit Baton Rouge and hold a series of conferences with those who are taking a leading part in the establishment of the Baton Rouge Chapter.

It is hoped that the matter will be brought to a successful conclusion in the early spring, and that the Society may hold one of its meetings at Baton Rouge before the summer adjournment.

In conclusion, the Board wishes to thank the various committees and members of the Society for the cooperation and interest in carrying on so successfully the work of the society.

Respectfully submitted,

MARCEL GARSAUD, President,
F. P. HAMILTON, Vice-President,
F. A. MUTH, Secretary,
W. B. MOSES, Treasurer,
Board of Direction.

ANNUAL REPORT OF THE SECRETARY.

Year 1925.

New Orleans, La., January 9, 1926.

To the Board of Direction, Louisiana Engineering Society, New Orleans, La.

Gentlemen: As Secretary of the Society, I herewith submit the following report for the year 1925.

During the past year the Board of Direction held ten regular meetings and two special meetings; the Society held ten regular meetings with an average attendance of 62, maximum 147, minimum 24. One of the meetings of the Society was a joint meeting of the American Institute of Steel Construction, another was a joint meeting of the American Society of Military Engineers; another joint meeting was held with the American Society of Mechanical Engineers.

The membership shows a steady increase from year to year. This year there has been a net increase of twenty-five members, although there was a total of fifty-one members elected and reinstated.

GRADE	On Roll Jan. 1, 1925	Elected	Reinstated	Transferred to	Transferred from	Dropped	Resigned	Failed to Qualify	Died	On Roll Jan. 1, 1926
Honorary	1	....	....	....	....	....	....	....	....	1
Resident Members	207	18	3	2	1	2	6	1	1	219
Non-Resident	79	4	1	2	1	6	2	....	2	75
Associate	20	4	....	....	....	1	1	....	....	22
Non-Res. Associate.	2	....	....	....	....	1	....	....	....	1
Junior	25	3	....	1	1	1	....	....	....	27
Non-Res. Junior	11	....	....	....	1	....	1	....	....	9
Student	33	18	....	....	1	1	....	....	....	49
Non-Res. Student	....	....	....	....	....	....	....	....	....	....
Total	378	47	4	5	5	12	10	1	3	403

It is with regret that we report the deaths of Mr. E. Wheeler Carr, Resident Member, also of Mr. Allard D'Heur and Mr. George Selman, Non-Resident Members.

The Treasurer's report is submitted separately and shows a cash balance of $1,416.33.

During the year the investment account as submitted in the Treasurer's report stands as follows:

1—Yerxa Steves Bond	$1,000.00
2—$100.00 Second Liberty Loan	200.00
2—$100.00 First Liberty Loan	200.00
1—$50.00 First Liberty Loan	50.00
5—$50.00 1917 Liberty Loan	250.00
Greater New Orleans Homestead	804.96
New Orleans Bank & Trust Co. Savings Account	1,300.76
Total	$3,805.72

In addition to the above the Society still holds a share in the New Orleans Building, Louisiana State Fair, costing $100.00.

The following technical exercises were held:

February 9.—"Structural Features of the Additions to the New Orleans Water Plant," by Mr. Eugene F. Delery. The address was followed by a moving picture showing "Monel and Nickel from Mines to Finished Product."

March 9.—"The Design, Fabrication and Erection of Structural Steel," by Mr. Lee H. Miller. This meeting was held in conjunction with the meeting of the American Institute of Steel Construction.

April 13.—"Construction of the Deep Foundations of the Bridges Over the Rigolets and Chef Menteur," by Mr. E. E. Elam.

May 11.—"Spillways," by Colonel C. McD. Townsend.

June 5.—"Traffic Theories and Regulations Especially as They Apply to Road and Street Designing and Construction," by Mr. Stanley W. Ray.

September 14.—"Camouflage," by Major H. S. Bennion. This meeting was held under the auspices of the Local Chapter of the American Society of Military Engineers.

October 12.—This meeting was a symposium on Highway Engineering participated in as follows:

"Location and Construction of Highways," by Mr. W. B. Robert, State Highway Engineer.

"Maintenance of Highways as Practiced by the Louisiana Highway Commission," by Mr. S. A. Theard, Maintenance Engineer.

"The Problems of Paved Streets," by Mr. Bryson Vallas, City Engineer, New Orleans.

"Proposed Highway Research in Louisiana," by Prof. John H. Bateman, Louisiana State University.

"Mechanical Traffic Aids in Highway Safety," by Mr. Paul Habans, Commissioner of Public Safety, New Orleans.

November 9.—"What We Don't Know About Our Southern Trees," by Mr. R. D. Forbes.

December 14.—"The Diesel Engine," by Mr. James M. Todd. This meeting was held under the auspices of the Local Chapter of the American Society of Mechanical Engineers.

Attached hereto are statements showing the financial condition of the Society.

During the year the Society continued serving of the collation in a nearby restaurant. Also the employment of a uniformed watchman for watching the automobiles of members attending the meetings of the Society was continued. Both of these features have proved highly successful and have met the approval of the members of the Society.

Your Secretary wishes again to express his appreciation of your cooperation during the past year. It has been an honor and privilege to serve you. I thank you.

Respectfully submitted,

F. A. MUTH, Secretary.

FINANCIAL CONDITION OF THE SOCIETY, JANUARY 1, 1926.

Assets:

Cash on hand	$1,416.33	
Membership Accounts Receivable	1,045.00	
Advertisers Accounts Receivable	362.09	
Investments	3,805.72	
Entrance Fees	75.00	
		$6,704.14

Liabilities:

Library Fund	624.17	
Proceedings Reserve Fund	1,311.97	
Building Fund	151.65	
Accounts Payable	172.63	
		2,360.42
		$4,343.72

General Reserve Fund.

Balance from 1914	$ 165.00	
Balance from 1915	189.75	
Balance from 1916	377.45	
Balance from 1918	299.49	
Balance from 1918	27.47	
	1,059.16	
Deficit from 1919	62.93	
Balance from 1920	198.09	
Balance from 1921	90.94	
Balance from 1922	1,186.58	
Balance from 1923	309.84	
Balance from 1924	586.43	
Balance from 1925	975.61	
		$4,343.72

General Fund, 1925.

Revenues:		
Membership Dues	$3,481.25	
Smoker Account	315.00	
Entrance Fees	299.00	
Gain on Investments	190.49	
		4,285.74
Expenses:		
Subscriptions to Proceedings	748.00	
Appropriation to Library	480.00	
Secretary Dues	12.00	
Secretary Account	420.00	
Printing and Postage	360.79	
Rerfeshments	119.80	
General Expense	213.67	
Balance, Delegate Expense	9.54	
Exchange	5.45	
Dues to American Engineering Council	271.76	
Auditor	50.00	
Smoker Expense	485.20	
Loss on Accounts Closed Out	133.92	
		3,310.13
		$ 976.61

Proceedings Reserve Fund.

Balance 1915	$ 112.20	
Balance 1916	566.13	
Balance 1917	568.14	
Balance 1918	567.52	
Balance 1919	41.08	
	1,856.07	
Deficit 1920	221.98	
	1,633.09	
Balance 1921	26.25	
		$1,659.34
Deficit 1922	301.02	
Deficit 1923	110.65	
Deficit 1924	120.26	
		531.93
Balance, January 1, 1925		$1,127.41
Gain, 1925		184.56
Balance, 1925		$1,311.97

Proceedings Fund.

Revenues:		
Advertisements	$1,145.67	
Members Subscriptions	748.00	
Proceedings Sales	48.55	
		$1,942.22
Expenses:		
Salary of Editor and Secretary	360.00	
Miscellaneous Expense	180.00	
Stenographer	44.50	
Printing and Mailing	1,135.14	
Losses on Cancelled Advertisements	38.02	
		$1,757.66
		$ 184.56

Annual Statement of the Library Fund, 1925.

Revenues:		
Balance on hand, January 1, 1925	$ 553.82	
Appropriation from General Fund	480.00	
		$1,032.82
Expenditures:		
January 12—		
American Society of Civil Engineers	6.00	
February 10—		
Concrete Publishing Co.	3.00	
Miss Carrie Freret	15.00	
March 10—		
E. Dietzgen & Co.	37.50	
Railway Age	10.00	
Miss Carrie Freret	15.00	
April 13—		
American Society for Testing Materials	10.40	
Owen Gernon Co.	69.00	
Miss Carrie Freret	15.00	
May 11—		
Miss Carrie Freret	15.00	
McGraw-Hill Co.	4.00	
June 5—		
Miss Carrie Freret	15.00	
July 15—		
Miss Carrie Freret	30.00	
September 14—		
Miss Carrie Freret	15.00	
E. Dietzgen & Co.	15.30	
October 12—		
E. Dietzgen & Co.	22.00	
Miss Carrie Freret	15.00	
American Society for Testing Materials	4.50	
November 9—		
Power	3.00	
American Society for Testing Materials	1.20	
Miss Carrie Freret	15.00	
December 14—		
Owen Gernon Co.	28.75	
Engineering News-Record	5.00	
Concrete Publishing Co.	3.00	
Railway Engineering & Maintenance	3.00	
Miss Carrie Freret	15.00	
December 31—		
Miss Carrie Freret	15.00	
Engineering & Contracting	4.00	
		409.66
		$ 624.17

Cash Account.

Receipts

1923 Dues	$ 14.50		
1924 Dues	457.00		
1925 Dues	2,679.75		
Smoker	30.00		
Smoker Membership	248.00		
Proceedings Sales	48.55		
Proceedings Advertisers	1,049.72		
Investments	1,092.97		
Delegate Expense	130.00		
Entrance Fees	224.00		
Miscellaneous Receipts (Telegram)	1.08		
		$5,975.57	
Add 1924 Balance			769.87
			$6,745.44
Less Check Returned No Acct			12.00
			$6,733.44
Deduct Exchange			5.45
			$6,727.99
Total Disbursements			5,311.66
Cash Balance, December 31, 1925			$1,416.33

ANNUAL REPORT OF THE TREASURER.
Year 1925.

January 1st, 1926.

To the President, Louisiana Engineering Society, New Orleans, La.

Dear Sir: As per requirements of Article No. 4 of the Constitution, I have the honor to submit the following report covering receipts and disbursements for the period of January 1sst, 1925, up to January 1sts, 1926.

Received from Secretary—	Deposited in New Orleans Bk. & Tr. Co.	Exchange Charged
Feb. 6, Memo 1 to 10	$1,619.42	$2.10
Mar. 5, Memo 11 to 12	520.70	.30
Apr. 4, Memo 13 to 14	338.11	.30
May 7, Memo 15 to 20	541.63	.70
June 1, Memo 21 to 22	156.37	.25
July 11, Memo 23 to 25	262.42	.30
Aug. 3, Memo 25 to 28	351.61	.60
Sept. 4, Memo 29 to 30	129.28	.00
Oct. 3, Memo 31 to 33	221.79	.20
Nov. 2, Memo 34 to 35	201.54	.10
Dec. 1, Memo 36 to 37	360.96	.15
Dec. 21, Memo 38 to 39	178.87	.45
	$4,882.70	$5.45
Less check returned, No Acct	12.00	
	$4,870.70	
January 1, 1925, U. S. Certif. Redeemed	1,000.00	
Int. Yerxa Steves Bond	16.25	
Coupons Deposited, December 18, 1925	76.62	
		$5,963.57
Less Exchange		5.45
		$5,958.12
Balance on hand as per Treasurer's Report, January 1, 1925		769.87
		$6,727.99

Disbursements from January 1st, 1925, to January 1st, 1926.

No.	Name—	Amount
January 10—		
1	James M. Robert	$ 130.00
January 12—		
2	Tulane Press	244.34
3	American Soc. of Civil Engrs	6.00
4	Aarde Stenographic Parlor	18.25
5	F. A. Muth	76.50
6	Carrie Freret	15.00
7	Edna Doll	15.00
8	Electrical World	5.00
9	Mortgage & Securities Co	1,007.94
10	New Orleans Bank & Trust Co	6.00
11	W. B. Gregory, Jr	50.00
February 10—		
12	Kolb's Restaurant	287.45
13	Addressograph Co	2.74
14	Tulane Press	101.67
15	R. H. Scott	8.00
16	Juan Gonzales	16.30
17	Concrete Pub. Co	3.00
18	Jos. Levy & Bros. Co	15.70
19	W. J. Brown, Jr	32.00
20	R. J. Derbes, Jr	50.00
21	F. A. Muth	44.50
22	Edna Doll	15.00
25	Carrie Freret	15.00
27	Boylan's Detective Agency	3.00
27-a	H. Solzer	3.00
28	American Engr. Council	84.88
30	Ditto, Inc	5.00
31	Victor Restaurant	21.80
March 10—		
32	Tulane Press	35.25
33	P. Kaul and Son	10.00
34	Chas. L. Franck	10.25
35	F. A. Muth	45.50
36	Aarde Stenographic Parlor	2.50
37	Eugene Dietzgen	37.50
38	Railway Age	10.00
39	Edna Doll	15.00
40	Carrie Freret	15.00

No.	Name—	Amount
April 13—		
41	T. J. Carbrey	5.00
42	Tulane Press	246.90
43	Amer. Soc. for Test. Mtls	10.40
44	Chas. L. Franck	2.00
45	Owen Gernon Co	69.00
46	F. A. Muth	48.50
47	Edna Doll	15.00
48	Carrie Freret	15.00
49	Victor Restaurant	20.25
May 11—		
50	Addressograph Co	.98
51	Amer. Engr. Council	51.00
52	F. A. Muth	43.00
53	Boylan's Detective Agcy	3.00
54	Edna Doll	15.00
55	Carrie Freret	15.00
56	Howland & McRedmond	20.00
57	Tulane Press	20.00
58	McGraw Hill Co. Inc	4.00
59	T. J. Carbrey	5.00
June 5—		
60	Tulane Press	263.61
61	Douglas Anderson	150.00
62	F. A. Muth	44.50
63	Aarde Stenog. Parlor	9.00
64	Edna Doll	15.00
65	Carrie Freret	15.00
66	Boylan's Detective Agcy	3.00
67	Victor Restaurant	15.50
July 15—		
68	Garcia Stationery Co	4.75
69	Earle J. Christenberry	7.50
70	Tulane Press	271.61
71	F. A. Muth	90.20
72	Carrie Freret	30.00
73	Edna Doll	30.00
September 14—		
74	Jos. Levy & Bros. Co	1.75
75	Edna Doll	15.00
76	Carrie Freret	15.00
77	F. A. Muth	50.50
78	Eugene Dietzgen Co	15.30
79	C. B. Charbonnier	5.00

No.	Name—	Amount
80	Boylan's Detective Agency	3.00
81	Amer. Engr. Council	67.94
82	Tulane Press	64.50
83	Pitre Restaurant	16.45
October 12—		
84	Tulane Press	235.16
85	Eugene Dietzgen Co	22.00
86	F. A. Muth	45.50
87	Edna Doll	15.00
88	Carrie Freret	15.00
89	Amer. Society for Test. Mtls	4.50
90	Boylans Detective Agcy	3.00
91	Pitre's Restaurant	15.05
November 9—		
92	Earle J. Christenberry	10.00
93	Jos. Levy & Bros. Co	6.75
94	Power	3.00
95	Tulane Press	33.00
96	Amer. Soc. for Test Mtls	1.20
97	T. J. Carbrey	5.50
98	Boylan's Detective Agcy	3.00
99	F. A. Muth	43.50
100	Carrie Freret	15.00
101	Edna Doll	15.00
102	Pitre's Restaurant	15.75
103	H. S. Salzer	3.00
December 14—		
104	Engr. News Record	5.00
105	Concrete	3.00
106	P. Kaul	7.50
107	Tulane Press	135.75
108	Railway Engr. & Maintenance	3.00
109	Amer. Engr. Council	67.94
110	F. A. Muth	45.50
111	Boylan's Detective Agency	3.00
112	Edna Doll	15.00
113	Carrie Freret	15.00
114	Douglas Anderson	150.00
115	E. M. LeBlanc	25.00
116	Pitre's Restaurant	15.00
117	C. B. Charbonnier	5.00
117½	Owen Gernon Co	28.75
Total Disbursements		$5,311.66

RECAPITULATION

Total Receipts	$6,727.99	
Total Disbursements	5,311.66	
Checking Account in New Orleans Bank & Trusts Co		$1,416.33
1 Yerxa Steves Bond	$1,000.00	
2 $100.00 Second Liberty Loan	200.00	
2 $100.00 First Liberty Loan	200.00	
1 $ 50.00 First Liberty Loan	50.00	
5 $ 50.00 1917 Liberty Loan	250.00	
Greater New Orleans Homestead	804.96	
New Orleans Bank & Trust Co., Savings Acct	1,300.76	
		3,805.72
		$5,222.05

REPORT OF THE PUBLICATION COMMITTEE—DIV. B. YEAR 1925.

January 4, 1925.

To the Members of the Louisiana Engineering Society:

Attention Mr. F. A. Muth, Secretary.

Gentlemen:

Your Committee on Publication, Division B, begs leave to report that they have given their attention and time to the securing of advertisements for the "Proceedings" during the year of 1925 and have been fairly successful. We have secured in all thirteen ads, all of which are substantial and established firms or industries that would interest engineers and contractors.

Much difficulty was experienced in persuading large firms that this publication not only reaches the leading engineers in the State and City, but also has its influence nationally.

The papers contained therein are of a high order and compare favorably with any technical journal of other societies.

Your committee is pleased to have had the opportunity to serve the Society and hopes that the coming year will bring larger and greater returns—but it will require work.

Yours very truly,

V. L. WILLOZ,
E. F. DELERY,
GEO. HAMMETT,
GEO. H. SEAVER,
PAUL F. JAHNCKE,
JOHN T. EASTWOOD, Chairman,

REPORT OF EMPLOYMENT COMMITTEE.

December 31, 1925.

F. A. Muth, Secretary,
La. Engineering Society,
La. State Museum Bldg.
City.

Dear Sir:

As Chairman of the Employment Committee, permit me to make the following report for 1925:

According to my records, I received 105 applications and during the year there were 77 vacancies, 61 of which were filled by applicants who applied to me.

I would appreciate very much if all members would please bear in mind to refer to me all members who may be out of employment, as well as informing me of any positions that may be open, and I will continue to use my best efforts in placing all applicants.

Yours truly,

R. H. BAUMBACH, Chairman.

January 9, 1926.

Louisiana Engineering Society,
New Orleans, La.

Attention Mr. Muth.

Dear Sir:

We presume that you would like to know what we have done during the past year of 1925 to assist engineers, etc., to obtain positions. We wish to advise that we had inquiries from 43 men who desired positions and had 31 inquiries for men from engineering concerns who desired the services of engineers, rodmen, etc. We have records of 20 men having been placed, and the chances are that there are some others who obtained positions but did not notify us.

We will continue, in future, to do our best along these lines, and with kindest wishes for 1926, beg to remain,

Yours very truly,

NEW ORLEANS BLUE PRINT AND SUPPLY CO., INC.,
RAYMOND BASSICH, Manager.

REPORT OF THE AUDITOR.

January 7, 1926.

To the President and Board of Directors, Louisiana Engineering Society,
New Orleans, La.

Gentlemen:

In accordance with your instructions I have audited the books and records of your Society for the calendar year 1925, and as a result of this examination beg to submit the following exhibits:

EXHIBIT "A"—General Balance Sheet, December 31, 1925.

EXHIBIT "B"—Detailed statement showing results of General Fund, January 1 to December 31, 1925.

EXHIBIT "C"—Detailed statement showing result of Proceedings Funds for the year 1925.

EXHIBIT "D"—Detailed statement of Library Fund.

EXHIBIT "E"—Statement of cash receipts and disbursements for the year 1925.

Cash.

I have made a careful check of cash receipts and vouchers for payments and found everything in order and the cash records in balance.

All funds show a very nice gain over all expenses for the year 1925 and have substantially increased your Reserves.

EXHIBIT "A" shows in detail all assets and liabilities as they stood on the books at December 31st, 1925, and to the best of my knowledge and belief reflect the true financial condition of your Society on that date.

It gives me pleasure to say that I have found all books and records neatly and correctly kept and that your Secretary and Treasurer deserve mention for their good work.

Respectfully yours,

R. J. DERBES, JR., C. P. A.
By LEO A. LOUBEN,
Public Accountant.

BALANCE SHEET.

December 31, 1925.

ASSETS:		
Cash in Bank	$1,416.33	
Membership Accounts Receivable	1,045.00	
Advertisers' Accounts Receivable	362.09	
Investments	3,805.72	
Entrance Fees	75.00	
		$6,704.14
LIABILITIES:		
Library Fund	$ 624.17	
Proceedings' Reserve Fund	1,311.97	
Building Fund	151.65	
Accounts Payable	272.63	
Balance General Fund	4,343.72	
		$6,704.14

EXHIBIT "A"

GENERAL RESERVE FUND.

December 31, 1925.

Balance from 1914	$ 165.00
Balance from 1915	189.75
Balance from 1916	377.45
Balance from 1917	299.49
Balance from 1918	27.47
	$1,059.16
Deficit from 1919	62.93
	$ 996.23
Balance from 1920	198.09
Balance from 1921	90.94
Balance from 1922	1,186.58
Balance from 1923	309.84
Balance from 1924	586.43
Balance December 31, 1924	$3,368.11
Add 1925 Profit	975.61
Balance General Reserve Fund December 31, 1925	$4,343.72

GENERAL FUND YEAR 1925.

REVENUES:		
Membership 1925 Dues	$3,481.25	
Smoker Account	315.00	
Entrance Fees	299.00	
Gain on Investments	190.49	
		$4,285.74
EXPENSES:		
Subscriptions to Proceedings	$ 748.00	
Appropriation to Library Fund	480.00	
Dues of Secretary	12.00	
Salary of Secretary	420.00	
Printing and Postage	360.79	
Refreshments	119.80	
General Expense	213.67	
Balance Delegates' Expense	9.54	
Exchange	5.45	
Due to American Engineering Council	271.76	
Auditor	50.00	
Smoker Expense	485.20	
Loss on Cancelled Accounts	133.92	
		3,310.13
Net Gain 1925		$ 975.61

EXHIBIT "B"

PROCEEDINGS RESERVE FUND
December 31, 1925.

Balance 1915	$ 112.20	
Balance 1916	566.13	
Balance 1917	568.14	
Balance 1918	567.52	
Balance 1919	41.08	
	$1,855.07	
Deficit 1920	221.98	
	$1,633.09	
Balance from 1921	26.25	
		$1,659.34
Deficit 1922	$ 301.02	
Deficit 1923	110.65	
Deficit 1924	120.26	
		531.93
Balance January 1, 1925		$1,127.41
Add Gain 1925		184.56
Balance December 31, 1925		$1,311.97

PROCEEDING FUND YEAR 1925.

REVENUES:		
Advertisements	$1,145.67	
Members' Subscription	748.00	
Proceeding Sales	48.55	
		$1,942.22
EXPENSES:		
Salary of Editor and Secretary	$ 360.00	
Miscellaneous Expense	180.00	
Stenographer	44.50	
Printing and Mailing	1,135.14	
Losses on Cancelled Ads	38.02	
		1,757.66
Net Gain for Year 1925		$ 184.56

EXHIBIT "C"

ANNUAL STATEMENT OF THE LIBRARY FUND
FOR THE YEAR 1925.

REVENUES:		
Balance January 1, 1925	$ 553.82	
Received from General Fund	480.00	
		$1,033.82

EXPENDITURES:

January 12—		
American Society Civil Engineers	$ 6.00	
February 10—		
Concrete Publishing Co	3.00	
Carrie Freret	15.00	
March 10—		
E. Dietzen & Co	37.50	
Railway Age	10.00	
Carrie Freret	15.00	
April 13—		
American Society Test Material	10.40	
Owen Germon Co	69.00	
Carrie Freret	15.00	
May 11—		
Carrie Freret	15.00	
McGraw, Hill Co	4.00	
June 5—		
Carrie Freret	15.00	
July 15—		
Carrie Freret	30.00	
September 14—		
Carrie Freret	15.00	
E. Dietzgen Co	15.30	
October 12—		
E. Dietzgen Co	22.00	
Carrie Freret	15.00	
American Society Test Material	4.50	
November 9—		
Power	3.00	
American Society Test Material	1.20	
Carrie Freret	15.00	
December 14—		
Engineering Nedws Record	5.00	
Concrete Publishing Co	3.00	
Railway Engineering & Maint	3.00	
Carrie Freret	15.00	
Owen Germon	28.75	
Miss Freret	15.00	
Engineering and Contracting	4.00	
		409.65
Balance December 31, 1925		$ 624.17

EXHIBIT "D"

CASH RECEIPTS AND DISBURSEMENTS FOR THE CALENDAR YEAR 1925.

Balance January 1, 1925			$ 769.87
RECEIPTS:			
1923 Dues	$ 14.50		
1924 Dues	457.00		
1925 Dues	2,667.75		
		$3,139.25	
1923 Smoker		30.00	
Smoker Membership		248.00	
Proceeding Sales		48.55	
Proceeding Advertising		1,049.72	
Sale of Securities		1,092.97	
Delegate Expense		130.00	
Entrance Fees		224.00	
Sundries		1.08	
			5,963.57
Total Receipts			$6,733.44
DISBURSEMENTS:			
General Expense		$ 210.17	
Library Fund		390.65	
Bills of 1924 Paid		335.84	
Securities Purchased		1,007.94	
Smoker Expense		456.12	
Refreshments		119.80	
Proceeding Miscellaneous Expense		165.00	
American Engineering Council		271.76	
Printing and Postage		299.74	
Printing and Mailing		1,040.14	
Exchange		5.45	
Stenographer		44.50	
Salary of Secretary and Editor		355.00	
Salary of Secretary		385.00	
Salary of Auditor		50.00	
Delegate Expense		130.00	
Ole Olsen—Prize		50.00	
Total Paid Out			$5,317.11
Balance in Bank			$1,416.33

EXHIBIT "E"

PROCEEDINGS
OF THE
LOUISIANA ENGINEERING SOCIETY

VOL. XII. APRIL, 1926 NO. 2

CONTENTS

EDITORIAL NOTES AND COMMENT

"Keep the Dry Land Dry and the Wet Lands Wet." This is the battle cry of Mr. Percy Viosca, Jr., Biologist of the Louisiana Department of Conservation, in his proposed method of warfare upon the salt marsh mosquito. Elsewhere in this issue is printed Mr. Viosca's paper upon The Engineering Aspects of the Problem of Salt Marsh Mosquito Suppression in Louisiana. He contrasts the problem of the New Jersey marshes with that of the Louisiana coastal swamps and some of the contrasts are very striking. The acreage in New Jersey yet to be ditched and drained is about 113,000 with a population to bear the expense thereof of about three million people. The corresponding acreage in Louisiana is about five million with a population of only about 700,000. The initial cost of the ditching, flood gates, necessary pumps, etc., in New Jersey would amount to about fifty cents per capita with an annual maintenance charge of three and one-half cents per capita. For Louisiana, adapting the same methods, Mr. Viosca estimates the initial cost per capita would be about $600.00, with an annual maintenance charge of $10.00 per capita.

If the so-called "high-lands" along the Louisiana coast were kept drained by a well-designed gravity system and means were adopted for keeping the water in the marshes at a constant level the year round, Mr. Viosca estimates the cost at about $6.00 per capita for installation and fifty cents per capita per year for maintenance. The high initial cost, as compared with New Jersey, would be considerably offset by the value of new agricultural lands made immediately available.

The principle of the method of control advocated by Mr. Viosca is to maintain as uniform and as constant as possible those conditions which permit the propagation and development of the natural enemies of the mosquito, one of the most important of which is the minnow.

Council Meeting of the A. S. M. E. Following the custom inaugurated a few years ago, of holding its Council meetings in different portions of the country, the A. S. M. E. this year selected New Orleans. This event coinciding with the time of the monthly meeting of the Louisiana Engineering Society, the program for March 8 was turned over to the Local Section of the A. S. M. E. This gave us the opportunity of hearing short addresses by several members of the Council who were present at the meeting. Preceding the meeting a dinner complimentary to the visitors was given under the auspices of the Local Section of the A. S. M. E. and the A. S. C. E.

The members of the Council who came to New Orleans for the meeting were:

Calvin W. Rice, Secretary of the Society, New York City.

Erik Oberg, Treasurer of the Society, New York City.

Sherwood F. Jeter, Hartford, Conn., Vice-President of the Society, Chief Engineer of the Hartford Steam Boiler Inspection and Insurance Company.

Robert W. Angus, Toronto, Canada, Vice-President of the Society, Professor of Mechanical Engineering, University of Toronto.

A. G. Christie, Baltimore, Md., Vice-President of the Society, Professor of Mechanical Engineering, Johns Hopkins University.

William T. Magruder, Columbus, Ohio, Vice-President of the Society, Professor of Mechanical Engineering, Ohio State University.

Roy V. Wright, New York City, Vice-President of the Society, Editor, Railway Age.

Edward A. Muller, Cincinnati, Ohio, Vice-President and General Manager, King Machine Tool Company.

Paul Wright, Birmingham, Ala., Paul Wright & Co.

Robert L. Daugherty, Pasadena, Calif., Professor of Mechanical and Hydraulic Engineering, California Institute of Technology.

Charles E. Gorton, New York City, Chairman, American Uniform Boiler Law Society.

H. V. Coes, Chicago, Ill., General Manager, Belden Manufacturing Company.

R. E. Flanders, Springfield, Vt., Manager, Jones and Lawson Machine Company.

C. H. Bromley, Fort Wayne, Ind., Manager, S. F. Bowser and Company.

Opportunities in Government Service. The United States Civil Service Commission has requested assistance in an effort to bring the examinations for architects and engineers to the attention of qualified persons. These positions pay from $2,400 to $3,800 for architects of various grades, $2,400 for assistant engineers and $3,000 for associate engineers. The following statement is made by the Commission:

"The Commission is called upon to recruit approximately 200 architects and engineers who will be needed by the Supervising Architect's Office in the execution of the extensive public building program provided in bills now pending before the House and Senate. The bills have been favorably reported to both houses of Congress. They carry $165,000,000 for public buildings, distributed as follows: For structures in Washington, D. C., $50,000,000; for post offices and other Federal buildings throughout the United States, $100,000,000; and to complete the unfinished portion of a building program ordered in 1913, $15,000,000.

"It will be noted that the examinations are of the unassembled type; that is, the competitors are not assembled in any place for examination but are rated upon their education, training, and experience. In the case of architects, specimens of the applicants' work must be filed with the application.

"Those who are interested in examinations may obtain application blanks as specified in the announcements.

"The Commission will appreciate your cooperation in this recruiting effort."

A Museum of Industrial Arts. Anyone who has had an opportunity of visiting the great industrial museums of London, Paris, Munich and other European cities must wonder in a way why, as one of the foremost industrial nations of the world, the United States has never developed such a museum on any large scale.

It is of interest to note, therefore, that those in charge of the establishment of the Museum of Peaceful Arts would go abroad during the summer to study museums and museum sites.

According to an announcement in the A. E. C. Bulletin for April:

> Calvin W. Rice, Secretary of the American Society of Mechanical Engineers, and honorary secretary of the Museum, sailed on April 10 for this purpose. Others who are to go are: Dr. John W. Lieb, a vice-president of the New York Edison Company, who will report on light, fuel and power; Dr. Samuel W. Stratton, president of the Massachusetts Institute of Technology, who will study ship models, navigation and aeroplanes; Dr. H. Foster Bain, formerly director of the United States Bureau of Mines, who will attend the International Geological Congress to be held in Madrid in May; Dr. Louis Livingston Seaman, who will study medicine and hygiene, and Dr. Ambrose Swasey, of Cleveland, manufacturer and inventor, who will study optics and physics. Elmer Ambrose Sperry, inventor and electrical engineer, sailed for Europe early in April to study exhibits of the gyro-compass, aeroplane and ship stabilizers, high power searchlights and other devices in which he is interested.
>
> It will be recalled that the establishment of this Museum was projected in 1909 but was suspended during the war. The Museum was partly endowed by Henry R. Towne before his death. It is now planned to make the Museum a permanent exposition of industrial arts in a manner that will inspire increased interest in them.
>
> Others interested in this development are taking up the matter of securing and displaying suitable exhibits with which to start.

BOOK REVIEW

BATS, MOSQUITOES AND DOLLARS.

By Charles A. R. Campbell, M. D.
(Published by the Stratford Company.)

A book written by a practicing physician and scientist, with an introduction by a world famed naturalist (Ernest Thompson Seton), intended for the general reader but of particular interest to the engineer engaged in municipal and sanitary works.

Practically without outside assistance, Doctor Campbell has done a wonderful amount of pioneer research work in his efforts to combat malaria, his principal efforts being made in a study of the natural enemies of the mosquito. In encouraging the propagation of bats as a means of reducing the mosquito population, he has constructed "bat towers," or artificial roosting places for bats, in the immediate vicinity of a number of notoriously mosquito infested places. The best known of these towers is at "Mitchell's Lake" in the suburbs of San Antonio. Before the introduction of bats to this section, the mosquitoes had become such a menace that even the cattle grazing in the vicinity were driven away and the Mexican truck farmers lost a large portion of working time, due to malarial infection. The writer has visited the locality and conversed with laborers who have lived there for a number of years. From the information so gathered, he is confident that Dr. Campbell has not overstated his case in his account of the phenomenal reduction in mosquitoes and in malaria.

Aside from the new information which the author has made available for the use of those engaged in ridding the race of the causes of disease, it is possible that the book may eventually be of even greater value in the suggestion which it contains for further investigations. The chapter on the Dragon Fly is especially intriguing. While some preliminary work has been done in studying the dragon fly, the author suggests that this would be an interesting and valuable field for others to take up. He repeats a well authenticated story of the observations made years ago, in Mexico, where it was established, long before the Cuban experiments, that the mosquito was a carrier of yellow fever. In the coffee growing section of the State of Cordova, the dragon flies came in great clouds each year and, on their appearance, there was great rejoicing as it was known that they would immediately devour the mosquitoes and that would mean the end of the fever for the season.

Another interesting chapter is that dealing with the common bedbug as a carrier of smallpox. While it is not claimed that full data have been collected in the studies already made, the evidence presented against this wingless insect is most incriminating.

While the author has avoided the unnecessary use of medical terms with which the average reader would be unfamiliar, he has included a complete glossary of all unusual terms. With the aid of this glossary, one may read the entire work intelligently. Even the special chapter on the function of the spleen is presented in an interesting manner, though this doubtless will be found to be of particular interest to the members of the medical profession.

It speaks well for the unselfish, painstaking and truly scientific work which Dr. Campbell has done that it has been indorsed by the members of his profession in San Antonio and throughout Texas generally and also has been enthusiastically approved by such men as Ernest Thompson Seton, Dr. J. A. L. Waddell and our own scientist-priest, Father Biever.

ARTHUR M. SHAW.

PAPERS AND DISCUSSIONS

ENGINEERING ASPECTS OF THE PROBLEM OF SALT MARSH MOSQUITO SUPPRESSION IN LOUISIANA

By Percy Viosca, Jr.,
Biologist, Department of Conservation of Louisiana.
Read Before the Society, February 8, 1926.

This paper is an analysis of some of the available figures on the cost of salt marsh mosquito control in New Jersey, and on the costs of reclamation and irrigation projects in Louisiana, in order that we might arrive at some conception of the order of magnitude of the problem confronting us if we would attempt to banish the so-called salt marsh mosquito from this state. These estimates, which are reduced to round numbers, are intended chiefly for their relative values, since experiment only can give us actual costs of the different methods of control when applied to the varying conditions found along the Gulf Coast. My remarks will be confined chiefly to the Louisiana situation, but application of the figures to our sister states is largely a matter of multiplication.

According to figures furnished by Thomas J. Headlee and Frank W. Miller, of the New Jersey Agricultural Experiment Station, in bulletins of that station, and in a personal communication dated January 15, 1926, the salt marshes of New Jersey originally consisted of nearly 300,000 acres, about 130,000 of which are considered to have been rendered reasonably free from mosquito breeding since the initiation of ditching for control work in 1902. There were about forty thousand acres which did not need drainage, leaving some 113,000 acres still to be drained. The territory originally affected by the mosquitoes raised along the coast of New Jersey extends some thirty to forty miles inland and has a population of about three million people.

The cost of salt marsh drainage based upon mosquito control work in nine counties of the State of New Jersey is $6.00 per acre. The major portion of this is the cost of installing 300 linear feet of open salt marsh trenching, reckoned on the basis of a ditch ten inches wide and thirty inches deep. In addition to this ditching, the drainage is maintained by means of dikes and tide gates, and in one area by means of pumps. There still remain to be drained over 113,000 acres at a cost of over $675,000 if the above figure would prevail in future drainage operations. At the rate of 10,000 acres per year, twelve years would be required to complete the initial drainage of 243,000 acres of New Jersey salt marsh. The development of efficient traction driven machinery may materially reduce the above costs and shorten the time required for future installations.

The annual cost of maintenance of the ditching systems would amount to $100,000 per year on the completed project or about forty cents per acre on 243,000 acres. At these figures, the initial drainage of the New Jersey marshes would be accomplished at fifty cents per capita, and maintenance of the ditching systems at about three and a half cents per capita per year. These figures apply to the cost of drainage for mosquito control only and not reclamation for agricultural or industrial purposes.

Let us apply the above figures to the Louisiana situation. The coastal region of this state comprises some four million acres of marsh. In addition, there are some one million acres of coastal plain, alluvial and sand ridge lands of low elevation, perhaps only half of which is or has been ditched for agricultural purposes. The population of the Louisiana area which is subject to invasions by mosquitoes raised along the coast is some two- thirds of a million people. Assuming that drainage is the best method of dealing with coastal mosquitoes, and that the New Jersey methods are applicable to the entire Louisiana area at the same cost per acre, we would have to spend $6.00 per acre on four and a half million acres or $27,000,000.00 for initial drainage and forty cents per acre on five million acres or $2,000,000.00 per year for maintenance. Considered in terms of our relatively sparse population, (even with New Orleans included) this would mean some $40.00 per capita for initial drainage and $3.00 per capita per year for maintenance. If New Jersey maintains that the cost of installing drainage is too great for counties, what will we Louisianians do with a per capita cost about eighty times as great.

Moreover, since we have an average of only about one foot normal tide throughout our outlying salt marsh area, and less or none in the interior, we cannot expect automatic tide gates to drain our marshes as in New Jersey where the normal tide is several feet. Therefore, for the thorough drainage necessary for complete mosquito control we would be compelled to resort to pumping plants. Experience with reclamation of marsh lands for agricultural purposes with the aid of pumping plants shows that the present cost per acre ranges from $50.00 to $100.00 while the cost for maintenance is about $1.00 per acre for pumping, plus the cost of keeping the ditches open. This would mean a cost of $250,000,000.00 to $500,000,000.00 for installation of drainage systems and perhaps $7,000,000.00 annually for maintenance. In terms of population, the per capita cost of this type of drainage would be somewhere between $375.00 and $750.00 per capita for reclamation and about $10.00 per year per capita for maintenance.

In the above estimates, I have not taken into account stormproof levees or insurance against tropical storm damage, cost of investigations and surveys, and unforeseen factors which are always sure to develop. I have no doubt that during the period in which a bond issue would be retired, if that plan be chosen to finance the drainage projects, the annual tax upon the population of south Louisiana would not be less than $100.00 per year per capita.

With all this we have no guarantee that drainage of the south Louisiana marshes would be a cure-all for the mosquito plague. On the contrary, all investigations that I have made on reclaimed areas, such for instance as at Lafitte in Jefferson Parish and at Phillips Land Company in Plaquemines Parish, have convinced me that under practical conditions drainage of coastal marsh in this state intensifies breeding of our most troublesome species of mosquitoes, particularly Aedes sollicitans and Culex salinarius. Besides, if these and many other relatively small projects were unsuccessful ventures because of financial, colonization and sundry difficulties, still less can we expect the agricultural lands in use in our mosquito infested area to stand a tax many times as great as is necessary for their own drainage, as would be the case if we undertook the more gigantic project.

Another factor must be taken into consideration. New Jersey with all her resources and relatively dense population and well organized anti-mosquito forces, reclaims about 10,000 acres per year. At this rate, even if the method would be successful in our marshes, it would take about 500 years to rid south Louisiana of mosquitoes, and unless we are assured that these pests are carried over into the spiritual world, I would not recommend that we follow New Jersey's footsteps.

From what the press and tourists reported regarding mosquito plagues on Manhattan and Long Island and in New Jersey last summer in spite of all the money spent on drainage up there, the New Jersey method is not 100% efficient and must not be considered a continuous means of control under all weather conditions. Eternal vigilance on the part of inspectors is required in the drained areas. These must be constantly on the lookout during the mosquito season, for sod or debris may clog the ditches and any other defects must be brought to light. Think of the army of experts that would have to be constantly on the alert on our five million acres if that system were employed here.

I am convinced, therefore, that the cost of installing ditching systems and tide gates in our marshes as done on the New Jersey coast, even though not practical along our coast, would be too great a tax upon our population, and complete drainage, with pumping plants would be many times more prohibitive merely as an anti-mosquito measure, since the demand for these lands for agricultural purposes is not sufficient that they all be rapidly reclaimed for that purpose at the present time. We must then resort to some other method of salt marsh mosquito control if we desire immediate relief.

Because of the elusive and shifting nature of their breeding habitats and other factors, oiling, the spreading of poison by airplane and other standard methods of mosquito control are also doomed to failure with our coastal mosquitoes because of their prohibitive cost and impracticability.

There still remains one method to be considered, viz: that suggested by the writer in the proceedings of the New Jersey Mosquito Extermination Association, February 5 and 7, 1925, and abstracted in the Times-Picayune, September 8, 1925. This method consists in keeping the dry lands dry and the wet lands wet so as to counteract the irregularities of nature which bring about the conditions conducive to mosquito breeding along our coast. It combines drainage of those lands which are of sufficient elevation above sea level for gravity drainage, with conservation of water in the marshes so as to maintain a constant water level all the year round. This is bound to be the cheapest method possible, for gravity drainage which is essential for agricultural purposes in the ridge lands along the coast is the cheapest method of drying the land even where flood gates and levees are used for storm protection, and it is bound to be much cheaper to keep the water in the marshes which are normally wet anyhow.

The cost of draining the million acres of so-called "high lands" along the coast would be comparable to the drainage of the New Jersey marshes and would amount to some $6.00 per acre for installation of ditches, etc., on that proportion which is in the raw state and forty cents per acre per year for maintenance. Perhaps half of this land is or has already been ditched and in cultivation, and this tax is not large for agricultural purposes for the balance of the area to be so treated. In other words, to install efficient gravity drainage on one-half million acres for agricultural purposes would cost about $3,000,000.00, a small fraction of the cost of reclamation of wet lands, and the ditches could be maintained on the entire million acres for $400,000 per year.

Since no figures are yet available on the cost of mosquito control in the marshes by conservation of water we must seek other sources of information in order to arrive at an estimate. Figures on the cheaper rice irrigation systems show that installation costs may be as low as $5.00 to $10.00 per acre, while maintenance may be reduced to ten cents per acre per year. The rice lands are above the marsh level and drain naturally, therefore retaining levees, ditches, wells, and pumps or siphons are included in the above figures. If it were necessary to install a cheap rice irrigation system to keep our wet lands wet, this would amount to $20,000,000.00 for installation on four million acres and $400,000.00 a year for maintenance. Add to this the $3,000,000.00 needed to complete drainage on the one million acres of "high lands" and $400,000.00 for maintenance and we would have $23,000,000.00 for installation suitable to control mosquitoes on both high and wet lands and $800,000.00 a year for maintenance, or some $34.00 per capita for installation, and a little over $1.00 a year per capita for maintenance. These figures, while high, are less than one-tenth the cost of complete drainage, and would be much more practical under all weather conditions, and the method has much more promise of achieving results than the more costly drainage projects. Ecological studies show that drainage of our marsh lands if not 100% complete artificially duplicates the very drouth conditions so conducive to mosquito propagation along our coasts, whereas the combination of drainage and irrigation suggested above would eliminate breeding on the high lands in wet weather while artificially creating in the marshes at all seasons a permanent wet condition such as we find in nature simultaneous with the low ebb of mosquito propagation.

Let us see now if we cannot reduce the cost of marsh irrigation somewhat. The Orange-Cameron Land Co., Inc., of Orange, Texas, and E. A. McIlhenny, of Avery Island, La., are contemplating the leveeing of large areas of marsh lands and damming the sloughs or outlets so as to conserve a certain amount of water in the marshes at all times, in connection with muskrat propagation. Mr. C. C. Leedy, of the former company, states that figures are not available yet but that the cost of closing up the outlets that drain the coastal mashes would be very nominal. He also confirms my opinion that, if a water level could be maintained in the marshes to such an extent that minnows could inhabit the entire marsh, the mosquito group would be greatly reduced.

Mr. McIlhenny's experiments are in a further advanced stage. The land is laid off in two mile square blocks, which makes about 2,600 acres to the block. The canals are eighteen feet wide by four feet deep, and this gives a levee sufficiently strong to hold the water on the land to the necessary depth.

which should not be more than about two inches over the grass roots for muskrat culture. The cost of this canaling was approximately $1,000.00 a mile. Mr. McIlhenny further states that previous to the 1924-25 trapping season he had only one block of land surrounded, and on this block he kept water by means of a pump. The cost of pumping, including the labor and gasoline, was between sixteen and seventeen hundred dollars. This block yielded something over $41,000.00 in fur, largely muskrats, while the land surrounding it yielded practically nothing. He has now about 13,000 acres surrounded by canals and levees, and has pumped water on almost all of it, but on most of it the water was pumped too late to be of much use for the present trapping season.

He also states that in the area flooded in 1924 where minnows and other natural enemies have had an opportunity to multiply in spite of the drouth, there are comparatively few mosquitoes, this in spite of the fact that they are constantly being wind-blown from adjoining areas where they are abundant. He further confirms my view that the secret of mosquito control in the marshes is to keep sufficient water on them at all times to enable the small fish to have free access to the pools, where they will destroy the wigglers.

If it were necessary to install Mr. McIlhenny's levee and canal system with suitable pumps on 4,000,000 acres of marsh, it would cost about $1.25 per acre or $5,000,000.00. Maintenance on this experimental plot was sixty cents per acre during a record-breaking drouth, but on a large scale this need not be greater than ten cents per acres as in rice irrigation. This would mean $7,500,000.00 for installation of such a system in conjunction with drainage of the adjoining high lands in the mosquito area, or only $1.00 per capita for installation and $1.00 per capita per year for maintenance as in rice irrigation.

For mosquito control only, however, we would certainly not need the elaborate system of canals and levees as on a muskrat ranch. All of our bayous and lakes bordering the marshes already have natural levees or beaches which tend to retain the water in the marshes. In such cases it would only be necessary to dam the sloughs and outlets with small pecky cypress dams.

The greatest difficulty would be met along some of the navigation and so-called drainage canals where the levee has been thrown only on one side. Since the marsh on the opposite side is alternately flooded and dried, a low embankment would have to be thrown up in such cases. The installation of such dams and levees where required would very likely cost between ten cents and fifty cents per acre, including pumps for use during dry seasons. At an average of twenty-five cents, 4,000,000 acres could be treated for $1,000,000.00. Since our marshes contain water for nine-tenths of the time, pumping when necessary, overseeing dams, repairs, etc., could easily be reduced at most to one-tenth the cost of rice irrigation maintenance, viz: one cent per acre per year or $40,000.00. Fairly complete mosquito control could then effectively be accomplished for some $6.00 per capita and maintenance at fifty cents per capita per year.

While at these figures, initial control would cost more per capita than in New Jersey, this is due to the new agricultural lands which would immediately become available and when cultivated could well stand the tax. At a crop valuation of $20.00 per acre per year above expenses, that produced on the half million acres of new development would be worth $12,500,000.00 per year or an annual dividend of 500% when this land is all in use. The only serious drawback to the agricultural lands in question is that at present they and not the marsh, as is commonly believed, are the greatest producers of the so-called marsh mosquitoes, and they depreciate as well those lands in the mosquito zone which are already developed.

From Mr. McIlhenny's experiments, it is evident that keeping the wet lands wet will multiply the muskrat crop considerably, in his instance more than tenfold. Last year's crop for the state was valued at over $4,000,000.00 in spite of the drouth. If this is only doubled due to irrigation we would have an increase of four million dollars or an annual dividend of 400% on the marsh portion of the project. On land given special attention this dividend could reach 1,000% or more. Intelligent steps taken to eradicate our coast mosquitoes would therefore not be a tax but an extremely profitable investment which

Louisiana cannot afford to overlook, this even without taking into account wild fowl and other resources of our marsh lands which are at present being driven to more restricted territory every year; but that is another story. Besides, it is not necessary to drain a single acre of marsh lands, (except near cities where real estate values can stand the tax), until the balance of our virgin alluvial and ridge lands in the coastal area are under cultivation, this not taking into account some five million acres of the best up-state farming lands which are idle at the present time and some ten million acres of idle cut-over forest lands which will perhaps not be needed for agricultural purposes for many generations.

There is nothing, however, in the plan suggested above which prevents us from using marsh lands for agracultural, industrial or real estate purposes, wherever and whenever economic conditions justify.

I hope that in this paper I have pointed a way whereby the people of this and adjoining states can capitalize mosquito control, even apart from its real estate aspects.

ABSTRACT OF ILLUSTRATED LECTURE.

After reading the above paper, Mr. Viosca gave a lecture, well illustrated with lantern slides, showing the relation of mosquito control to reclamation and to wild life conservation. First shown were the development stages of the mospito and the relationships of their larvae to other pond life. The different types of habitats in which the more common mosquitoes of this region are found were successively illustrated with views made from actual photographs. The conditions under which certain species are found more or less constantly when temperature factors are right and the conditions conducive to mosquito plagues were both demonstrated. Special emphasis was placed upon the habitat of the so-called salt marsh mosquito, Aedes sollicitans, and the factors causing its prolific breeding, because this species is erroneously believed to breed widespread over our marshes, whereas it is really not a permanent marsh mosquito in any sense of the word, since it inhabits very temporary breeding places.

The physiographic feature and natural irrigation and drainage of south Louisiana were next described and those factors in nature which are tending to prevent mosquito breeding were pointed out. Some of the more common natural enemies were illustrated. Man's interference with nature, the building of levees, deforestation, artificial drainage, and other factors which create the conditions most favorable to mosquito breeding in our low country were next illustrated. Remedies were discussed. The most important natural resources which are dependent upon our marshes for their existence were taken up and it was shown what a sacrifice we must make if we are to continue our unwise methods of interfering with nature. If we continue such practices, we face a dilemma, since it is admitted that we cannot develop our lower coast and its resources until we get rid of the mosquito; yet if we attempt the widespread use of artificial methods of mosquito control, even if we eventually get rid of the mosquito, we will sacrifice those very natural resources which make our lower coast worth developing.

The lecture demonstrated the root cause of our trouble and pointed the way to a solution of our most perplexing problem. which took into consideration the continued existence of those natural resources which form a basis for substantial land values, rather than merely as an adjunct to artificial inflation.

DISCUSSION.

Prof. Robert: Mr. Chairman, I would like to ask Mr. Viosca one question. After these places dry out and all the natural enemies are killed, how do they get re-established when the water comes in again?

Mr. Viosca: I think I touched on that in the illustrated lecture. In the case of some competitors, small crustaceae, etc., the eggs may be dessicated and hatch when the rain falls. Then we have such cases as the frogs where the adult has survived in the mud or crevices in the bottom of the pond, swamp or marsh in a semi-dormant state, or hidden in the grass or damp places; when the water comes back in the pond, these deposit their eggs. Adult insects such as water bugs and dragonflies also deposit their eggs when and where conditions are suitable.

The fish, particularly the top-minnows and small specimens of larger species, often survive in the crayfish burrows. If you cut a canal in this low country, you will see that the whole area is tunneled with a network of subterranean passages about an inch or two in diameter and certain organisms can migrate underground for long distances without touching the surface, because these tunnels are interconnected underground. Each crayfish has a cavity which may connect with one or more of the others and they don't have to come to the surface except occasionally to feed. In these underground burrows of the crayfish and its associates, these enemies of the mosquito survive. In certain small basins or deeper pools which were the last places to go dry, whenever light rains fell, bringing the ground water again to the surface, I would observe the minnows in the entrances to these burrows. When the water recedes they go again into the underground tunnels.

The top-minnows can also get from some larger body of water into newly made pools by migrating overland during heavy downpours. During torrential rains, such as we experienced last week, the water ran down the slightly sloping alluvial land in thin sheets a quarter of an inch or more in depth, and these fish, which always tend to migrate upstream, negotiated this thin sheet of water. They usually find some ditch or pond to stop in, but may sometimes be stranded in the fields. You all have heard the story about it raining fish. These are simply fish which have migrated overland in flat country during torrential rains.

Prof. Anderson: Mr. Chairman, I would like to ask Mr. Viosca about the bat as an enemy of the mosquito. I know there are many scientific men who still think that the bat is an enemy of the mosquito, and that he could be used as one of the means to eradicate the mosquito.

Mr. Viosca: I looked up the literature on that subject about a year ago. There have been some scientific investigations for the purpose of determining the food of bats, and it was found that the stomachs contained no great percentage of mosquitoes. In fact it was found that bats fed on insects generally, showing a preference, if any, for moths, and, if anything, they are a greater protection to our crops than a protection against mosquitoes. There is one species that lives here in abundance and we have a great many flying over the city, and plenty of them are found roosting in the cotton sheds down on Press Street and various other places. There is plenty of room for more of them, and evidently greater numbers cannot live here probably for the reason that they do not get enough food at all times. At any rate they are of no appreciable protection to us in this city. While we are constantly fighting adult insects by swatting flies, mosquitoes and others, we are unable to successfully get rid of them, therefore we must attack the breeding ground, the source of supply, which is much more practical anyhow.

COL. SHAW: In regard to the efforts which have been made to spread the gospel of the bat as a destroyer of mosquitoes, I would like to say that I have known its principal exponent, Dr. Campbell, of San Antonio, for a number of years. While a number of visits with him and the reading of his various articles and his book which deals principally with this subject have failed to convince me that it will be feasible for them to stamp out the mosquito pest, I have become convinced that under conditions as they exist in certain locaties bats may become an important factor in the control of night-flying mosquitoes, which variety includes the malaria-carrying mosquito. In 1918 and 1919, I had an opportunity to observe quite closely the operation of an artificial "bat roost" at San Antonio, Texas. Here the mosquito supply obviously has contributed largely to the food supply of the bats, through it undoubtedly is true that in other localities the supply is too limited or subject to too great seasonable variations, or surroundings too unfavorable to bat life to permit their successful use as a destroying agent. I recall seeing one bat roost which was built several years ago which had been abandoned. Upon inquiry as to the cause of its apparent failure to function as contemplated, I received the reply that, "I guess the mosquitoes chased them out." Of course, this was not intended to be taken seriously, but it illustrates the attitude of the average layman toward any solution of a common problem unless the success of the particular effort is more or less spectacular. In other localities the residents in the vicinity of bat roosts are fully convinced of the benefits derived from their new neighbors, the bats.

I was especially interested in Mr. Viosca's inclusion of the crayfish as an indirect agency in our fight against the mosquito. Heretofore, I had supposed that the sole end and aim of this crustacean was the making of crayfish bisque.

Mr. Viosca: I looked up the malaria fever situation at San Antonio and found that San Antonio, with the bat roost there, had a much higher death rate from malaria than New Orleans had without any bat roost; and malaria has disappeared from New Orleans without the introduction of more bats, and therefore the disappearance of malaria from a locality need not be attributed to bats.

About that particular lake experiment, I would not accept the statement that the bats have eradicated the malaria there. Of course, I am not familiar with the conditions, but I am inclined to believe that, if so, some other factors caused that.

Col. Shaw: Mitchell Lake is an artificial body of water created by impounding the discharge of the city sewer; it is anything but a resort. There are pastures and truck farms around using the water for irrigation purposes, and none but Mexicans living in the vicinity. They work the truck farms and, so far as I know, no efforts have been made toward the regulation and control of mosquitoes in that section, other than the construction of the bat roost. There is no drainage.

San Antonio has always been a mosquito infested locality and malaria has been very bad there. The Mitchell Lake conditions are not typical of the San Antonio district as a whole and do not have any material bearing on the situation within the city. The position of the lake is isolated and the conditions were artificially created. For ten or fifteen years, conditions continually grew worse up to the time that the bat roost was built, while since that time there has been a pronounced decrease in the number of night-flying mosquitoes and malaria in that section came under practical control.

Mr. Viosca: That may have been a coincidence; the mosquitoes may possibly have decreased because of a biological condition of the sewer, septic action developing, or it getting too concentrated for Anopheles larvae.

COL. SHAW: This may be true though conditions are not favorable for anaerobic action. There are no septic tanks and no particular opportunity for septic action, so the conditions of the sewage should be more or less uniform from year to year. It must be conceded, however, that even with a steady drawing off of irrigation water and no deliberate effort to promote septic action, there may be an accumulative effect from natural changes and from concentration.

MR. YOUNG: I would like to ask Mr. Viosca if the insect called the mosquito-hawk really catches mosquitoes and if it has any appreciable effect on the destruction of mosquitoes?

MR. VIOSCA: If we controlled the breeding conditions or rather caused the conditions in our marshes to become adverse to breeding, all these natural enemies working together, the mosquito hawks, the bats, birds, lizards, frogs and other insect eaters put together would be of immense value in fighting the greatly reduced army of adult mosquitoes. The mosquito-hawks themselves eat all the mosquitotse they can consume, which is not very much during mosquito plagues because conditions are such that they are very scarce during those periods, and vice versa.

I had a very interesting experience with the mosquito-hawk during the last flood. I was out on the coast in Bay Jaque, just west of the mouth of the Mississippi River, and the river water was flowing over that marsh country in a thin sheet. The nymphs of a small species of mosquito-hawk could be seen in the water in abundance, and on the tip of every single stem of grass there was an adult of this small mosquito-hawk, and the moment one left another took its place. Along about sunset the wind shifted over to the west, coming in a light breeze, and there were some marsh mosquitoes coming from the direction of Grand Isle. As long as we were on the Gulf beach, these mosquitoes bit us, but if we got back ten feet in the marsh not a single mosquito would bother us that far back. I never did see such a large scale warfare between mosquito hawks and mosquitoes. On Grand Isle and that vicinity there were ideal mosquito-breeding conditions at the time, but in the fresh water marsh of the delta there was no mosquito-breeding, but an abundance of mosquito-hawks breeding there, so that when mosquitoes flew into that marsh they could not penetrate more than ten feet back from the beach without being devoured. Some mosquitoes were actually picked up as they lit on our bodies.

COL. SHAW: I would like to know if there is any considerable advantage in keeping down the shrubbery and grass around our yards in New Orleans. We know that grass does not serve as a breeding place for mosquitoes, but by getting rid of it we could reduce the pests from around our homes. They appear to need shelter from heavy winds, and at least some varieties, even of day mosquitoes, appear to shun strong sunlight.

MR. VIOSCA: I say reducing the grass and weeds would reduce the mosquitoes considerably, as the adult mosquitoes not only survive in damp places but actually feed on the juices of plants when they cannot get blood, and will survive for a considerable period of time there. If you reduce the grass you deprive them of this source of food supply. They seem to need blood, however, to enable them to lay eggs. The adults do feed on plant juices, however, and that's the reason you find them surviving for a long period out in the permanently wet marshes, even where their larvae cannot live. That is perhaps the reason that this mosquito gets the name salt marsh mosquito. They do not breed in the permanent salt marshes, but actually live there in great quantities. They breed only in temporarily flooded salt meadows.

PROF. ANDERSON: Mr. Chairman, I would like to ask a question connected with the engineering aspect of mosquito control. There is all around the shores of Lake Pontchartrain a movement to reclaim lands for industrial and real estate purposes. Now a great deal of that land, described and shown in the pictures, consists of a more or less narrow fringe of swamp with many small intersecting streams. Now, one effect of this reclamation will be to fill up those streams, and I would like to know what would be the general effect on the mosquitoes around Lake Pontchartrain.

MR. VIOSCA: If the land is filled to a high level and well drained, there is no chance for propagation of these mosquitoes.

Let us consider the swamp between Mandeville and Lewisburg. It was mosquito free until drained because fish had access to the entire surface. Behind it you have the high lands without any great transition zone. If the swamp is filled with earth to the level of the high lands, there will be no trouble at all, but it is better to restore the swamp than leave it as it is today. Take the situation at Citrus and Little Woods, which is worse now than it ever was before drainage, and at LaBranch, which has gone back to the marshes. It all depends on whether or not the job is properly done. It seems to me it is folly to reclaim more land than we can use in the immediate future, and reclamation, if overdone, defeats its own purpose by encouraging mosquitoes and discouraging settlers.

PROF. DERICKSON: When the construction of a lake in Audubon Park was first contemplated a feeling of apprehension was shared by some residents of the vicinity as to the possibility of the lake becoming a breeding place for mosquitoes. As you know, the level of the lake changes somewhat with the rains and accordingly the margin of the lake is subjected to varying conditions.

In view of your very instructive paper, to which I have listened with great interest, I would like to ask, if I may, as to whether or not, in your opinion, the lake in Audubon Park is responsible for, or has greatly contributed to, the mosquito nuisance which has been so flagrant in the park and its immediate neighborhood during the past summer and autumn?

MR. VIOSCA: Audubon Park lake is absolutely fresh water. and because of that fact alone there would be no breeding of salt meadow mosquitoes there, however numerous they were in the park. There are, however, areas in the back of the park where an attempt has been made to drain those lakes. Back there there is some mosquito breeding, though not this species. There is a little breeding of other species at times in the front lake at one end, but I do not think it is much of a problem as there is a good deal of natural control. Now, those banded legged mosquitoes are coming from somewhere else. Right across the river there is a low area called Westwego Heights; it is the lowest high land across the river, being covered with about twelve inches of water today. It is a marshy place drained by a canal, which, however, does not drain properly. The land is too low to be drained without pumps. In the meadows on that place which are periodically flooded you have mosquitoes breeding in abundance and coming over to Audubon Park, which is directly across the river.

Mr. Frost: I would like to know if the mosquitoes lay their eggs after having blood. I wonder if the mosquito feeds altogether on the human blood, or hunts any other kind of animal to get enough blood and then go back into the meadows to lay the eggs.

Mr. Viosca: They lay their eggs after their blood meals, but they all don't have to leave the meadows to get blood. They can get it from the muskrats, ducks, and other creatures. They can feed on any kind of blood. It does not necessarily have to be human blood, but these creatures are better protected by their fur and feathers than we are.

Mr. Schneider: What is the average life of the various classes of mosquitoes?

Mr. Viosca: It varies very much with the species of the mosquito, the conditions, the blood supply. I might say for the salt marsh mosquito you have the adults produced under maximum conditions about five days after the meadows are flooded. The female is ready to bite only a few minutes after emergence. A day or so later the first batch of eggs is laid. Then about a day or two and another bite of blood. After several batches of eggs, depending upon the availability of blood, she dies. The maximum cycle would be a little over a week, if other conditions are ideal, during darm weather. On the other hand, they may be dormant for months in cold climates. If they cannot get blood, they will keep feeding on plant juices and not lay their eggs until they can get blood. All factors vary so much that you cannot state the average.

Mr. Burwell: How far do mosquitoes travel?

Mr. Viosca: I have found the banded legged salt meadow mosquito abundant in Monroe in salt ponds formed from the water from the gas wells. To get there originally some mosquito must have traveled about one hundred and seventy-five miles on a straight line from the Gulf. Whether it traveled on the wind or on a railroad train, I don't know, but it traveled that one hundred and seventy-five miles.

Last year during the height of the mosquito plague some of these mosquitoes reached as far north as Amite City. That was about sixty miles from the closest significant breeding ground. and considering the increase in abundance as you came south toward Hammond and east toward Slidell, and knowing their habitat, those hosquitoes did not breed in great abundance that far up, but were blown in there periodically. After a cycle started on the coast, it would take several days for them to get there, but traveling is not done by the mosquito, they are carried in by light winds. The farther from the breeding grounds. the less numerous they were and the quicker they disappeared. They travel with the wind, and sometimes a heavy wind will come up while they are over the water causing them to cling to any object, perhaps an excursion boat. During an initial flight across Lake Pontchartrain, after they have traveled that twenty-five miles across the water, those that survive will be so exhausted that they cling to the first things they strike along the beach, while about ten feet back there will be none until the wind slackens, so they will at least travel twenty-five miles and then go a good distance back. After the heavy winds you will find thousands and thousands of them floating on the water dead. They usually stop when they find conditions to their liking, viz: cities, towns, and golf links. On the other hand. you seldom find them linger over water, and they clear out of the wooded swamps or fresh water marshes as quickly as they can get away from them. I think they are known to get on ships a hundred miles out in the Gulf. I think it safe to assume that they can travel easily a hundred miles on light winds over water where there is no source of blood to divert their attention.

Mr. Hamilton: I would like to ask Mr. Viosca one question about Audubon Park mosquitoes. They seem to be worse out on the clear area where the golf course links are more than anywhere else in the hot season. How does it happen they are worse in the open area than anywhere else?

Mr. Viosca: The misnomer "salt marsh mosquito" will now be changed to "Audubon Park mosquito." The adults always linger around Bermuda and some other grasses and on the salt meadows lay their eggs near the roots of these grasses, and when the rain or tide floods these low places the eggs hatch. Audubon Park would be an ideal breeding place if you furnished it with brackish water and in about five days you would have thousands of them. They are there probably laying their eggs right on the golf links, as this condition more closely approximates their natural habitat than any other area in the city. There is plenty of blood, plenty of grass, and the only thing lacking is the slightly saline water as at Westwego Heights.

Mr. Dreyfus: You say that drainage of low land with protection levees along the river and ditches in the back causes the breeding of these mosquitoes. Now, it is very probable that cannot be prevented. People are going to drain their land whether it causes breeding of mosquitoes or not. The question is, can these areas be drained and reclaimed in such a manner as to avoid the mosquito breeding at the same time?

Mr. Viosca: I think if we spent enough money on it we could, that is for real estate purposes, but for agricultural purposes it evidently does not pay to drain these lands. You would have to spend too much money to drain it for agricultural purposes, and farmers would not buy land at such a high figure, as good lands of higher elevation can be bought for $100.00 per acre or less.

I repeat, if the land were worth it, and you spent enough money on it to keep it dry, as New Orleans is today, yes, but if you want a practical illustration of that, you can go to the New Orleans Lake Shore Land Company project, and I can show you many other reclaimed projects in the state where there are mosquitoes right now on any of them which are still under the pumps. Near Citrus, there is as much as one foot of water out there now, yet that project is under the pumps.

MINUTES OF MEETINGS AND BUSINESS OF THE SOCIETY.

Minutes of Regular Meeting of Board of Direction, February 8, 1926.

Meeting was called to order by President Hamilton and the following members were present: Messers. Fey, Lanphier, Porter, Moses and Muth.

The minutes of the previous meeting of the Board were read and approved.

Upon consideration of the matter the Board decided to take up at the next meeting the purchase of homestead stock to the value of about $500.00.

Membership of W. B. Gregory, Jr., was transferred to Non-Resident Membership. Mr. Carl Schneider was transferred to grade of Resident Member.

Communication was read from the Facultad of Ciencias Fisicomatematicas Puras y Aplicadas LAPLATA COMISION de PUBLICATIONES, Argentine, and on motion duly seconded it was voted to exchange the Proceedings of this Society for their publication.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

Meeting of the Society, February 8, 1926.

The meeting was called to order by President Hamilton, F. A. Muth, Secretary, and present forty-seven members and guests.

The minutes of the previous meeting were read and approved.

The President announced the personnel of the committees for the ensuing year.

The Society then listened to an interesting paper on the "Engineering Aspects of the Salt Marsh Mosquito Suppression in Louisiana" by Mr. Percy Viosca, Jr., Biologist, Louisiana Conservation Commission.

The paper was illustrated with numerous slides and interesting and helpful discussion followed. A rising vote of thanks was then tendered the speaker.

The President then announced that owing to the fact that the delegate and alternate to the American Engineering Council could not attend the annual meeting of that Council, Mr. E. S. Lanphier, who was at the time in Washington, was requested to represent the Society. Mr. Lanphier then gave an interesting report on the work accomplished at the council meetings which he attended.

The meeting then adjourned to Petrie's Restaurant.

F. A. MUTH, Secretary.

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PROCEEDINGS
OF THE
LOUISIANA ENGINEERING SOCIETY

VOL. XII. JUNE, 1926 NO. 3

CONTENTS

EDITORIAL NOTES AND COMMENT

Radio Reception. Mr. Freitag's paper upon this subject, read before the April meeting of the Society, while brief, is a very clear elementary explanation of radio reception in such form that a person who knows something of the elements of electricity can gain a good working idea of the way in which his receiving set functions. The paper has another very excellent quality, not always to be found in technical papers, and that is, the author sticks closely to his subject and does not yield to the temptation to wander off into the many fascinating ramifications of the field of radio.

Mr. Freitag describes the two modern methods of radio reception, the crystal detector and the vacuum tube, both of which are intensely interesting to the radio fan, from the standpoint of the fundamental principles involved as well as the expert manipulations of the auxiliary devices which go to make up the sum total of a receiving set.

Talks by Members of Council of A. S. M. E. As reported in the April issue of the Proceedings, the members of the Louisiana Engineering Society had the pleasure of hearing short addresses by some of the Council members at the regular meeting on March 8th. The stenographer's transcript of this meeting has just now become available and these talks are published in this issue.

Ductile Arc Welds. Research Narratives in its issue of June 1, 1926, supplies the following information on two new processes of arc welding, which may result ultimately in some quite revolutionary changes in methods of building metal structures where riveting is now the accepted method. The article is as follows:

> A step forward in the utilization of the heat of electric arcs in the joining of metal parts or the building of metal structures—another step toward the day when the pounding, noisy riveter will resign in favor of the quiet electric welder for most work—has been taken in the development of two methods of producing ductile welds. The one was developed by Dr. Irving Langmuir in the Schenectady research laboratory of the General Electric Company; the other almost simultaneously in the Thompson research laboratory of the company at Lynn, Massachusetts, by Peter Alexander.
>
> In both processes, while the welding is being done, air is excluded from the metal at the joint by means of a bath of hydrogen or other suitable gas. The formation oxides and nitrides which are objectionable, in the weld metal, is thus prevented; the fused metal is as strong and ductile as the original metal.
>
> The development of the Schenectady method is a good example of the unexpected eventual commercial application of experiments in pure scientific research. Fifteen years ago, while studying the loss of heat of the tungsten filaments of incandescent lamps in an atmosphere of hydrogen, Dr. Langmuir found that at a high temperature the hydrogen gas was changed from the molecular to the atomic state. Two atoms are grouped together as a unit in a molecule of hydrogen gas; in the atomic state each atom acts as a unit. The molecular form is the more stable, and when the

atoms recombine to form the molecules, intense heat is liberated.

Dr. Langmuir's study of lamp filaments in hydrogen was a theoretical investigation. Now, fifteen years later, the results have been applied in a different field—in the development of a new and improved method of welding.

Continuing the theoretical investigation, Dr. Langmuir found that more atomic hydrogen was formed by passing a powerful electric arc between tungsten electrodes in hydrogen at atmospheric pressure. By directing a jet of hydrogen from a small tube into the arc, atomic hydrogen could be blown out of the arc, forming an intensely hot flame of atomic hydrogen burning to molecular form and liberating about half again as much heat as does the oxy-hydrogen flame.

By using such a flame of atomic hydrogen, iron can be welded or melted without contamination by carbon, oxygen or nitrogen. Because of the powerful reducing action of the atomic hydrogen, alloys containing chromium, aluminum, silicon or manganese, can be welded without fluxes and without oxidation. The rapidity with which such metals as iron can be melted exceeds that in the oxy-acetylene flame, so that the process promises to be particularly valuable for welding. Either alternating or direct current can be used with this process.

Materials of many kinds have been welded with the atomic hydrogen flame. Low carbon steels up to one-half inch in thickness have been welded without additional material after butting together tightly. Much work has also been done in connection with full automatic welding, using a butt joint, with no metal added to the seam. A number of welds have been made on seamless tubes having a diameter of four inches, and with boiler plate one inch thick. Welds on deoxidized copper, such as silicon-copper, have been made up to three-eighths-inch metal, giving unusually good sections.

In testing welds made by this process, the welded portions have been twisted and bent double without cracking or otherwise being injured. Such results have not been attained with the ordinary arc weld, since such welds are usually brittle because of the presence of nitrides or a thin film of oxide or scale.

avoided in the new process by the presence of the hydrogen.

The process developed in the Lynn laboratory is based on the utilization of the chemical and physical properties of hydrogen and other gases in the molecular state. This process aims primarily at the prevention of the formation of the nitrides and oxides in the arc-deposited metal, which limit the ductility of the usual arc welds.

In this process the arc is struck between the metallic wire or carbon used as one electrode and the plate or work to be welded used as the other electrode. The crater of the arc is always on the work to be welded. The gaseous atmosphere is supplied in the form of a stream around the arc. Pure hydrogen, water gas, hydrogen-nitrogen mixtures, anhydrous ammonia, methanol vapor and some other gases can be used, according to the nature of the work. The process makes arc welding more efficient, and suitable for fields which at present are out of its reach. Low-carbon steel, alloy steels, and most of the non-ferrous alloys can be welded with success by this process in suitable gaseous mixtures.

Based on information supplied by Dr. Irving Langmuir, General Electric Research Laboratory, Schenectady, New York, and Peter Alexander, the Thomson Rresearch Laboratory of the same company, Lynn, Massachusetts.

PAPERS AND DISCUSSIONS

THE FUNDAMENTAL PRINCIPLES OF RADIO RECEPTION.

By C. A. Freitag,
Radio Engineer.

Read Before the Society, April 12, 1926.

The development of electric means of communication has profoundly modified business and social life. Electric communication may be accomplished by transmitting dot-and-dash signals arranged according to code, as in telegraphy, or by transmitting the voice itself, as in telephony. A means of communication in which the voice itself is transmitted is obviously far more direct and convenient than a means of communication that employs code signals.

Talking across the room to a friend is such a familiar experience that we take it for granted. We do not stop to think how many steps are really involved. The development of the phonograph by Edison and of the telephone by Bell was made possible because both inventors thoroughly understood sound waves. If we wish to realize and apply the principles of radiotelephony, we must have a clear understanding not only of the behavior of the sound waves at the sending and receiving stations, but also of the intermediate steps by means of which a sound at the transmitting station produces a corresponding sound at the receiving station.

Communication between two distant points may be obtained by pushing or pulling something connecting the places, by projectiles or by wave motion. Wave motion is the most important of these, and has the notable characteristic that it is essentially a broadcast method of communication; that is, a signal from one sending station is transmitted in such a way that it may be received at any one of the many receiving stations. Waves in a pond are easily visible. Sound is transmitted by invisible waves in the air. The X-ray, light, heat, and radio, are all electromagnetic waves in the ether. The eye is an apparatus for receiving light waves, and the light sent out broadcast from a lamp can be perceived by a person at any point within a certain distance of the lamp.

Every wave has certain characteristic properties, and these are length, frequency, velocity, height and form. All of these properties may be noted in a water wave. The length is the distance between successive crests; the frequency is the number of crests that passes a given point in a given interval of time; the velocity is the speed with which the wave transmits a disturbance from one point to another; the height is the vertical distance between crests and trough; and the form is the shape assumed by the sides of the wave. The greater the height of a wave, the greater the amount of energy that it is transmitting and the greater the amount of work that it can be made to perform.

As a wave spreads out from the point from which it starts, its height becomes less and less, and at a sufficiently great distance it becomes so feeble as to be imperceptible. Thus, in a pond, waves die out as they spread, and so a sound quickly dies out as the listener moves away from its source. The distance to which a wave of a given kind will travel before dying out depends to a certain extent on its frequency.

Sound waves travel in air with a velocity of about 1,090 feet per second. Electromagnetic waves, including light, heat, and radio waves, travel with a velocity of about 186,000 miles per second.

Sounds are caused by vibrations or to-and-fro motions of some sounding body that creates waves in the air. The vibrating body may be a piano wire, an anvil, a vocal cord, any one of an almost infinite variety of objects. The waves sent out by different kinds of vibrating bodies differ greatly in form. Probably the purest sounds that we ever hear are emitted by tuning forks, such as piano tuners use.

Sound waves that reach the ear cause the ear-drum to vibrate just as the source of the sound vibrates, and thus the sound is reproduced.

The ear can best hear sounds that have frequencies varying between 1000 and 4000 per second. Sounds can be heard, however, which have frequencies between the extreme limits of 16 vibrations and 32,000 vibrations per second, but for these extreme limits it takes a great deal more energy to make a sound wave audible. The ear cannot hear sounds having frequencies greater than 32,000.

The frequency of the electromagnetic waves employed in radio communication greatly exceeds 32,000. In radio work it is very convenient to distinguish the two classes, radio frequencies and audio frequencies. The audio frequencies or voice frequencies are the frequencies which can be heard; that is, the ones that are audible; the radio frequencies are the higher frequencies that cannot be heard.

If a piece of wood on the surface of a pond is given a continuous series of up-and-down impulses, there will be produced a continuous series of waves which will be transmitted or radiated out over the surface of the pond. Whenever an electric current is reversed rapidly in direction, corresponding radio waves are radiated out into space. The greater the frequency of the reversals of the current, the greater the energy radiated for the same energy input. The flow of 60-cycle alternating current sends out into space feeble radio waves, and because of the feeble energy, they do not travel very far. If we wish to have radio waves sent out that represent considerable energy, we must supply an alternating current of a much higher frequency, perhaps a million cycles per second. The current, varying at the low voice frequency, which is transmitting the voice over a wire in ordinary telephony, will cause corresponding feeble radio waves to be radiated into space, but because of the small radiation they will travel only a short distance before they die out.

The problem of wireless telephony is thus seen to have two fundamental difficulties: first, we cannot use low frequency current because the radiation from the low frequency current is very feeble, and second in the use of high frequency currents, we are confronted with the difficulty that the ear cannot hear the high frequency and the voice cannot reproduce them. The low frequency can be thought of as a cripple with good hearing who cannot walk a step, and the high frequency can be thought of as a man who can walk perfectly well but is deaf and dumb. An obvious solution is that these men should form a partnership, and that the cripples should be carried by the deaf man. The radio-frequency wave is shaped or moulded to the form of the voice frequency wave which it is desired to transmit, by varying the amplitude or height of the radio-frequency. Such a moulded or modulated high frequency radio wave can be transmitted over long distances, and can be made to reproduce the voice at the distant receiving station.

The process of moulding or modulating the radio-frequency wave is usually accomplished by means of the vacuum tube. Into the modulator there is fed both the unmodulated radio frequency current from the oscillator and the current from the telephone transmitter which is varying at low voice frequencies. These two currents are combined in the modulator unit, from which results the modulated radio-frequency wave which is radiated out into space. The telephone transmitter used may be the same type that is employed in telephony over wires.

In order to secure the most effective radiation of the radio waves into space, it is necessary to use an antenna, or aerial.

All that is needed to receive radio-telephone messages is an antenna connected with a circuit tuned to the radio-frequency wave which it is desired to receive, and means for making the radio-frequency current audible. The radio wave which arrives at the receiving station causes a corresponding alternating current to flow in the antenna and the circuit connected with it.

Suppose that the telephone receiver and the tuning coil are connected directly in series between the antenna and the ground, and that the tuning coil is tuned to the wave length of the wave which it is desired to receive, but that no other apparatus is present. The incoming wave will have a frequency of perhaps a million cycles per second. If there were an extremely light and sensitive device which could vibrate a million times a second, it could be connected in the circuit and would respond to the incoming wave and vibrate at the wave's frequency. But the diaphragm of the telephone receiver is not nearly light enough to respond to so high a frequency. During one-half of each radio-frequency wave the diaphragm is subjected to an outward force, and during the other half it is subject to an inward pull, but the duration of these forces is so short that the diaphragm does not have time to get started moving in one direction before it is pulled in the other direction. And even if the diaphragm were so light that it could accurately follow these very rapid changes in the magnetic force acting on it, the ear would not perceive any sound because the frequency is far above the highest audible frequency.

If the incoming wave is a radio-frequency wave having a frequency of a million cycles per second, which is modulated by a sound having a frequency of three hundred cycles per second, the sound cannot be made audible in the telephone receivers with the apparatus mentioned above. But if we could devise some kind of valve which would pass only the halves of waves acting to pull the diaphragm in one direction, and would prevent the other halves of the waves from acting on the diaphragm, we would accomplish our result. During each three-hundredth of a second, the diaphragm would be acted upon by three thousand impulses acting in the same direction, and the effect of these impulses would add up and pull the diaphragm, and the sound transmitted could thus be made audible.

There are several devices which act as such an electrical valve. The most important of these are the crystal detector and the vacuum tube.

Galena is a native mineral, and is an important lead ore. It has been found that if a fine wire is placed in contact with the surface of a selected crystal of galena, an electric current will flow in one direction through the fine wire and the contact and the crystal. The contact between the fine wire and the surface of the crystal acts like a flap valve which lets water pass in one direction only in a pipe. Iron pyrites also acts in this way. Such minerals are called crystal detectors. It is by no means every specimen of either of these minerals that will act as crystal detector, and it is not every spot on the surface of a given crystal that will give a contact that will act as a detector and pass current only in one direction. A good crystal must be selected and then the surface of the crystal must be searched with the fine wire to find a spot which is satisfactory.

The crystal detector simply cuts off the lower halves of the waves, and the current that passes through will be made up of a series of impulses or gushes, all acting in the same direction. Such a wave is called a rectified wave. These impulses of current pass through the windings of the telephone receiver and since they are all acting in the same direction they all tend to pull the diaphragm in the same way. Some of the impulses of current are larger than others and therefore pull harder.

Thus, the crystal detector and the telephone receiver working together reconvert the modulated radio-frequency waves into sound waves.

One of the most serious limitations to radio communication is the noise produced in the telephone receivers by stray currents caused by atmospheric electricity. These stray disturbances are much worse in summer than in winter, and more vexatious in tropical latitudes than in temperate latitudes. They are variously called static, strays, atmospherics and other names. Often in summer static is so severe as to make reception by radio-telephone entirely impossible for hours. Many persons having little familiarity with radio have installed receiving sets during the winter with the expectation that the same receiving conditions would continue all the year and that they could always hear broadcast concerts. Much disappointment has been caused when the existence of severe static was inevitably discovered with the approach of spring.

Interference from transmitting stations other than the one which it is desired to receive, is another difficulty met in radio communication. If the interfering station is working on a wave length not too close to the wave length of the staton which it is desired to receive, it is possible to tune out the interfering station. If the interfering station is working on the same wave length as the station which it is desired to receive, relief may be obtained by a coil or loop antenna, provided the two transmitting stations lie in different directions from the receiving station.

It often happens that a person will hear an incoming signal very loud and clear for some time, and then without any apparent cause or change of adjustments of the receiving set the signal will fade away until it becomes almost inaudible. This efect is particularly likely to occur on short waves, especially under 400 meters. Fading is not usually observed at short distances from a transmitting station, but only at distances from the transmitting station which are perhaps 20% of the normal transmitting range of the station. After a time, perhaps a few minutes or perhaps hours, the signals will resume their normal intensity without apparent cause. Fading is usually observed especially at night and in transmission over land. Satisfactory explanation of fading has not yet been found.

The second of these devices which acts as an electrical valve is the vacuum tube, and a great many of us have often wondered how the vacuum tube used in present day sets works.

The radiation of electrons from a heated metallic substance constitutes the fundamental basis on which the modern vacuum tube was developed. It is sometimes spoken of as the "Edison Effect" since it was first discovered by Edison about 1890 in the manufacture of electric lamps. Edison, however, did not then realize its significance and did not thoroughly understand it. He discovered that if an electrode were sealed into an electric lamp and insulated from the filament, it became negatively charged when the filament was lighted. This phenomenon was assumed to be due to the radiation of negative electrons.

If the filament is heated sufficiently, actual metallic atoms will be radiated from it in addition to the negative electrons. It is the radiation of these atoms, not of the electrons, which blackens the inner wall of an ordinary lamp after long use.

If in the manufacture of an ordinary electric lamp, an additional electrode (a plate of metal) is sealed into the bulb, when the filament is lighted there will be an emission of free electrons from the filament surface. Now, if we connect a battery called a "B" battery in the plate circuit so that the plate will have a positive potential and attach the other end of this circuit to the filament, a current of electricity will flow. This is caused by the attraction of the electrons, which are negative electrical charges, toward the positively charged plate.

It has long been accepted as a convention that the electric current flows from a point of high potential to a point of low potential, so that on this basis we say that a current flows from the plate to the filament. As a matter of fact the electron stream is the current and is in the opposite direction, but it would produce so much confusion to change our idea of direction of current flow that we continue to follow the older convention. It was this current flow which first brought Edison's attention to what is now known as the Edison Effect. If the "B" battery is reversed so that the plate will be negatively charged, then no current will flow in the circuit between plate and filament, since the negative free electrons are repelled by the negative plate potential.

In 1904, Mr. J. A. Fleming, of London, brought out a tube containing two elements—filament and plate—which was known as the Fleming Valve. Mr. Fleming realized that such a device, based on the Edison Effect, would have the properties of a rectifier since it would pass current between the plate and the filament in but one direction.

The filament of the Fleming Valve is usually made of tungsten and is lighted from a storage battery connected in series with a variable resistance or rheostat which serves to vary the current through the filament. This battery is called the "A" battery.

The radio frequency potential of an incoming signal is tuned to a maximum and at the same time impressed across the filament and plate of a valve or vacuum tube. Due to its property of rectification the valve permits a series of direct current impulses to charge a small fixed condenser shunted across the telephone receivers. This causes the diaphragm of the telephone receivers to be actuated at an audible frequency.

The Fleming Valve proved to be considerably more sensitive than the crystal detector and had the advantage of being easily operated, the only adjustment being that of the battery rheostat. However, it was soon superseded by the audion, or vacuum tube as it is more commonly termed.

The modern vacuum tube was invented by Dr. Lee DeForest, an American Radio Engineer, in 1906. It differs from the Fleming Valve only in the addition of a third member, the grid. The grid is placed between the filament and the plate and is so constructed that the electrons radiated from the filament may pass through it to the plate. In order that the grid shall not obstruct the electronic flow, it is usually made of fine wire either in the form of a spiral or lattice completely surrounding the filament, or in a flat zig-zag grid placed on either side of the filament.

When the filament is heated to a temperature sufficient to cause a prolific emission of negative electrons, the space around the filament becomes negatively charged just as though it were a solid, metallic substance. This negative charge around the filament is called the space charge. This space charge being of the same polarity as that of the electrons, tends to repel more negative electrons which might be driven off from the filament. Or we may say that the radiation of negative electrons from the filament tends to leave it positively charged, with the result that this unlike charge on the filament tends to attract some of the free electrons back to it. There is, therefore, a limit to the number of electrons which can be radiated from the filament to the plate of the Fleming Valve due to this negative space charge.

If we apply a positive potential to the plate, this unlike charge will tend to attract the electrons to it so that the majority of them will not return to the filament. As we increase the "B" battery potential on the plate, more and more electrons are attracted to it from the filament. This flow of current from the plate to the filament, under the influence of the positive potential of the plate is termed the plate current.

Consequently, with increased plate potential there is an increased plate current.

At moderate potentials of the "B" battery, only a few of the electrons are attracted to the plate. The rest, under the influence of the negative space charge, are returned to the filament. For a fixed value of filament current, and hence electronic radiation, more and more electrons are attracted to the plate as the plate potential is increased until finally all of the electrons which are radiated in a given length of time reach the plate. At this point the negative space charge is completely neutralized or annulled by the positive potential. Any further increase in the plate potential will not increase the plate current, since all of the electrons which can be radiated are now flowing between the filament and the plate. The plate current is, therefore, said to be saturated.

By interposing the grid between the filament and the plate. DeForest provided a means for controlling the space charge and hence the plate current. When the grid is positively charged it tends to reduce the space charge and hence to increase the plate current. When it is negative the space charge is assisted, since a greater number of electrons are returned to the filament and the plate current is reduced.

The vacuum tube will thus be seen to resemble in principle an ordinary telegraph relay in that feeble inpulses in the grid or input circuit of the tube will be faithfully reproduced in the plate or "local" circuit. However, only a very slight change in the grid potential is required to produce a very large fluctuation of the plate current. It is this property of a tube which makes it an amplifier. The very small amount of energy contained in the received radio wave when impressed on the grid, releases a large amount of energy in the plate or "B" battery circuit.

We may compare this principle of tube action to a pistol. in which the light pressure of the finger on the trigger releases a large amount of stored up energy in the cartridge. The trigger is the grid, the finger-pressure is the potential of the incoming wave, the stored energy of the powder is the "B" battery, and the propelled bullet represents the plate or "B" battery current.

As a detector, the vacuum tube makes use of both its rectifying and amplifying properties. The filament is heated to the proper temperature by the "A" battery, and the required positive charge is impressed on the plate by the "B" battery. The received radio current, when properly tuned in the antenna and secondary circuits, impresses a radio frequency potential on the terminals of the secondary variable condenser. When that side of the stopping condenser which is connected to the grid, is positively charged by this radio frequency potential which is also impressed across the grid and filament, since they are shunted or connected in parallel across the secondary condenser, a current passes from the grid to the filament. When it is negatively charged, however. the rectifying property of the tube does not permit a current to flow from the filament to the grid. Consequently, for each radio cycle or wave in an incoming train, a negative charge is given to the stopping condenser and grid.

With the vacuum tube detector, the telephone current, while produced by the receiving energy, is actually supplied by the "B" battery and in energy content is very much greater than that received. In other words, as we have previously seen, the vacuum tube detector not only rectifies the received energy, as does the crystal detector, but amplifies it. Consequently the vacuum tube is very much more sensitive than the crystal and much more desirable as a detector.

DISCUSSION.

Mr. Moses: I had a letter from someone the other day stating that he had a new type of aerial, which would not eliminate static, but reduced it to less than half it is now. Could you tell us something about that?

Mr. Freitag: I haven't heard anything about this new type of aerial. I do not believe there is very much in a claim of that sort. The loop aerial comes nearer to reducing static than anything I know of, and that is not sufficient to reduce it entirely.

Prof. Steinmayer: Are other ores besides sulphate ore used in crystal detectors?

Mr. Freitag: Yes.

PROF. STEINMAYER: Can any crystals be used as detectors?

MR. FREITAG: There are any number of crystals that can be used as detectors, galena being the chief of them all. It seems to be the one that gives the best all around satisfaction, but carborundum is used and quite a number of others. I can't think of the names of them just now.

PROF. STEINMAYER: Then the form of crystal has nothing to do with it?

MR. FREITAG: No.

PROF. STEINMAYER: Is not the whole crystal considered as the detector, or only part of it?

MR. FREITAG: The only thing I can say is the crystals have been found to be sensitive in certain spots, and the actual reason for it I cannot tell you.

REPORT ON ADDRESSES MADE AT MEETING UNDER AUSPICES OF LOCAL CHAPTER OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Professor James M. Robert, Chairman.

Prof. Robert: This happens to be a rather auspicious occasion in that we have with us one of the Managers of the American Society of Civil Engineers, and we have with us practically the entire Council of the American Society of Mechanical Engineers.

We regret that the President of the American Society of Mechanical Engineers is not with us, but we have four Vice-Presidents and I suppose they will equal one President; we shall at least make that assumption for this evening.

One of the first Vice-Presidents, upon whom I would like to call for a few minutes of his time, is a gentleman whom we would all like to see. He is supposedly an old man in the organization, or at least in point of membership in that organization. He is Prof. W. T. Magruder of the Ohio State University. We have had so many imposters lately that this is his picture (exhibiting picture). Now, if the man who gets up to talk does not look like this picture, why don't let him talk. I am going to call on some man by the name of Prof. Magruder. Professor, we should like to have a word from you.

Prof. Magruder: Mr. Chairman, Gentlemen of the Louisiana Engineering Society and of the American Societies of Civil and Mechanical Engineers.

I do not know whether I am the gentleman to whom Professor Robert refers and do not think that the photograph represents me as I now am. I understand we are to have four speakers and I suppose that means that I am to be the first quarter, being one of the senior members of the American Society of Mechanical Engineers. In fact, I remember when the Society was founded, as I was a student at Stevens Institute and was running a Pond lathe in the shop when Professor Thurston, the Society's first President, brought the charter members around on a tour of inspection.

I was also one of the earliest members, if not one of the founders, of the Engineering Association of the South. I remember that I presented a paper on "Mechanics as a Fine Art" before that Association in 1894. I also had the pleasure of corresponding with and being otherwise connected with a man who has now gone to his reward, both as an engineer and a citizen of Texas. I refer to Julius Krutschnitt, who contributed an article before the Engineering Association of the South on the bridge over the Pecos River. Another member of that Association, and one who was stationed in this city as the representative of the engineering corps of the army, was Colonel Robert. the author of Robert's "Rules of Order."

Your guests enjoyed and were much impressed with the dinner for many reasons. First of all it was a meeting of engineers and that is always pleasant. Then I noticed that the tables were set in the form of the Greek letter Pi. Then I noticed that we were in the hall of mirrors but that they did not lend themselves to the vanity of those present. We noted that the local members of the American Society of Civil Engineers joined with those of the American Society of Mechanical Engineers in entertaining the visitors. This is always a wise procedure and tends toward co-operation and comity in our profession. On behalf of the visitors, I desire to thank you for your gracious hospitality, for the kindly courtesies extended to us during our visit to your city, for giving us a pleasant evening, and for the privilege of hearing from Mr. Howe, who discussed at the dinner some of the problems which have come before the American Society of Civil Engineers just as they have come, and are coming, before the American Society of Mechanical Engineers.

Prof. Robert: Prof. Magruder, I know everyone was glad to get a look at you, and hear you also.

We have another Vice-President here tonight, who has travelled a long way from his home for the purpose of adding his bit of service to the Engineering profession. He comes all the way from Toronto, Canada. He is Professor of Mechanical Engineering at the University of Toronto. The gentleman to whom I refer is Professor Angus.

Prof. Robert W. Angus: Mr. Chairman, and members of the Louisiana Engineering Society. It gives me a great deal of pleasure to come down here and to see you. I have been thinking recently of the change in attitude of your people toward us in Canada. I lived on this side of the line for a while, although a Canadian, and I frequently visit this country, although I have not come quite so far South before, and the question formerly asked me was, "What are the feelings of Canada towards the United States and when are you going to join us?" Now, you seem to be afraid, for some reason or other, that we may join the United States, and that the dividing line may be removed, and some of your privileges taken away. On this side of the line, I understand there is a dry area, and on some parts of the other side of the line is a source of irrigation, and you apparently like to have that line so that this source is always available.

Since I have been here I have been looking at some of the engineering problems that confront you, and they seem to be connected with drainage and difficulties resulting therefrom. Perhaps you might be interested in learning what we are trying to do in our part of the country. The Province I am in is fairly large, being about a thousand miles wide and perhaps eight hundred miles from north to south, but it is really a small part of the whole Dominion, and probably there is only about one-fourth of the Province fully developed. It has in it approximately one-fourth of the total population of Canada and is a great industrial part of it.

We are so situated that we have no appreciable supply of fuel at all; our Canadian coal must come from Alberta, some thousand or twelve hundred miles to the west, or from Nova Scotia, about eight hundred miles to the east. Our main supply comes from the United States, and there is not any objection to that source, but it is a long distance from my home city, Toronto, to the Pennsylvania fields, and so the price of coal is fairly high.

When the industries began to develop extensively, of course we had to have power, and we had great sources of hydro-electric power close to us, it being only eighty miles from Toronto to Niagara Falls. We have just recently developed at Queenston, on the Niagara River, a plant of 550,000 horsepower in nine units of 55,000 to 60,000 horsepower each, and in addition to that, there are two other plants on the same river supplying nearly 250,000 horsepower, although a small amount of this is exported. We have at another place a total of 80,000 horsepower available, and we also develop small streams with heads as low as 8 to 10 feet, and others as high as 600 feet. We will have a total of nearly 1,900,000 horsepower when all projected plans are operating to capacity, this figure not including the proposed St. Lawrence scheme.

We are using at the present time in Ontario about 900 kilowatt hours per year per capita, and there is, therefore, placed at the disposal of every citizen of our Province the equivalent of approximately 4-10th horsepower, which shows that we use electricity on a very large scale, and the problems involved in it are amongst the most important the engineering profession in our section has to deal with. The result of this development has been an extremely low rate for the sale of current. The average rate in Toronto, and I may say for cities and towns in the whole Province, would not be far from 1.9 cents per kilowatt hour for domestic light.

There are 415,000 consumers, or about one to every seven of population, and, assuming the average home to have four persons in it. one-half of the homes are equipped with that cheap type of energy. The cost of commercial power is in the neighborhood of twenty dollars per horsepower per annum.

Hydro-electric development introduced to us some very difficult problems that you, fortunately, know nothing about here. Ice is one thing that gives us much trouble. In the early spring of the year there is a tremendous amount of ice going down in such rivers as the Niagara, and if one crosses the International Bridge at Buffalo at certain times one will find the river covered with ice, which a favorable wind will shove over to our power plants, and sometimes stop them altogether. The ice carries stones and debris. some stones six inches in diameter having been carried through a closed flume for nearly 7,000 feet, and finally into the turbines, causing serious damage.

The ice, of course, also forms where the water comes into the plant. and in some cases forms a dam and stops the water.

and it is quite difficult to get it out; they frequently must use dynamite. With all these difficulties, however, we are practically always able to get current for light and power, and I do not think in the last fifteen or twenty years, that we have been without a very satisfactory source of power. But I do not want to take up any more time talking about this subject, which is a very large one.

In closing, I wish to say I am very glad to see this combination of Societies, which is something we have been working on, but we find it very difficult to get the different classes of Engineers to come together. Each man seems to feel that his is a special branch; the Civil does not think he is interested in the same problems as the Electrical Engineer, and the Mechanical Engineers feel the same way about the Civil Engineers; but after all, it seems to me, we are all working with the same general class of problems, and it has never been definitely decided what is the exact limitation of the Mechanical Engineer, or any other type of Engineer. In many cases one does not know to which group a class of work belongs, as, for instance, problems connected with Waterworks plants. Therefore, I think it desirable, so far as possible, for the groups to get together so that each may see the problems the others have, and the whole profession may work together, and so combine as to render the best service to mankind.

PROF. ROBERT: Another one of our Vice-Presidents covers a little different line of work. He is a writer and I am glad to welcome him here, Mr. Roy V. Wright, the Managing Editor of the Railway Age and Editor of the Mechanical Engineering, I believe.

MR. ROY V. WRIGHT: I feel just a wee bit out of place up here with all these professors. There is one thing I want to bring to your attention for a few minutes, and that is the progress in industry and in transportation. We have had more or less of a revolution in the last few years and instead of placing emphasis upon the material we are placing it on the man; the engineer is bringing about more or less that change. Some years ago we had an awful time in the engineering society to get away from the strictly material point of view. This is a difficult point and I was rather interested in noticing in that connection a paragraph from Mr. Houghton's article in the last number of Mechanical Engineering. Those of you who have read it will recall that Mr| Houghton says a recent development has greatly increased the mind and broadened the scope of the technical engineer. His services are no longer limited to designing or supervising for manufacturing or construction.

If one should review the presidential addresses delivered before the American Society of Mechanical Engineers in recent years, he would be struck by the fact that we have gotten away from the type of former years, which dealt almost exclusively with the technical or material side of engineering problems. Of recent years far greater stress has been laid upon the place of the engineer in the growing complexity of our social order; his responsibility in the matter of the human side of industrial relations, his ideals of service to his community and his growing importance in the matter of national leadership.

If we catch the spirit of these messages, it will not be difficult to see the important problems to the engineering industry.

We want as leaders in engineering men who are far-sighted and close-fisted; men who will permit important engineering projects and developments to proceed only under the most carefully matured plans. That statement might also stand as a platform for the engineers.

It is the engineer who has made possible this present wonderful era of mass production. Only as far as fifteen years back there were some sections with such poor transportation facilities as to render mass production a very difficult problem. The engineer has met this problem and solved it.

In the growing complexity of our modern civilization there are many types of problems, industrial, economic, social and political. And the engineer is the man best fitted to cope with many of the phases of these problems, so that we may expect to see more and more the ranks of our national leaders recruited from the engineering profession.

Prof. Robert: Gentlemen, you heard Mr. Wright say he felt embarrassed about getting up here among so many professors. I think he had a colossal nerve to say that to start out with. You got, I suppose, what he meant by that. That word "professor" has some peculiar meaning to him. It reminds me of an incident I heard of Booker T. Washington, whom you know as a brilliant negro.

At a convention at one time Washington was there, and when some of the Southern representatives got back to their home town and were asked how they addressed him, one representative scratched his head, and said, "I tell you, it was this way, he being a negro and Southern people not wanting to call him Mr. Washington, and being such a noted man we couldn't call him Washington, so we compromised and called him Professor." That is the other side of the picture.

Gentlemen, we have the fourth quarter of our presidential equivalent and that is a man who at one time was a resident of New Orleans, and has now moved his home far away up in Connecticut, Mr. Sherwood Jeter of the Hartford Steam Boiler & Inspection Company.

MR. SHERWOOD F. JETER: Mr. Chairman, and members of the Civil and uncivil engineers. The Chairman leaned over my back this morning as passing by and said, "We are going to call on you to say a few words tonight." Now, I am called on frequently as a member of the Council of the A. S. M. E. to do this. and to keep my knees from doing the Charleston on such occasions, I carry around stuff already made up, like Roy Wright, but I really don't know that you would like my giving you this high-brow stuff—I think you would rather I gave you some facts. I have jotted down on the back of this document a few notes that might guide me in telling you some facts that may be of interest.

Now, of course, facts are not always relished, and in giving you these facts I feel somewhat like the negro preacher who had been in jail for some time, and when he got out, as you all know here is quite common with the Southern negro, he took up the Ministry. He moved himself a good way from the scene of his incarceration so that he might not be recognized by any members of his congregation, but in mounting the pulpit one Sunday morning to deliver his sermon, much to his consternation he saw his old cell mate on the front row. He decided at once that it would be necessary to send a wireless message to this coon to keep him from spilling the beans, so he says: "Brethren and sisters, I is going to take for my text this morning these words: 'I say unto him what sees me and knows me, him I will see later.'" Now if any of these facts happen to hit any of the Council members or even the natives, just remember I will see you later and fix it up, if I can.

I feel almost like a citizen of Louisiana. It is true I was born and bred in Georgia, but it is not very far from New Orleans. I arrived in New Orleans just 26 years ago on the fifth of this month and at that time the city was provided with a system of open sewers, as some of your older members will recall. I went out to lunch—By the way, I want to say before I forget it, I am very grateful to you for that dinner. I enjoyed it very much.

Well, anyway, I arrived here on the 5th of March in the morning, on the L. & N., and my friends who met me here wanted to introduce me to some of the local dishes, and among them, "river shrimp," and I particularly liked peeling them without breaking the meat, and I probably ate more than I should, or maybe it was because they told me how they generally caught them, on a dead mule that fell in the river at about St. Louis. Anyway, on my way home I found that the open sewer was a great convenience, so you can remember that when you "Civils" are recommending that sewers be placed under the ground.

Now, I lived here for four happy years among the best people on earth. I didn't know what I would have done without that experience, and then I moved to the Nutmeg State of Connecticut.

I recently had the pleasure of introducing Past President Durand at a meeting and I made a reference to the Nutmeg State, since Mr. Durand was born in Connecticut, but he did not seem to mind it at all and went on to tell us about the Basswood hams. I don't know anything about these hams and I don't think they sold any in the South, but sent them to the West Indies. Can you imagine one of those black natives with a Basswood ham trying to boil it and keep it from floating.

Now, you probably wonder what the idea is in having me speak here tonight, but every member of the Council has some duty to perform, and my duty is to keep these fellows from taking themselves too seriously. When one of them begins to swell up with importance to a dangerous extent I try to jab in a pin at the proper time and deflate him.

Most members of the Council, gentlemen, are in the golf class, that is, they chase around a little white ball because they are too old to chase anything else. Roy Wright is the only one not qualifying in that class, but he is old enough.

Now, you gentlemen must not take the Council members too seriously. Just look at the recent break in the stock market. If you fellows could buy the Council at their own estimated value and sell them at market value, you would lose more money than you could lose on the Stock Exchange in a year.

You are probably going out tomorrow and rub elbows with these fellows. My advice is to keep your hands in your pockets while you are doing it. If a Council member says something to you and you don't understand him, don't think that it is over your head. Ask him to explain and you probably will find that you know more about it than he does.

Take this fellow Wright, he admits he is a railroad man; well, he is late generally and off the track most of the time. There is another fellow, Gorton. What do you think of when you see the name "Gorton"? Boneless codfish, of course. Well, that poor fish is the boniest thing I have ever seen in my life. I'll leave it to any other member of the Council.

Now, there is dear Prof. Magruder, who has a keen sense of humor, but also a lot of horse sense, but that's not a necessary qualification to be on the Council. Another peculiar thing is, there seem to be so many professors on this Council, and what is stranger still, they seem to be the most intelligent members we have. That is not usual. To show you how thick some of the Council members are, one of them asked me this morning why they called this the Crescent City, and I told him it was probably because only a part of the liquor here was moonshine. "Gosh!" he said, "I never thought of that."

Seriously, gentlemen, I think the engineers pull together less than any other profession I know of. Did you ever go into a dentist's office and have him criticize another dentist's work—say it was poor work, nothing to brag about? No. The bridge work in your mouth may be falling down but the dentist will swear it was the finest piece of work he had ever seen.

Now, you know what happened to the bridge at Quebec. Every engineer knew it was no good and incorrectly designed when it fell the first time, and when it fell the second time, it was absolutely no good. There is no use criticizing your fellow engineers. When you are called in on a case, try to find something good in the work of your fellow engineer. If you find something wrong say it is wrong and try to remedy it, but try and show the good points and pull together with one another.

Now a word about your local engineers' organization. We have an Engineers Club in Hartford and have arranged so that there will be no perpetuation in office. It is surprising to know how many will sit around and criticize and the few who will do the work. Out of a hundred men, about ninety-eight will sit around and criticize the others. The best thing to do is to put the critic in office and see what he can do, and if you will adopt that practice you will reduce your critics to a minimum number in short order.

I wish to thank you very much for your attention.

PROF. ROBERT: Gentlemen, it is ten minutes after nine and some of the visiting members have to make the ten o'clock train, but we would like to have a word from the good old war horse Secretary, Mr. Calvin Rice.

MR. RICE: The officers of the Society like to see the members of their Society. I want to speak for all of the officers of the Society who came here at quite some expense and time to meet the members of the Society and to say that they do so to show their interest and to do their duty in every way possible.

The first thing I have particularly in mind is that every member in this room is a member of the Engineering profession, and the reason for his membership in a Society is that he can express individuality and self better in a Society than he could without the organization. Second, the four Societies, principally the four Societies of Civil, Mechanical, Electrical and Mining Engineers, are working hand in glove at headquarters. I happen to have known and worked with all the Secretaries, even back to John Bogart of the American Society of Civil Engineers, who, I think, was the second or third Secretary of that body; also, of course, Professor Hutton, my predecessor, Mr. Ralph Pope of the Electricals, and then the Mining Engineers, Dr. Raymond and Dr. Struthers, and many others. We have had in each case uniform co-operation among the Societies.

Another condition exists in Great Britain. There the several societies prefer to work separately in distinction from our method, here, where we all get together and discuss the problems of the Profession. In France there is another state of affairs, as you know. In the Societe they have six dixisions. In Germany there is but one Society. In Italy they have advanced to perhaps a different professional status than in other places of the world. There the engineer has a standing like that of a lawyer or a physician, and he is recognized in Court as having privileges with respect to his relations with his clients, but as yet in no other country do they have this feeling.

A point I wish to make is that the spirit of co-operation must start with the local section. We have it at headquarters, and we must have it at the foundaion. The foundation is with the members at home, and I want to congratulate you here tonight for getting us together in that dining room, for meeting here tonight and hearing from each of the officers, because that all leads up to this state of mind which we, as engineers, must contribute throughout the nation.

I want to give credit to Mr. Jeter for his splendid assistance in giving a touch of humor. In Council Meetings we all get so serious that it is a pleasure to have some one with us who has a little sense of humor.

In the medical profession, as you know, there are more varieties and specialties than there are among the Engineers. In the annual meeting of the American Medical Asociation there are thirty simultaneous sessions going on during each of the three or four days of their annual meeting. They occupy all the different hotels and auditoriums in the city.

Now the lawyers also have their several specialties, but they pull together, and you could not get a lawyer or a physician to take a case until he is satisfied that the former lawyer or physician, if there was one engaged, has been discharged, and he has called up that lawyer or physician on the phone and had an understanding with him that it is all right for him to take the case.

In conclusion, I trust the engineers will take to heart that our profession needs a code of ethics. Until we have a code of ethics we have no profession. I am hoping that right here and in every other group of the members of the profession, that they have elected for their life's work, which distinguishes them from the other members of the community because of the fact that they profess something, will adopt a code of ethics, and each of us will, of our own volition, take upon ourselves an oath that we will live up to it.

I trust every one will individually feel the solidarity of the profession and personally contribute to the advancement of that profession.

Prof. Robert: Gentlemen, you have heard the four Vice-Presidents, equal to one President, and a Secretary. The Secretary was added as what is known around this part of the country as lagniappe. I want to say to you that if you take the four Vice-Presidents all together and the lagniappe, it will take some Presidents to equal that whole layout.

Just one more thing, we have another visitor here, whom we would like to hear from and that is Mr. P. L. Eagan, President of the Ohio and Alabama Transport Company and a member of the Society of Pennsylvania.

Mr. P. L. Egan: I didn't expect to speak before this meeting. In fact I am not a speaker, do very little speaking.

I have had some engineering work before my own Society, and as you have asked me to say something I am afraid I am going to impose on you the only thing I have in mind, and that is transportation.

Transportation in this country, as all of you can appreciate, was the most critical this country has had for many, many years, during the world war. At that time I was engaged as Consulting Engineer at Pittsburgh, and for a few years I was in Marine work, United States Navy, marine work on the lake transportation, and very suddenly, in fact over the phone, I was called into the transportation question for the United States Steel Corporation.

This was the condition that we had to meet. When we entered into the war the Government asked the United States Steel Corporation for a certain production of tonnage on steel plates and shapes for the Shipping Board program, and with that the Steel Corporation was given a certain number of days to prepare a statement as to what they would do.

I don't mind stating that production on steel plates in fabric shape was large, and they asked the Pittsburgh District in addition to that, not only to furnish the plates and the shapes, but to fabricate the goods for the Shipping Board program. The answer went back to the Government that we would get out that production.

It involved the designing of a building and placing in service new mills. We placed a plate mill in service in said steel works in seven weeks from the first move until we rolled the first plate. Against that production which had been promised, we had this condition, that probably is not known to you men here.

For the past eighteen years, each year in the Pittsburgh District there has been a minimum of $20,000 expended on preliminary surveys to get just one part of rails into Pittsburgh. Those two rails have not come into Pittsburgh yet. We have a railroad twelve miles long, a private road built during the war, which cost almost an even million dollars a mile. That is a private railroad, and is showing a profit on the company's investment. Now just a word on that transportation in Pittsburgh.

We developed new mills, new process speed of production. I believe our Engineering force in Pittsburgh worked just as hard in the office and the mills as at least some of our boys did on the other side. I collapsed, I broke down myself while the war was on. I was out two weeks and went back on the job. I will say for the Pittsburgh Engineers, they certainly did their share in fighting the world war.

I for one was proud that we could get out that production. The steel plates were loaded up—we had five plants there getting detail out. We loaded that stuff, took it out in the storage hall, under the crane in the plant of the American Bridge Company, where they were piled up to the limit of the crane, but they could not be moved on account of transportation, but something had to be done to move that stuff. Mr. Ray, at that time President of the Pittsburgh Railroad, appeared before the United States Congress and answered the question of transportation conditions. He said, "We cannot move the tonnage at all, and it will not get better. How much worse they are going to get I cannot at this time say.' That's the answer that the Congress of the United States received from him. This was a most critical condition for us. Something had to be done and had to be done quickly.

River transportation at that time in the Pittsburg District had gone down to almost nothing, and the Steel Corporation solved that problem. I was the Engineer called on the phone and we started a program of relieving that condition on the river.

The first appropriation was thirteen and a half million dollars. We designed and built four steel boats, placed them in service, two of them in the local harbor with tonnage from Pittsburgh. I designed and built those two boats and barges and placed them in operation, and we started to move tonnage on the river.

Our first expenditure was such a wonderful return on the investment, that it was doubled and then doubled again.

Now the thing I want to bring out in just these few words is this. New Orleans is going ahead, I have looked over the city, I have looked over the port. I wonder if the Engineering Society here has a full appreciation of what this port of New Orleans really means to the City from the standpoint of the entire United States. That is the thing that is interesting to me.

PROF. ROBERT: Gentlemen, this whole assembly is invited to walk down a block and a half to Pitre's Restaurant where a little collation has been provided by the Louisiana Engineering Society, and I trust you will all be there. We want the whole assembly, when they go back home, to realize how the Mechanical Engineers and the Civil Engineers, and those not civil as Mr. Jeter said, all work in harmony in New Orleans. Gentlemen, we are glad to have had you here with us.

MINUTES OF MEETINGS AND BUSINESS OF THE SOCIETY.

Minutes of Regular Meeting of Society, March 8, 1926.

The Meeting was called to order at 8:10 p. m., Mr. F. P. Hamilton, President, in the chair; F. A. Muth, Secretary, and 46 members and guests present.

The Minutes of the previous meeting were read and approved.

It was announced that no meeting of the Board was held this night for the reason that owing to a joint meeting of the Local Chapter of the American Society of Civil Engineers with the American Society of Mechanical Engineers, it was impracticable to hold a Board meeting.

The proposed draft of the Bill for Establishing a Geological Survey in Louisiana was introduced to be taken up for final action at next meeting.

Mr. John F. Coleman announced that he had a request from General Allison Owen for a joint meeting of the Local Architects with the Louisiana Engineering Society to discuss certain features in regard to foundations, etc. On motion duly seconded, it was voted that such a meeting be arranged and that the President be authorized to appoint a Committee to make necessary arrangements for a suitable date.

Mr. James M. Howe, Director of the American Society of Civil Engineers, was present and he was requested to address the meeting but Mr. Howe declined, stating that he had just delivered an address before the joint meeting which preceded this meeting.

This meeting was held under the auspices of the Local Section of the A. E. M. E., Prof. James M. Robert, Chairman, Mr. I. O. Mall, Secretary.

The meeting was then turned over to Professor Robert.

The exercises of the evening consisted of interesting talks from four Vice-Presidents of the A. S. M. E. as follows: Prof. W. T. Magruder, Prof. Robt. W. Angus, Mr. Sherwood Jeter and Mr. Roy V. Wright.

Mr. Calvin W. Rice, Secretary of the A. S. M. E., and Mr. P. L. Eagan, visiting Engineer, also added to the discussions of the evening.

A rising vote of thanks was tendered the speakers and the meeting adjourned to Pitre's Restaurant.

F. A. MUTH, Secretary.

Minutes of Board of Direction, April 12, 1926.

The meeting was called to order by President Hamilton and the following members were present: Messrs. Lanphier, Fox, Fey, Porter, Moses, Muth.

The Minutes of the meeting of February 8th were read and approved, attention being invited to the fact that no meeting of the Board was held in March.

Bills on hand were ordered paid.

Mr. H. H. Waters and Mr. G. O. Beardslee were dropped from the roster of the Society with regret.

The membership of Mr. O. P. Adams and Mr. Chas. E. Joubert were changed from Resident to Non-Resident Member. The membership of Mr. J. B. Reymond was changed to Non-Resident Member.

The matter of the purchase of Homestead stock was discussed and on motion duly seconded, it was voted that the President and Treasurer select a suitable Homestead and purchase about $500 worth of Homestead stock.

Communication was read from the Curator of the State Museum and the Board drafted a Resolution, it being the sense of the members present that the Governor and the Louisiana Tax Commission be requested to give favorable consideration to appropriations for maintaining the State Museum Building.

Mr. Charles M. Kerr brought up before the Board the matter of the Louisiana Engineering Society becoming a member of the Highway Research Council and on motion duly seconded, it was voted that Professor Fox, who is a member of that Council, take up the matter before the Society at its next meeting and meanwhile the Secretary request the Council to furnish information to the board members and state advantages and obligations of membership in that Council.

There being no further business, the meeting adjourned.

F. A. MUTH, Secretary.

Minutes of Regular Meeting of Society, April 12, 1926.

The meeting was called to order about 8:10 p. m. Mr. F. P. Hamilton, President, in the chair; F. A. Muth, Secretary, and 51 members and guests present.

The Minutes of previous meeting were read and approved.

The proposed draft of the Bill for Establishing a Geological Survey in Louisiana was given the second reading and after one or two minor changes on motion duly seconded, it was voted that the Society indorse the Bill and that the Committee be authorized to have the Bill presented to the Legislature in the proper manner.

The technical exercises of the evening consisted of an interesting talk on The Fundamental Principles of 'Radio Reception by Mr. C. A. Freitag, Radio Engineer. Interesting discussion followed the talk.

On motion duly seconded a rising vote of thanks was tended the speaker.

There being no further business the meeting then adjourned to Pitre's Restaurant.

F. A. MUTH, Secretary.

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LOUISIANA ENGINEERING SOCIETY

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The headquarters of the Society are in the State Museum Building, Jackson Square.

All business communications should be addressed to F. A. Muth, Secretary, 7705 Willow Street, New Orleans, La.

PROCEEDINGS
OF THE
LOUISIANA ENGINEERING SOCIETY

VOL. XII. AUGUST, 1926 NO. 4

CONTENTS

EDITORIAL NOTES AND COMMENT

Engineering Education. Dean Anderson's talk upon this subject was based upon an investigation being made by the Society for the Promotion of Engineering Education. The date and statistics which have been collected through questionnaires and other means have been worked up in such a way as to indicate average conditions throughout the country. They were then put into graphical form and published from time to time in the official journal of the Society. In order that these results might be more readily available for presentation before college faculties, engineering societies and other interested parties, lantern slides were made of the charts, and the talk given by Dean Anderson at the May meeting was based upon certain of these slides which were selected to illustrate the topics considered to be of greatest interest to an audience made up largely of practicing engineers.

Engineering Education, in common with all of the other agencies of modern civilization, has come in for its share of criticism, more particularly since the World War. The results of this investigation will serve as answers to these criticisms and will show us our virtues as well as our faults. In his preliminary report, Mr. Wickenden, the Director of the investigation, makes this significant statement: "The evidence which has been set before you as the first fruits of this investigation does not point to any radical or dramatic reform. Orderly readjustments to evolutionary trends in education, industry and professional life are needed, but not revolution."

The Trend of the Engineering Profession. In the introduction to his Preliminary Report of the investigation of engineering education, Mr. Wickendem sets forth in a most interesting statement the lines along which we may look for the best development of the engineer and his profession. He says:

> "Professions owe their distinctive qualities to the type of men they enlist and the traditions with which they become invested. Men become technically proficient by being well trained, but they exercise leadership by virtue of native gifts and favoring circumstances. The engineer of tomorrow will not rise to leadership by abandoning his distinctive rôle or by permitting it to become ill-defined. He will do so by remaining essentially an engineer, by becoming a more competent engineer, by extending the reach of engineering methods and ideals to larger realms of life, and withal, by making himself a team-mate eagerly desired by other types of men. If engineering education is to serve these ends, it must safeguard all the distinctive qualities and virtues of its past and add to them a more generous humanism."
>
> "In so far as leadership depends on favoring circumstances, engineers have solid grounds for optimism. The era of a dynastic type of individual domination in industry and of political leadership in public works and services is in its wane and there is emerging a new type of administration by a professional group into which the engineer fits admirably."
>
> "In visioning the engineer of tomorrow, it seems plain that a career in independent practice will be open to only a small and diminishing majority. The consulting

engineer will remain a distinguished professional type, but scarcely a normal model for the entire scheme of engineering education. The services of the profession will be more largely administrative, making the art of organizing men no less prominent than the art of controlling material nature. The services of engineers in the line, or operating activities of industry, bids fair to overtake their advisory or planning activities. Specialization is plainly on the increase. Few men will have occasion to practice a wide variety of engineering activities, but many will need to be expert in some one realm and intelligent in many realms."

"The engineer tends to become less and less a single, distinctive type like the clergyman, the lawyer and the physician. His field of work tends to embrace an ever-widening range of functional and technical types of activity which calls for recognition in the educational scheme. There is no well-defined threshold stage which marks off the professional in engineering from the sub-professional . In its many levels and its broad range of activities engineering can use the one-talent man, as well as the five-talent and the ten-talent man."

Library Periodicals. The Librarian of the Society submits the following as the periodicals regularly subscribed to by our Society:

Power
Electric Railway Journal
Electrical World
Engineering News-Record
Railway Age
Engineering & Contracting
Municipal & County Engineering
Railway Maintenance Engineer
Professional Engineer
Engineers & Engineering
Concrete
Concrete Highway Magazine
Power Notes

At the suggestion of the Library Committee, members are requested to review this list and to make suggestions to Colonel A. M. Shaw, Chairman, Library Committee, as to whether or not changes should be made in the periodicals subscribed to by the Louisiana Engineering Society.

The Chairman of the Library Committee will be pleased to receive communications stating whether in the opinion of the members some of the periodicals are unnecessary or whether others should be added to the list.

A Paper on Bridge Construction. In a former issue of the Proceedings a paper by Mr. Elam was published on the method of placing the piers for the new railway bridges of the Louisville and Nashville R. R. across the Rigolets and Chef Menteur. For this issue Mr. Lloyd G. Frost has contributed a brief paper describing the construction of the L. R. & N. Co.'s new bridge across the Atchafalaya River at Simmsport.

New Members. The Following new members have been received into the Society:

Resident Members.

Daniel M. Beard, with A. M. Lockett & Co.

Leon Lassen, Assistant Engineer with Sewerage & Water Board.

Transfer From Student to Resident Member.

Everett G. Roessle, with S. A. Colongne Sons.

Resident Associate Member.

Richard H. Miller, Manager, A. K. Miller Engineering Company.

Non-Resident Members.

Winston Atteberry, Baton Rouge, La., Louisiana Highway Commission.

J. Nelson Ball, Jr., Baton Rouge, La., Louisiana Highway Commission.

E. G. Blakewood, Jr., Baton Rouge, La., Louisiana Highway Commission.

Paul Bonham, Gulfport, Miss., with Geo. G. Ehrenborg.

Serge P. Higginbotham, Baton Rouge, La., Engineer and Surveyor.

Union S. Roane, Baton Rouge, La., Louisiana Highway Commission.

Kirby L. Swinney, Biloxi, Miss., Southern States Building and Construction Co.

Richard C. S. Watson, Hattiesburg, Miss., General Engineering Practice.

Resident Junior Member.

Frank E. Hoight, Louisiana Highway Commission.

PAPERS AND DISCUSSIONS

SOME QUESTIONS ABOUT ENGINEERING EDUCATION.

By Douglas S. Anderson.

Delivered before the Society, May 10, 1926.

Gentlemen of the Society: Having wielded the pen for so many years as Editor of your Proceedings, I must confess to a feeling of misgiving in appearing before you as a speaker this evening, more particularly so as a number of men in this audience, Tulane professors and students, have quite recently heard an address upon this same subject by one far abler than myself in its presentation.

For the past five or six years there has been in progress an investigation of the whole field of engineering education with the avowed purpose of determining is faults, its virtues, and the most efficient methods of improvement where such necessity is indicated. This is being done by the Society for the Promotion of Engineering Education, an organization of the leading engineering and technical institutions of this country and Canada.

You will recall the that something of the same thing was carried out some years ago in the case of medical schools by the American Medical Association. They undertook to classify existing medical schools and to specify quite definitely the qualifications for a Class A medical school.

The engineering schools decided to conduct their investigations themselves and the work is still in progress. Numerous questionnaires have been sent to institutions, to individuals and to industrial organizations, the answers to which have been carefully studied and correlated in such manner as to give an average result for each of the topics under discussion. For the purpose of presentation before just such audience as the one I am addressing this evening, these data and answers to the questionnaires have been arranged in graphical form and stereoptican slides made therefrom. I shall not attempt to show you all of the slides, but have selected those which I think will be of greatest interest to you as engineers engaged in the practice of your profession, and thereby employers of the young men who are each year being turned out by our engineering schools.

I commend this investigation to you not only for the high intrinsic value of its results, but as a most effective and efficient piece of work, planned and executed in a way that has earned the highest praise and commendation from all who have studied the reports. The present investigation is being carried on with the aid of a grant from the Carnegie Foundation, and it is the earnest desire of all concerned that it may be carried still further through the co-operation of the national engineering societies and the great industrial corporations and organizations.

Naturally the most interesting feature of the problem of engineering education is the student himself, so we have tried to find out all we could about him, before he enters college, while he is there, and after he leaves.

Slide No. 1 shows us the types of business in which the student's father is engaged and the amount and character of his education. From it you will see that about 16% of them are professional men, 17% are farmers, 18% are engaged in miscellaneous activities, while more than half are in industrial, financial and mercantile occupations. It is of interest to note that fathers who are themselves engineers number only 4% of the total.

There are some significant facts furnished by the statistics of the education of students' fathers. Approximately 12% of these have college degrees, 40% are high school graduates, whereas 60% have less than a complete high school education. These facts are important to keep in mind when we are discussing the relative value of technical and cultural subjects in an engineering curriculum. If our engineering students do not have the desirable background of education and culture in their homes, it would seem to be the duty of the college to so plan its training as to supply something of this background.

Slide No. 2 indicates that a large majority of the students in engineering colleges come from the public high schools. The engineering schools also draw more largely from the small and medium sized cities. It is a noticeable fact that boys from the larger cities are more apt to be attracted to financial and mercantile pursuits, and if they go to college at all, they choose the colleges of commerce or business administration.

Slide No. 3 affords an index of the scholastic standing of these students during their high school training. More than 60% of those entering engineering schools come from the upper third of the graduating classes, while only about 2.5% come from the lowest third.

Slide No. 4. As engineering teaches we are constantly called upon to answer criticisms of the content of our curricula, some of them constructive, but many of them in ignorance of the real objective of engineering education. The statement is also often made in criticism of our engineering schools that they turn out mere technicians and neglect those broader aspects of training so essential to success in the world. This slide shows that about one and one-quarter years of our four-year program are devoted to studies which would be accepted toward the bachelor's degree in an arts college. About one and one-eighth years are devoted to *general* technological subjects, while slightly more than one year is devoted to technical subjects within the particular fields of civil, electrical, mechanical engineering, etc. About one-fifth of a year is devoted to elective studies. In the average engineering school the requirement for the degree, conferred at the end of four years, is approximately equivalent to five years of a standard course in arts and sciences.

Slide No. 5 presents in striking fashion a phase of the problem which is most interesting to all of us and which, at the same time, gives us cause for great anxiety. Of one hundred students entering the Freshman Class only 60 pass on to the Sophomore year, approximately 42 pass to the Junior year and that only about 28 remain to graduate. This is a heavy "mortality," particularly when compared with that of other professional schools, such as Medicine and Law. It is to be remembered in this connection that Medicine and Law courses are based upon two or three years of college preparatory work, while several of the best medical schools require the bachelor's degree for entrance into the professional school.

The boy who decides to take up an engineering course often does so with very slight idea of what engineering really is, and when he is confronted later on by difficult mathematical and analytical subjects, he finds he lacks either the aptitude or the intense application required for their mastery. He is then very apt to become discouraged and to drop out.

Slide No. 6 shows statistics gathered in an effort to determine the principal causes of this high percentage of eliminations between entrance and graduation. It shows quite clearly that poor scholarship is the outstanding cause. Contrary to the general belief, financial difficulty and ill health account for only a small percentage of the failures.

There is no question whatever that the most difficult problems with which the colleges have to deal in connection with its entering classes is the poor quality of their preparation. In the opinion of the speaker there are two outstanding reasons for this poor preparation; one is that the high schools are attempting to include too great a variety of subjects in their curricula, thus neglecting thorough training in fundamentals; the other is a general lack of thoroughness in methods of instruction and a failure to insist upon high standards of scholarship.

As has been shown the majority of our engineering students come from the public high schools. The public school system of this country is highly organized on its administrative side, and in many states at least, it is subject to political control. As a matter of course it must take care of a much larger body of students than simply those who go to the colleges. Its administrative heads may feel that their ideas and methods of training are just as good as those of the colleges. And there are not lacking indications that they have greater influence with the general public in getting their ideas across than have the colleges. It remains then an open question whether the colleges will be able to influence the high schools to furnish the character of preparation desired, or whether they must accept what the high school chooses to furnish and devise some method of meeting the situation within their own walls.

To what extent do engineering graduates follow lines of activity closely related to their college courses? Slide No. 7

indicates that the civil engineering group is most stable in this respect. It also shows that only about 16% of engineering graduates shift over ultimately into non-engineering activities. This disproves the statement often made that large numbers of engineering graduates give up their profession sooner or later.

Slide No. 8 shows rather strikingly the progress of engineering graduates from the purely technical positions in their profession to those of an executive or administrative character. Of the men who have been out of college for periods ranging from 15 to 40 years, 70% are occupying positions which are primarily administrative or executive.

The facts brought out by Slide No. 9 are what one would naturally expect in these days. The ratio of college trained engineers to those who gained their knowledge entirely through experience grows rapidly larger each year. The statistics are gotten from an analysis of one of the National Engineering Societies.

Slide No. 10 indicates the extent to which engineering graduates shift from one position to another during the first two or three years out of college. Some of this shifting is due to the temporary nature of the work in which the young man may be employed, while in other cases it may be due to his desire for a wider experience. Sometimes it comes from an impatience with the routine character of the work which he is called upon to do. It is just here that the engineering graduate must realize that a certain amount of this routine training and experience is essential to his future progress, but at the same time the employer must realize on his part that the student engineer does not require the same degree or character of routine training as would be necessary for the apprentice who has not had the college education.

Slide No. 11 is one which should be of interest to all of us. The median line shows the average earnings of engineering graduates at different periods after graduation; it affords a basis of comparison for engineers already engaged in practice as well as an indication to engineering students as to what they may expect in the way of financial reward. Following this median line you will see that on the average an engineer should be earning $4000.00 ten years after graduation, $5000.00 fifteen years after graduation and $7500.00 thirty years after graduation.

The next three slides show, as well as can be done in statistical form, the opinions of college graduates as to the general effectiveness of collegiate training, the value of college experiences, and the content of the curriculum. They indicate a general desire for more training in economics and psychology, a due appreciation of the value and importance of cultural subjects, and an emphatic expression of opinion as to the very great importance of the scientific subjects in the curriculum.

Slide No. 15 shows the qualities which are believed to be essential or desirable for success in the engineering profession. As one would naturally expect character is given the first place, while scholastic record is placed last. Employers of engineering graduates and personnel managers are inclined also to place great stress upon personality, and they are always interested in the type of student who will develop ability as a salesman. Leadership and initiative are also emphasized as highly desirable qualities.

Slide No. 16 is closely connected with the preceding one, as it indicates the opinions of engineering graduates as to the extent which courses in engineering tend to develop the qualities there shown. These graduates evidently believe that the courses are of great value in producing habits of accuracy and thoroughness; they might be improved as far as the development of diligence is concerned, and their influence in the production of leadership is not considered to be very great. This question of leadership has received considerable attention in the recent discussion upon engineering education and there is a wide diversity of opinion, in the first place as to the value of engineering courses in training for leadership, and in the second place, as to whether there is any such thing as a definite training for leadership. A rigorous insistence upon high standards of scholarship on the part of the student, exercise of the greatest care in the selection of instructors and professors, not only to the end that they must be men of ability and sound training in their several lines, but that they must be men of refinement and high character, qualities which count for so much in their unconscious influence upon the student. There is such a strong tendency in some directions toward the perfection of organization and standardization in our college teaching, that there is danger of the student losing completely the inestimable benefits which come from contact with a teacher of individuality, refinement and character.

Many enthusiasts claim that football and other extra-curriculum activities, which are so greatly emphasized in our modern colleges, are of outstanding value in the development of the qualities of leadership. While there are no statistics upon which to base these claims, it is granted that such activities should be of value to the desired end if they are properly co-ordinated with the scholastic training. When their importance is so grossly over-exaggerated, as is now the case in many institutions, it is highly probable that they constitute a source of harm rather than of good.

Slide No. 17 indicates what graduates feel are important omissions from their college courses. The increasing trend of engineers toward the commercial or business side of their profession is reflected in the almost unanimous expression of a desire for more training of this nature. The desire for the inclusion of more instruction in English in the courses is emphasized, and there is also a need for instruction in psychology.

Slide No. 18 shows the sources from which engineering teachers are drawn. The statement has been made that "in-breeding," or the employment of its own graduates as teachers, is a serious fault of many of our American institutions. These statistics, however, indicate a reasonably good condition of affairs in this respect, as at least 50% of the teachers in the average engineering school are drawn from sources other than its own graduates. The annual loss to industry is about ten per cent.

Slide No. 19, and the final one which is to be shown this evening, gives a comparison of the earnings of teachers with the earnings of graduates who are engaged in the practice of the profession of engineering. You may see for yourselves how much lower is the annual salary of the teacher than that of the engineer at the end of different periods after graduation. Almost all engineering professors supplement their college salaries by some outside practice, but even so, their total earnings fall below those of the engineer. If these conditions continue to prevail, will the engineering colleges be able to hold the best men as professors in the face of inducements from the outside? It is a problem in the solution of which the engineering schools must have the moral and material support of the engineering profession, through the national engineering societies, perhaps, and of the industries which are so dependent upon a yearly supply of well trained men for the recruitment of their forces.

By means of these graphical statistics and the running comment thereon. I have attempted to present to you a cross-section of the present status of engineering education as viewed by the men most directly responsible for its proper functioning and development. I believe you will agree with me that engineering education in this country is fundamentally sound, but that it has its defects, some of them in the broader phases of its organization, and some of them in the narrower details of administration and operation.

One of the outstanding problems is that connected with the large percentage of failures in course, or the small percentage of men who graduate from the engineering schools.

If we examine the general organization of technical education in some of the European countries, we shall find a frank recognition of the different degrees of aptitude and ability of the student and a system of schools based upon this fact. There are three types of technical schools. First of all there is the trades school similar to our own Delgado Central Trades School; then there is what the Germans call a "middle school," and thirdly, what the Germans call the "technical high-school" corresponding in its curriculum and standards to the best of our engineering colleges.

In this country we have a few very excellent trades schools, not enough of them, however. Although we have over 150 engineering colleges, we have only about ten or twelve schools of the intermediate or middle class. From studies made by the co-operative efforts of some of the great industrial organizations, it is indicated that a very considerable majority of the positions in industry could be well handled by young men, who have had a scientific and technical training equivalent to the first two or three years of the present engineering curriculum. If this problem is to be handled by the existing types of engineering college it would seem to be necessary to devise a program of work divided into at least two stages, thus providing an intermediate goal of achievement as well as a final one, which is the present graduation from a rather inflexible four or five-year course. The introductory stage in such a plan of organization would be devoted to scientific foundations, elementary technical information, elementary technique, language tools and engineering orientation, without including the higher analytical problems of engineering.

The advanced stage should be definitely professional in organization, content and spirit. Admission to this could be made as highly selective as the college should desire, and would have the advantage of being based upon a very definite knowledge of the students' aptitude and abilities, acquired after several years of direct contact with him.

The psychological effect upon the student himself would be good; at the end of the introductory stage, whatever might be the method of selection for the advanced stage, if it should be decided that he was not fitted for the advanced work, he would not be placed in the position of dropping out of college with the stigma of failure, but would have achieved a definite goal along the way and would be well trained for lines of activity in which there is a great demand for men. His achievement could be recognized by the institution by whatever material evidence it might desire.

There would be difficulties in the way of some of the smaller engineering schools putting such a plan into effect, but it could well be done in the larger institutions with their extensive organizations of material and personnel for handling large numbers of students.

It is believed that the advanced stage of engineering training should be followed by a still more advanced stage after graduation. This might, in the greater number of cases, take the form of a sort of extension service in which the student would keep in touch with his college and receive advice and guidance in the continuation of his studies in connection with his practical experience. Upon the completion of a definite plan of work along the lines indicated, the student would be in position to receive the professional title of engineer. Some such plan might very well be the beginning of an organized effort to protect the title of *engineer*. There is no title more loosely used in this country than engineer, unless it be that of professor. It has been suggested that the National Engineering Societies might well co-operate with the colleges in the organization of this third stage of engineering education and in the awarding of the professional title of engineer.

As a conclusion to and summing up of these remarks of mine, I should like to read to you the following statement from the American Society of Mechanical Engineers, based upon a study of engineering education along lines somewhat similar to those we have been considering.

"The comment and opinions are necessarily varied. They come from men engaged in all branches and phases of mechanical engineering, from the strictly technical work of design to the broad administrative work of the president of a large corporation. They reflect distinctly the character and experience of those making them. Sometimes they stress a course deemed responsible for success; at others they seek to correct a deficiency in training felt by their makers. They cannot be summed up mathematically, but the general import of the opinions expressed is that the training of the engineer should be particularly sound in whatever subjects are given; that more cultural and elementary scientific subjects should be included in the usual four-year course than it now contains, and that the more specialized technical work should be sacrificed to make room for them. Manifestly, it is appreciated that the graduate will rarely have available in the incentive or the facilities for the further study of the natural sciences and that the foundation in them must be substantially entirely laid during his college course, whereas, if he is given a trained mind, these fundamental, cultural, and scientific subjects and the fundamental technological subjects, his direct professional interest will lead him to acquire the additional technical training during the earlier years of his practical work. It is understood that at best a four or even a five-year course cannot make the student a finished engineer, but can only prepare him soundly for the study of his profession, and that a broad, substantial foundation upon which he may build any kind of a career is far better for him than the narrow specialized course which is too often unsuited to his personal qualifications or his opportunities. It is clearly shown by the questionnaire and by the comment thereon that large numbers of engineers are engaged in other major divisions of engineering than those for which they were specially educated, and that still others, in large numbers, have passed through the technical phases of the professional work into administrative or executive positions where the broad training is of the utmost importance. It is clearly desirable that the specialist shall have opportunity, as a graduate student, to delve deeply into the work of his choice, but that the normal course shall turn out men at perhaps the most formative period of life, well equipped to take up any branch of engineering, any line of work opportunity provides or taste dictates, and to carry it out with satisfaction and success."

DISCUSSION

Mr. Shaw: I would like to ask the question why so many engineering students fall by the wayside before finishing their course. It may be caused by financial conditions. Take for instance the medical student, he is very careful before he undertakes the course, and counts the cost, for if he did not go through the course, his entire work would be practically thrown away. It is very seldom you hear of a medical student making any practical use of the knowledge he has acquired in a year or so. To a lesser degree that is true of the law student, but with the engineer, if he has had one year of training, he is wonderfully more valuable than the man without it.

He probably does not enter the course with the idea of dropping it at the end of the year, but he has not thrown away that work if he does not continue his course, and he is not taking as great a chance when he starts in as the medical student or law student, and that ability to realize increases as he gets more of the course.

In my own practice, if I have occasion to employ a man strictly as a rodman or instrument man, I am frank to confess if I want him strictly for that job. I would just about as soon have a man who has just been in college for only one year. I do not employ a man this way purposely to hold him down to a small salary, but from a practical point of view and with that specific job, with a few weeks out in the field, he can develop into a mighty good man, and at the end of two years he knows he can get out and make a good living. That might probably answer the question why so many do drop out.

PROF. ANDERSON: It seems to me that Mr. Shaw has given a very good answer to his own question. In many instances boys decide to study engineering with a very inadequate conception of what is involved in the course. A boy who likes to build and operate radio sets thinks he would like to study electrical engineering; one who has considerable facility in adjusting and repairing his father's automobile thinks he should become a mechanical engineer; in many instances when they find that the first two years of the course are taken up with difficult subjects like mathematics, mechanics, descriptive geometry, chemistry, physics, etc., they begin to wonder if they are not in the wrong pew and many of them drop out. Even so, however, if he completes two years or even one year, he has acquired sufficient knowledge of the fundamentals of engineering and has had enough training in mechanical drawing and elementary surveying to make him of greater value as an engineering assistant in the way that Mr. Shaw has just outlined. Some of these men, however, are quite earnest in their desire to secure training in engineering, but they lack the preparation or the peculiar ability to carry on to the very end. These are the men in whom we are interested, and it is for the benefit of these men that we would like to revise our courses so that during their time in college they might come more into contact with engineering realities, and so that at the end of this short period of training they should receive some recognition rather than to be simply dropped with the stigma of failure.

It should be made clear that such men are not engineers; neither is the graduate from a regular four-year course when he receives his engineering degree. On the other hand, there are many men whose college training may have been cut short, who have developed into engineers of outstanding ability, and who really deserve the professional title. All of which emphasizes a point brought out in my talk that we need some plan or system of protecting the dignity of the profession of engineering. A carefully administered plan of registration, the beginnings of which have already been made as far as civil engineering is concerned, would be of great value to this end. Here again the European nations are far ahead of us in the safeguards they throw around the practice of the profession and in the care shown in the use of the title of engineer.

Mr. Young: Do any of the statistics show what becomes of the seventy per cent of the students who do not carry through their courses in engineering? Do they change to other more attractive or easier courses, or do they just give up and drop out entirely?

Prof. Anderson: Efforts are being made now toward a statistical study of this phase of the problem. You can readily appreciate that it is rather difficult to secure such statistics, but it is very important that we should know about these men as they are the very ones whom we hope to save by some such readjustment of our curriculum as that outlined above.

Mr. Eckstein: Have you any data showing the comparative earnings of engineers and men engaged in the other professions?

Prof. Anderson: I have not. While we have before us this question of salaries, and referring to the comparative earnings of engineers and engineering professors, I should like to call attention to an interesting condition that exists in Germany with reference to the status of the engineering teacher. And incidently, while the Germans were our late enemies, we must not fail to recognize that in the future they are going to be our most active competitors in the industrial world, and there are many things we may learn from them to our advantage. In Germany, an engineer who has gained some distinction in the practice of his profession, will almost always, without hesitation, accept a call to a professorship, even though his income may be reduced thereby. The university professor there enjoys such a high social and political status, that a call to one of these positions is regarded in the light of a promotion to higher responsibilities and greater public honor. Contrast this with conditions in our own country.

Mr. Hamilton: I would like to suggest that we hear from some of the Tulane professors.

Prof. Gregory: It seems to me the ground has been pretty well covered. I was interested to note that Dean Anderson stressed the point that all engineers should be registered, and that there should be more protection for the title of engineer and the dignity of the profession than now exists in this country.

There has been a strong movement in that direction, and we hoped last year that the matter would be presented to the Legislature at the present session. I understand, however, there were some obstacles in the way so any legislative action will have to go over for another two years. It is certainly to the interest of the Louisiana Engineering Society within the next two years to have this matter lined up, and to be among those of the country who are seeking to have their profession properly recognized and properly safeguarded.

Mr. Todd: I should like to second this statement of Professor Gregory. We should by all means make every effort to have the question thoroughly worked up into form for presentation to the Legislature.

Dr. Elliott: I recall an interesting statement made by Mr. Wickenden, the Director of this investigation, in the introduction to his talk before the faculty and students of Tulane University. He called attention to the rapid rate at which the cities in this country were growing in comparison with the country districts. This growth of the cities introduces problems of increasing complexity with regard to housing, transportation, water supply, disposal of waste, adequate food supplies, light, heat, etc., all of which are dependent upon the work of the engineer. We must, therefore, look to the time when the engineer will assume a much larger share of responsibility for efficient municipal administration than is now the case.

Prof. Anderson: I think Mr. Wickenden also put this point quite succinctly in the statement that the politicians having demonstrated their inability to handle the job, it is now time to turn it over to the engineers.

Mr. Hogg: Possibly one of the reasons why there is such a large percentage of failures is that there is a lack of sympathy with the boy on the part of his parents, who are not educated people themselves. I know in my own experience I was kept back for several years, not on account of financial difficulties, but because my family failed to recognize the importance of college training.

Prof. Anderson: There may be something in what Mr. Hogg suggests, but it has been my experience that parents, who have not themselves had the advantages of a college education, are most anxious that their sons should have it. Particularly is this true of the mothers.

Mr. Muth: I should like to have an expression of opinion from Professor Anderson as to the value of co-operative courses in engineering, such as are given at the University of Cincinnati, in which the student alternates his study in college with practical work on the outside.

Prof. Anderson: I have never given very close study to the details of the co-operative method. Its value depends largely upon local industrial conditions. It has apparently been very successful at the University of Cincinnati, principally for the reason that Cincinnati is primarily a manufacturing city. The local industries are thus prepared to handle these co-operative students in their plants and to absorb them after graduation. Some of the courses at Massachusetts Institute of Technology are co-operative, and the method is used also in other institutions. It would be difficult to introduce at Tulane for the reason that there are not enough manufacturing plants in this community to take care of the students.

Among engineering educators there is a wide divergence of opinion as to the value of the co-operative method. Some feel that it is a serious pedagogic error to interrupt the continuity of the scholastic training by periods of work in the factory or plant. Others think the experience gained by the student through actual contact with the realities of industry and with the men who constitute the working forces of industry more than offsets any disadvantage as suggested above.

PROF. DERICKSON: The engineering student in Tulane University, particularly those in the Civil Engineering Course, acquire a considerable amount of practical experience before they graduate. Practically all of them secure positions during the summer vacation, through which they have the opportunity to acquire experience similar to that required by the co-operative method. I believe that a great majority of engineering students, not speaking of Tulane alone, earns a good part of the money which they require to go through college so that even in the non-co-operative colleges they have ample opportunity to acquire the most valuable kind of experience.

THE ATCHAFALAYA RIVER BRIDGE FOR THE LOUISIANA RAILWAY & NAVIGATION COMPANY AT SIMMESPORT, LA.

By Lloyd G. Frost.

The position of the Louisiana Railway and Navigation Co. among railroads and in relation to the development of Louisiana is unique in several ways that cause the construction of this bridge to be of interest, not only to engineers but to the lay public as well. Constructed as a private enterprise by William Edenborn, a picturesque and powerful figure in the development of one of our great industries, the manufacture of steel, the L. R. & N. Co. is the only remaining railroad on the continent owned and operated by an individual.

It is also the only railroad, to the writer's knowledge, in the world that ferries its trains through the waters of three rivers in one continuous crossing. This ferriage commences at the Naples incline on Red River, a short distance from its confluence with the Atchafalaya, and the passage to the Mississippi, known as Old River. Trains are transported down the Red River, into Old River, through this passage to the Mississippi, and across the Mississippi to the incline at Angola, an aggregate distance of about ten miles.

The adverse rise and fall of the Red and Mississippi and frequent heavy fogs render this a hazardous and uncertain passage.. Trains are continually delayed, occasionally as much as twenty-four hours. This ferriage could only be eliminated by a change in location necessitating the construction of a new incline, the building of some eighteen miles of new line and the abandonment of the old, and the bridging of the Atchafalaya River.

The necessity of eliminating the erratic and expensive link in the system became yearly more apparent, and in May, 1925, Mr. Edenborn decided to make the change.

Owing to the depth of the water, the wide range, rapidity and uncertainty of its flood stages, and the treacherous action of its banks, the Atchafalaya River is considered one of, if not the most hazardous of streams to bridge on this continent.

The sloughing of its banks, locally termed "batture," is perhaps its most dangerous characteristic. There exists in the territory traversed by the Atchafalaya a top soil which, during periods of flood, become saturated. The exceedingly rapid fall of the river leaves this soil thus impregnated; the underlying strata of blue clay, or gumbo, provides a well lubricated plane of cleavage. The internal hydraulic head of the saturated top-soil causes considerable areas of the bank to move bodily into the stream. This action is particularly liable to occur when the banks are disturbed by excavation for bridge piers. On the bridge at Krotz Springs, which was designed by Mr. Hedrick, and built under his supervision, a section, one-quarter mile in length and two hundred feet deep sloughed off, overturning one pier and necessitating the addition of one 300-ft. span to the original design.

With these conditions in mind, considerable study was given to the location of the structure, and that at Simmesport finally chosen. At this point the Government has had for many years, two sill dams across the river. Their successful action in preventing scour and erosion is apparent in studying the river records, and the final site of the structure was fixed immediately above the dam farthest upstream.

Borings were made at the site of each pier under the supervision of the writer. The wash method was used and tests were carried to depths varying from 90 to 120 feet below mean Gulf level. In all cases these tests indicated that from a depth of about 20 feet below mean Gulf level, the stratification was uniformly a clear water sand, increasing in coarseness with depth. No logs or other obstructions were encountered.

The structure when completed will consist of two 150-ft. through steel truss shore spans, two 300-ft. through steel truss river spans and one 300-ft. swing span. All spans are of the Petit truss type with parallel chords. The bridge is to carry highway traffic as well as railway, at present on the same deck, for which reason trusses are 19′ 6″ center to center. The parallel chord truss was used and the bridge so designed that if at any future time the combined traffic became too heavy for the one deck, an upper highway deck may be added with no revision except removal of upper sway bracing.

The substructure consists of five main river piers and two shore piers. The method of sinking is interesting mainly because of the character of the stream, and the fact that both bases and shafts were sunk by the open dredging process.

The depth of water and liability of floods and drift made the use of conventional cribs, sealed and pumped out to permit placing formwork for the shafts, extremely hazardous and costly. The shafts were therefore designed with a small dredging well, and the piers were sunk to position enirely by the open process. Caissons for Piers Nos. 5 and 1 were built on docks at the pier site and lowered into place with screws. The fluctuation of the river stage rendered this method impracticable after No. 1 was in place and the others were built on launching ways and floated to position.

In order to secure anchorage for caissons in the deep water one hundred Douglas fir piling, one hundred feet in length, were shipped from Ryderwood, Washington, and used to form docks to hold the caissons.

Caissons were constructed on steel cutting edges; there were double walls of 8″x8″ walling and 3″x″10 friction plank, built 6′ 8″ apart. Caissons were landed and sunk by depositing concrete between these walls. This concrete was carried above water at all times and when caissons were constructed to the full height of the base, 72 feet, sinking was halted about three feet from the water line, formwork for shafts set in 16-foot sections, and poured. Forms were stripped after setting, the pier was again sunk to about three feet above water level and the operation repeated until the pier was finally landed.

No difficulty was encountered in sinking by this method. Foundation materials discovered bore out the result of the borings, and no obstructions were met. It was feared at one time that Pier No. 5, the first one to be sunk, had met with disaster. When at a depth of about 18 feet below mud line, a sloughing of the bank occurred, dangerously tilting the caisson. It was finally righted, however, and landed at a depth of 80 feet below mean Gulf level, total height of the pier from cutting edge to cap being 140 feet.

Scour occurred on the upstream edge of Caisson No. 4 when landed. The depth of water was sixty-five feet and current very swift and carrying much drift. The dock of 100-ft. piles proved adequate, however, scour was stopped by depositing about 2000 bags of sand, and the caisson righted without difficulty.

After being landed in final position, about forty vertical feet of concrete was poured in the wells by tremie; gravel deposited for the rest of the distance to within 10 feet of the water level and the final formwork set and piers topped out.

As a preventive against scour and erosion in future, a continuous willow mattress, 150 feet wide and overlapping the Government sill dam, is being woven around the piers extending from end to end of the structure to above bank level on each side.

Erection of steel will commence August 15th. The railway and highway approaches will be completed by December 1st, and it is planned to open the bridge for traffic not later than January 1, 1927.

This bridge was designed by Hedrick & Frost, Consulting Engineers, New Orleans, La., substructure constructed force account by them. Fabrication and erection of superstructure by Virginia Bridge & Iron Company.

MINUTES OF MEETINGS AND BUSINESS OF THE SOCIETY.

Minutes of Board of Direction, May 10, 1926.

The meeting was called to order by President Hamilton and the following members were present: Messrs. Porter, Fey, Moses, Garsaud and Muth.

The minutes of the previous meeting were read and approved.

The resignation of Colonel Marcel Garsaud as delegate to the American Engineering Council was accepted with regret. Mr. F. P. Hamilton, alternate, was authorized to serve during the remainder of Colonel Garsaud's term of office.

On motion, duly seconded, it was voted to take up before the Society the matter of becoming a member of the Highway Research Council, it being understood that Professor F. H. Fox will present the matter to the Society.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

Minutes of the Society, May 10, 1926.

The meeting was called to order about 8:10 p. m., Mr. F. P. Hamilton, President, in the chair, F. A. Muth, Secretary, present, and 49 members and guests.

The minutes of the previous meeting were read and approved.

Reports were received from the chairmen of the committees present.

In the absence of the chairman of the Committee on Registration of Professional Engineers, the Secretary was instructed to request Chairman Grehan to submit report as to the work of his committee.

Upon report of the chairman of the Library Committee the Secretary was requested to prepare a list of the periodicals regularly received by the Society, which list is to be published in the Proceedings for the information of the members.

The Society then listened to a most interesting address on "Some Questions About Engineering Education," by Professor Douglas Anderson. This address was illustrated with many lantern slides. Considerable discussion followed.

A rising vote of thanks was tendered Professor Anderson for his delightful address.

The meeting then adjourned to the collation in Pitre's Restaurant.

F. A. MUTH, Secretary.

Minutes of Board of Direction, June 14, 1926.

The meeting was called to order with Vice-President Lanphier in the chair and the following members were present: Messrs. Fey, Moses and Muth.

The minutes of the previous meeting were read and approved and bills on hand were ordered paid.

Communication from the National Research Council relative to "Coast Protection Devices" was read and was ordered referred to Col. Marcel Garsaud, General Manager, Dock Board, for reply.

On motion, duly seconded, the following applications for membership in the Society were ordered to ballot:

Resident Members—Daniel M. Beard, Leon Lassen.

For Transfer From Student Member to Member—Everett G. Roessle.

Resident Associate Member—Richard Harrison Miller.

Non-Resident Members—Winton Atteberry, J. Nelson Ball, Jr., Eldred Griffin Blakewood, Jr., Paul Bonham, Serge Powers Higginbotham, Union Sanders Roane, Kirby Land Swinney, Richard Charles Sanchez Watson.

Resident Junior Member—Frank E. Hoight.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

Minutes of the Regular Meeting of the Society, June 14, 1926.

The meeting was called to order with Vice-President Lanphier in the chair, F. A. Muth, Secretary, and 59 members and guests present.

The minutes of the previous meeting were read and approved.

Reports were received from chairmen of committees present including report of Mr. B. H. Grehan, chairman of the special committee on Registration of Professional Engineers. F. A. Muth, chairman, Legislative Committee, submitted report as to the progress of the two bills in the State Legislature in which the Society was interested, i. e., "Establishment of a Geological Survey in Louisiana," and "Registration and Licensing of Mechanical and Electrical Engineers,'' which latter bill had been introduced in the House at the request of an engineer in the State who is not a member of the Society. Several features of this bill were read to the Society and it was pointed out that since the bill did not carry the usual ''grandfather clause'' or statement which would include the mechanical and electrical engineers practicing in the State at the time the act would become effective, on motion of Mr. W. B. Moses, seconded by Mr. Alcus, it was voted that it was the sense of this meeting that the ''grandfather clause'' be included in the proposed bill.

The technical exercises of the evening consisted of an address on ''Pulverized Coal as Applied to Industrial Plants,'' by Mr. W. E. Penfield. This interesting address was illustrated with many slides and considerable discussion followed. A rising vote of thanks was then tendered the speaker.

After announcement was made that it was customary for the Society to recess during the months of July and August, on motion, duly seconded, it was voted that the Society recess until the September meeting.

The meeting then adjourned to the collation, which was served in Pitre's Restaurant.

F. A. MUTH, Secretary.

Minutes of Special Meeting of the Board, July 21, 1926.

The meeting was called to order with President Hamilton in the chair and the following members were present: Messrs. Lanphier, Moses and Muth.

The minutes of the previous meeting were read and approved and bills on hand were ordered paid.

Ballots were canvassed, there being 77 formal ballots and 3 informal ballots. The following members were declared elcteed:

Resident Members—Daniel M. Beard, Leon Lassen.

For Transfer From Student Member to Member—Everett G. Roessle.

Resident Associate Member—Richard Harrison Miller.

Non-Resident Members—Winton Atteberry, J. Nelson Ball ,Jr., Eldred Griffin Blakewood, Jr., Paul Bonham, Serge Powers Higginbotham, Union Sanders Roane, Kirby Land Swinner, Richard Charles Sanchez Watson.

Resident Junior Member—Frank E. Hoight.

The resignation of Mr. Clifford Hoey Stem was accepted with regret.

On motion, duly seconded, the following motion was adopted:

As a continuation of the policy of the Board as heretofore expressed, be it moved, that the Secretary communicate with some of the members of the Society residing in Baton Rouge, to the end that if it is desired by those members that a Baton Rouge Chapter of the Society be organized that the Board will be pleased to receive a communication from the Baton Rouge Chapter.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

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LOUISIANA ENGINEERING SOCIETY

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All business communications should be addressed to F. A. Muth, Secretary, 7705 Willow Street, New Orleans, La.

PROCEEDINGS
OF THE
LOUISIANA ENGINEERING SOCIETY

VOL. XII. OCTOBER 1926 NO. 5

CONTENTS

EDITORIAL NOTES AND COMMENT

Pulverized Coal as Fuel. The paper by Mr. Penfield upc this subject, published in this issue of the Proceedings, is ai interesting and clear description of the application of powdered coal as fuel in an industrial plant of moderate capacity. In the technical journals may be found articles dealing with the application of this system to large public service plants and central power stations, but Mr. Penfield's paper is of interest in that through it and the discussion thereupon we get some insight into the phases of the problems peculiar to industrial plants and to the conditions found in this locality.

In his discussion of the paper, Mr. Frost of the New Orleans Public Service, Inc., calls attention to several points of great interest, which have come up in their experience with the re-installation of new boiler equipment for the burning of powdered coal.

The first of these is the necessity for distinguishing between *inherent* moisture and *surface* moisture in the coal. Mr. Frost states that with either of the systems, the unit fired on the one hand or the bin and feed system on the other, they can secure successful operation with coal containing one per cent or two per cent of surface moisture and as high as three per cent or four per cent of inherent moisture, making a total of from four per cent to six per cent of moisture.

For central station service the use of powdered coal as fuel presents the very great advantage of rapid response to a change in load. If necessary a cold boiler may be fired up and placed on the line in thirty minutes, and a boiler which has been dropped out around ten P. M. after the evening peak may be put back on the line in the morning at 100% load within five minutes.

The use of powdered coal as fuel for boilers presents to the mechanical engineer and the combustion engineer many problems which are of great interest and which are as yet only partially solved. Almost any new installation affords material for experimentation and research and, it is hoped that members of this Society who have the opportunity to do so will supplement this paper and discussion with additional data and observation.

Cement and Concrete. Having been called upon at very short notice, Mr. Mottram presented to the Society at the September meeting a brief but interesting paper upon the manufacture of Portland Cement and the control of concrete mixtures. He illustrated his paper by means of one of the standard films of the Portland Cement Association, showing the method of manufacture.

In the paper he gave a brief resumé of the history of concrete, pointing out the fact of its use by the Romans in the foundations of many of their monumental structures. The United States is now one of the largest users of concrete and also the greatest producer of cement. Its importation does not exceed two per cent of its domestic production.

Interest in the discussion of the paper seemed to center around the "water-cement ratio" method of controlling the mixture in the making of concrete. The testimony there adduced indicates how rapidly this method is being adopted by the engineers in their specifications and also that the contractors are realizing its usefulness and importance to them in securing the best results in their work.

What is an Engineer? Many definitions and various specifications have been given in answer to this question; perhaps one of the best of them, certainly the most appealing of them, is the poem by Mr. Randolph called The Engineer "If". This is a parody on Mr. Kipling's well-known poetical definition of a "Man", and it has been published in a number of different engineering journals. Some of our members may not have read it; it will still be interesting to those who have:—

The Engineer "If."

By Robert Isham Randoph, M. W. S. E.

If you can swing an axe, or wield a brushhook,
  Or drive a stake, or drag a chain all day;
If you can scribble "figgers" in a note book
  Or shoot a range pole half a mile away;
If you can sight a transit or a level,
  Or move a target up and down a rod;
If you fear neither man nor devil,
  And know yourself and trust the living God.

If you can wade a swamp or swim a river,
  Nor fear the deep, nor yet the dizzy heights;
If you can stand the cold without a shiver,
  And take the Higgins ink to bed o'nights;
If you can turn a thumb screw with your fingers,
  When every digit's like a frozen thumb;
If you can work as long as daylight lingers,
  And not complain, or think you're going some.

If you can sight through tropic heat's refraction,
  Or toil all day beneath a blistering sun;
If you can find a sort of satisfaction
  In knowing that you've got a job well done;
If you can be an Eskimo and nigger
  And try to be a gentleman to boot;
If you can use a "guessin' stick" to figger.
  And know a coefficient from a root.

If your calculus and descriptive are forgotten,
And your algebra just serves you fairly well;
If your drafting and your lettering are rotten,
And your Trautwine's always handy by to tell;
If you can close a traverse without fudgin',
Or check a line of levels by a foot;
If you can set a slope stake, just by judgin',
And never kicked a tripod with your foot.

If you can run a line where you are told,
And make it stay somewhere upon the map;
If you can read your notes when they get cold,
And you know that contours mustn't ever lap;
If you can line a truss or tap a rivet,
Or make a surly foreman come across;
If you can take an order, as well as give it,
And not have secret pity for the boss.

If you can climb a stool and not feel lowly,
Nor have your head turned by a swivel chair;
If you can reach your judgments slowly,
And make your rulings always just and fair;
If you can give yourself and all that's in you
And make the others give their own best, too;
If you can handle men of brawn and sinew,
And like the men and make 'em like you too.

If you can't boast a college education,
Or, if you've got a sheep-skin, can forget;
If you get a living wage for compensation,
And give a little more than what you get;
If you can meet with triumph and disaster
And treat them without favor nor with fear;—
You'll be a man and your own master,
But, what is more, you'll be an **Engineer.**

Diesels Necessary to Meet Competition Says Adm. Benson. American shipping, if it would compete with European shipping, must eventually discard the steam engine and equip its ships with up-to-date Diesel motor engines, according to a statement just issued by Adm. W. S. Benson, of the U. S. Shipping Board, who said in part:

"The old days of slow freights are over, and the shipping companies which get the trade today are those which can give fast regular schedules and can tell the merchants within an hour or so when their vessels will reach port. Their ships must maintain an average of from 12 to 14 knots an hour.

"The Diesel engine has been proven the best type of engine to do this and do it at low cost. Its advantages are, first, that it saves one-third on fuel; second, that it eliminates the boiler and thus gives more cargo space; and third, the coal passers and boiler-room crew are eliminated. Repairs, which are always a large item in operating a steam vessel, are also cut down because of the elimination of the boiler and piping which are most frequently subject to repair on steam vessels.

"Although American shippers have used the Diesel engine for motor ships and tugs, they have not adopted motor engines for large operations until the Shipping Board paved the way by ordering the installation of Diesel engines in 16 of its vessels."—*A. E. C. Bulletin.*

Federal Judges Salaries Bill.

Washington, D. C.,
November 11, 1926.

To Members of Engineering Societies:

The time has arrived for final action on behalf of this important measure. The bill has passed the Senate, and is definitely set for a vote in the House of Representatives, December 9th. It is believed the bill can be passed, if sufficiently vigorous support is given to it, and every man and corporation does his or its part. It must be passed, if the quality of the Federal Judiciary is to be maintained.

United States District Judges are now receiving only $7,500, and the Circuit Judges $8,500 per annum. The Chief Justice of the Supreme Court of the United States receives only $15,500, and the Associate Justices only $15,000 per annum. The salaries of the United States Circuit and District Judges are much below those paid in many States, and are only one-third of the amount paid to the corresponding judges in the State of New York.

These United States judges can live only by the greatest economy on their present salaries, and it is actually impossible for them to send their children to college on these salaries. They are practically shut off, by their position, from all other ways of earning money, except from simple investments, savings for which it is impossible to accumulate. A considerable number of the judges have resigned in recent years and months, because of this situation. All of those in the larger cities feel unjustly treated, and some of them feel bitter. Not a few of the judges will resign if the bill does not pass on December 9th.

The bill to be voted upon increases their salaries to $10,000 for the District Judges, and $12,500 for the Circuit Judges, and $20,500 for the Chief Justice of the United States, and $20,000 for the Associate Justices, and corresponding increases for other Federal Judges.

American Engineering Council and its constituent Engineering Societies have been vigorously supporting the bill in the Senate and House of Representatives, and have been represented before a number of Congressional Committee meetings.

The passage of this bill deeply concerns not only every American engineer, but the welfare of our country. It is grossly unjust to have invited capable lawyers to give up profitable practices and take an appointment as a United States Circuit or District Judge in days past, when the salary afforded a comfortable and dignified living, and then, when the cost of living goes up, not to increase the salaries at least proportionately. This condition is not only unjust, but it is poor business; because the judges cannot do their best work when their minds are harrassed with the almost impossibility of making both ends meet, and living with the dignity which their position requires. American Engineering Council is certain that the members of the constituent engineering societies, having undertaken to see this legislation safely through, will give hearty response to this call for appeal to the members of Congress.

Please write to your member of Congress in the early days of December, urging him to be present December 9th, when the Graham Bill, H. R. 10,554, will be voted upon, and to give the bill his hearty support.

If the bill should not pass December 9th, the leaders of Congress predict that it will be many years before another attempt would have any chance for success.

American Engineering Council and its constituent societies was one of the three great factors in passing the Patent Office Relief Bills. This Judges' Salaries Bill is of equal importance with the Patent Office Bill. We believe it can be passed, but only if every man will do his part. We hope and expect that the great majority of the engineers will respond to this call for public service.

Very truly yours,

EDWIN J. PRINDLE,
Chairman, Patents Committee.

DEXTER S. KIMBALL,
President,
American Engineering Council.

Again, "The Usual Collation." To promote greater sociability among its members the Society has given up the plan of holding the above-named function in a "nearby local restaurant" and has returned to the sepulchral twilight and the dim recesses of the vestibule of the State Museum. There, while the glassy eyes of the ever-patient beasts of the forest gaze in mild wonder upon the doings of the *genus homo*, we quench our thirst and wet our feet with luke-warm libations of not nearly beer.

There is a conservatism and lack of progressiveness about the sandwiches made down in that part of the "Vieux Carré" which would seem to indicate that the specifications thereof have not been revised for many years. Perhaps we might solicit the aid of the Portland Cement Association and ask them to "design" for us a new mixture, one in which the cheese-bread or the ham-bread ratio would play a more significant part. We would further suggest that the "fineness modulus" might be improved by the addition of more sand in the form of mustard, mayonnaise, pickles, even a bit of salt. The aggregate might occasionally be coarsened by the use of rye bread; many of us of Nordic antecedents believe that the use of the latter would be a great improvement.

An occasional batch of hot dogs would almost certainly have the effect of strengthening the mixture, while the substitution of liver or bologna sausage, even good old roast beef, for the inevitable cheese and ham, shaven to a degree of thinness comparable only to the mahogany veneer of modern antique furniture, would, without doubt, increase the workability. And over it all, let us have *more light*. *Verbum sap!*

PAPERS AND DISCUSSIONS

PULVERIZED COAL AS APPLIED TO INDUSTRIAL PLANTS.

By W. E. Penfield, Engineer, E-Z Opener Bag Co.
Read before the Society, June 14, 1926.

Problems which are ever present with industrial plants are lower fuel costs, smaller labor pay rolls and increased maintenance charges. To find a partial solution for these problems an investigation of fuels and equipment was made by the E-Z Opener Bag Company.

The Company is operating a pulp and paper mill which requires about 3,000 boiler horse power and to date has been burning fuel oil. In considering a change to coal burning equipment, it developed that although stoker equipment would give excellent results, it did not easily permit a quick conversion to the use of fuel oil. This was of considerable importance, due to limited facilities for coal storage. The burning of pulverized coal under boilers has gained great popularity, and because this method allows an almost immediate return to fuel oil, should occasion demand, it seemed of particular interest.

There are two systems of pulverized coal utilization, the essential difference being only in the methods of preparing and handling the coal before introducing it into the boiler furnace.

The Storage System ordinarily consists of a coal dryer, pulverizers and pumps for handling the pulverized coal. From the pulverized the coal is conveyed either by air or pumps of special design to storage bins from whence it flows by gravity to other pumps which deliver it to the burners.

Usually there is sufficient moisture in the undried coal as received to cause caking in the bin and a resulting uneven flow to the burners. The use of a coal dryer permits a wider range of coals to be burned and eliminates the trouble just mentioned. It is, however, expensive both as to first cost and maintenance.

The Storage System is favored by very large plants because enough pulverized coal may be stored to allow the mills to be shut down for inspection and repairs without effecting the operation of the plant. Large mills are used, which reduces the power consumption per ton of coal pulverized. The cost of the equipment is approximately double that of the unit system and additional buildings and a large operating crew are required.

The Unit System which is in general favor with plants generating less than 500,000 lbs. of steam per hour has the following advantages:

The initial cost is much less than that of the storage system. The danger of explosion is very slight as the amount of air mixed with the pulverized coal passing to the burner is too small to make an explosive mixture. The system is easily installed, runs quietly and is reliable in its operation.

Usually there is one mill to each boiler and the coal as received is conveyed directly to the mill. After being pulverized the coal dust is carried on a current of air supplied by the mill itself directly into the burners.

The various types of unit mill range in capacity from 500 lbs. per hour to 10,000 lbs. per hour. The power requirements vary from about 40 K. W. per ton for the smallest size down to approximately 8 K. W. per ton for the largest. If the mills are operated below their capacity the power requirements are materially increased.

The unit type of mill may be divided into three classes. The first class grinds the coal between rollers or balls and a race. A fan which is an integral part of the mill draws sufficient air through the mill to separate the fine coal from the coarse and carry it to the burners.

The second class is a tumbling drum which is partially filled with balls and coal. The hammering action of the balls and the grinding together of the coal and the balls result in a very fine pulverization. Like the first class of mill the fine coal dust is drawn from the mill by a current of air. A screen separates the fine particles from the coarse and prevents the passage of the latter from the mill. The amount of air delivered to the boiler is dependent on the velocity of the air passing through the mill and there is a tendency under high ratings to carry coarser coal to the boiler. About 40% of the air necessary for combustion passes through the mill. The power required is very low, being about 8 K. W. per ton, and is the same for either high or low ratings of the mill.

The third class, called the impact mill, consists of a stationary element which is divited by screens or partitions into two or more compartments. A horizontal shaft passes through the center of the machine and on it are mounted discs to which are attached paddles, bars or pegs. depending on the particular make of machine. The shaft rotates at from 600 to 1800 r. p. m. A fan is mounted on the shaft at the discharge end of the machine and the coal is fed into the opposite end. Air entering the mill at the same point as the coal carries the fine particles of coal from one compartment to the next until pulverization is complete. The separation of the fine from the coarse coal may be effected by screens and air, or by air alone. In the latter case the air and coal pass through an orifice in the center of the partition. Centrifugal force acting on the larger particles forces them to the outside of the machine. When the particle becomes so small as to present sufficient surface to the air, the action of centrifugal force is overbalanced, the particle is carried to the center of the machine and through the partition into the next compartment. This action is repeated until the mixture of coal and air passes through the fan. Here additional air is added and the mixture passes to the burners and into the furnace. The air passing to the burner from the mill is called the primary air. The remainder admitted to the furnace is designated as the secondary air.

The beating elements will pulverize from 500 to 1500 tons of coal and may be renewed when necessary in from 25 minutes to 2 hours. There is little in the way of data on the life of the liners for the stationary part of the mill, as they wear very slowly. The maintenance cost on the pulverizer varies from 4c to 10c per ton of coal, depending on the mill, the rating at which it is operated, and the physical characteristics of the coal. The top half of the machine is usually arranged to open back and give quick access to the interior. Protection from breakage is provided for either by magnetic devices or traps, in which the foreign material lodges, to be removed when it is convenient.

The success of a pulverized coal installation depends primarily on the furnace, which if poorly designed may become so expensive to maintain that any other advantages obtained with pulverized coal are completely offset. A liberation of from 16,000 to 25,000 B. T. U. per hr. per cu. ft. of furnace volume is good practice. This of course depends on the coal fired, the type of construction used in the furnace, the fineness of pulverization, and the type of burner.

For the best results, the coal fired should be friable, and contain very little bone or shale, which cause rapid wear of the pulverizer parts. The fusing temperature of the ash should be high, preferably around 2600 degrees Fahrenheit. This is very important in connection with small furnaces, as the slagging of the ash not only makes its removal from the bottom of the furnace very difficult but causes excessive wear on the brick work.

The moisture content of the coal should not be much over 5%, as above this the power required for pulverizing increases rapidly and the capacity of certain mills is greatly reduced. Above 5% moisture every 1% increase means a loss of about 0.1%. The completeness of combustion is as good as with coal dried to 1% but the propagation of the flame through the mixture is slower and the ignition temperature is raised. The same effect is observed when the coal contains less than 25% of volatile matter.

It is possible to burn very poor coal, efficiencies as high as 72% being obtained with coal of the following analysis:

Moisture	.52%
Volatile Matter	7.67%
Fixed Carbon	72.67%
Ash	19.14%
B. T. U.	11,952 per lb.

When the freight on the coal is high however, it is ultimately cheaper to buy a good quality of coal, as better efficiencies are obtained and the cost of maintaining the pulverizing equipment is materially lessened.

Generally speaking, furnaces constructed with solid walls and floors give satisfactory results with boilers operated to approximately 200% of rating. Above this the resulting furnace temperatures are higher than the brick work will withstand. Furnaces constructed with air cooled walls and floors are being operated at ratings arount 250% with very good results. From two to three cu. ft. of furnace volume are required per developed boiler horse power. Water cooled walls and a water screen above the floor increase the life of the furnace and permit ratings as high as 400%.

In the past it was thought that coal must be pulverized to a fineness such that 95% would pass through a 100 mesh screen and 85% would pass a 200 mesh screen. From tests and experiments made by the Bureau of Mines it develops that as long as the coal is so fine that the particles remain suspended in the gases until combustion is complete, further expenditures of power for increased fineness are unnecessary. As the rapidity of combustion depends upon the quality of the coal and the thorough mixing of the required air with the coal dust, it follows that the type of burner to use must be considered.

There are two types of burners, one of which produces a straight flame of rather high velocity, the other a turbulent flame of low velocity. The straight flame may be obtained with either round, fish tail or rectangular burners.

With this type of burner the secondary air is usually drawn through the furnace walls by natural draft. This air entering at an angle to the mixture of coal and air entering the furnace through the burner supports the particles of coal in the hot zone of the furnace long enough to obtain complete combustion. As the velocity of entrance from the burner is high, large furnaces are required to prevent slagging and erosion. The unit type mill used with these burners handles from 40% to 50% of the total air necessary for combustion. The coal is pulverized to a fineness of about 75% through a 200 mesh screen. One concern manufactures a straight flame type of burner in which the mixing is completed in the burner. About 10% of the total air passes through the pulverizer, the secondary air being added at the burner under forced draft. The coal fired is pulverized to 85% through a 200 mesh screen and very good results are obtained with this equipment.

Burners which produce a turbulent flame, operate under either forced or induced draft for the secondary air though the former is more frequently found. The turbulence is obtained by forcing the secondary air to pass through a set of vanes so placed around the burner that a circular or whirling motion is given to the air as it is directed against the stream of coal and air coming from the pulverizer. An intimate mixture is obtained which burns rapidly and completely, ignition occurring almost at the tip of the burner.

There is one burner on the market of the turbulent flame type which is so constructed that either powdered coal or fuel oil may be used. This burner was not investigated but appears to be well worth following up.

Pulverized coal when properly fired burns to an extremely fine ash, part of which drops to the floor of the furnace, where it forms a coke like mass easily removed unless slagging occurs. Approximately 25% of the ash is found in the furnace, 5% in the flues and breeching and the remainder passes out the stack. The appearance of the gases leaving the stack is the same as when oil is being fired, only a slight haze being visible.

Reports from a number of plants where pulverized coal is being burned, indicate that very satisfactory results are being obtained. Two plants operating horizontal return tubular boilers of approximately 500 H. P. each at ratings varying from 75% to 125% report efficiencies of 76% under test. The boilers are set about 10 ft. high, with solid walls and floor, and are horizontally fired. No trouble has been encountered wtih slagging and after about one year of operation the furnaces appear to be in very good condition. Coal of the following analysis was being burned:

Moisture	2.36%
Volatile Matter	34.64%
Fixed Carbon	49.85%
Ash	13.15%
Sulphur	2.46%
B. T. U.	13,225 dry basis

Both plants have since increased their capacity by installing additional boilers and pulverizing equipment.

Another plant operates a 450 H. P. water tube boiler set 18 feet high, with solid walls and air-cooled floor. The boiler is fired vertically downward, and ratings from 200% to 300% are claimed. It has been in operation about 14 months and no slagging or erosion is reported.

A third plant has operated a 1000 H. P. Badenhause boiler at 200% rating for over a year and reports excellent results. The boiler was only down on Sundays to enable the ash to be removed from the furnace floor. They expect to obtain another year of service out of the setting. Very little has been done to the pulverizer, which is of the impact type, the maintenance being about 6c per ton. The company plans to put in several more installations of the same general type, as they say they are absolutely satisfied with the results obtained.

The installations mentioned are all industrial plants with one exception. The boilers are operated at about 200%, the furnaces are standing up well and the results are entirely satisfactory.

A plant operating a 400 H. P. boiler at 200% rating and 79% efficiency reports that their furnace has given no serious trouble. The walls are of solid construction and the furnace volume figures only 1.8 cu. ft. per developed horse power. The burner used is of the round turbulent flame type.

Another plant has been operating a Standard 380 H. P. boiler for the last two years at 200% rating. The furnace is of the solid wall type of construction and has held up very well. The coal fired is of good grade, sized ½ inch and down, and contains 5 to 8% moisture. Another boiler is being fitted up, the furnace to be of air cooled block. A larger pulverizer of the same make will supply coal to both boilers.

Reports from these plants indicate that a minimum efficiency of 70% can be maintained. Then with coal of the analysis—

Moisture	1.16%
Volatile Matter	29.03%
Fixed Carbon	59.72%
Ash	10.09%
Sulphur	.83%
B. T. U.	13,750 per lb. try basis

Fusing point of the ash 2600 to 2800 degrees F. Coal containing 5% of moisture as received.

3.67 lbs. of coal are required per boiler horse power.

If the coal costs $4.50 delivered at the plant, to this must be added the cost of handling, pulverizing, the maintenance of conveying and pulverizing equipment, and the disposal of the ash. They are approximately as follows:

Handling	$ .15 per ton
Pulverizing	.17 " "
Maintenance	.05 " "
Ash Disposal	.03 " "
Total	.40 " "

Assuming 17 K. W. per ton at 1c per K.W.

The cost of the coal is then $4.90 per ton or 0.9c per boiler horse power. These figures will of course vary with the size and location of the plant and labor conditions.

Assuming that fuel oil can be bought for $1.50 per bbl. of 336 lbs., the cost per pound is then .446 cents. With a boiler and furnace efficeincy of 70% and the heating value of the oil being taken as 18,000 B. T. U. per lb., then 2.66 lbs. of oil are required per boiler horse power. At least 3% of the steam generated will be used for heating the oil and atomizing in the burners. This will make the cost 1.225 cents per boiler horse power.

The same help required to fire the oil should be able to fire the pulverized coal satisfactorily. The maintenance of the fuel oil burning equipment is very small and may be neglected. It is evident then that the slight increase in maintenance charges on the pulverized coal equipment and the increased labor charge, is more than offset by the lower cost of the coal.

The cost of pulverizing equipment can only be approximated, but for the unit systems should be about $15.00 per rated horse power, exclusive of coal handling equipment and any changes required in the boiler settings.

Information received from plants using pulverized fuel shows that the equipment can be installed in small plants at reasonable costs, a saving in fuel costs can be made, and that the operation of the equipment is not so complicated as to require specially trained boiler room help. The equipment is reliable in operation, there is very little danger of explosion, the boiler room can be kept clean and quiet and changes in the load are quickly and easily met.

Discussion

THE CHAIRMAN: Mr. Penfield's paper is now open for discussion. Any members or guests present may ask any questions they desire and I am sure Mr. Penfield will be glad to answer them. I believe we have with us tonight Mr. Frost of the Public Service. Would you like to ask any questions, Mr. Frost?

MR. FROST: I am not familiar with the use of powdered coal for industrial plants, but will be glad to tell you what we have been doing for the past eight months with burning powdered coal in our generating station.

We have three 1850 H. P. boilers in our Market Street Generating Station, which were installed in the latter part of the summer of 1925, and which are equipped to burn powdered coal. These boilers were put in operation during last November. One of these boilers is equipped with the bin and feeder system, both systems having been described in the paper this evening.

We had our troubles in getting started. Originally coal dryers were not installed, but the boilers are equipped with water-cooled side walls, the air that supports combustion passing between the outer section of the wall and the fire brick lining, and thus becomes heated to a temperature of from 130° to 140°, and then passes through the pulverizers. This air carries the coal from the pulverizers in the unit fired mills into the boilers. In the boilers equipped with the bin and feeder system, this air carries the coal from the mills to the powdered coal bunkers. It was expected that this heated air would sufficiently dry the coal so that it could be easily handled, but this was only partially successful.

The wet coal, during periods of continuous rain, in feeding from the bin through the screw feeders, to be picked up by the secondary air, which also comes from the same heated source as the primary air, would cake in the thread of the screw and stop up the feeder. Even when the feeder was not stopped the feed would be irregular and create unstable conditions in the furnace. With the unit fired boilers, the wet coal also created unstable conditions, and while it gave very much less trouble than with the bin and feeder system, the conditions were such as to convince us that with air at temperature not more than 140° through the mills, dryers to dry coal before powdering are needed. In the early part of this year steam dryers to dry the coal for the three powdered coal boilers in our Market Street Station were ordered and we now anticipate that they will be installed and in operation within the next sixty to ninety days.

We also had considerable trouble from slagging on the furnace side walls. In some instances the slag would attach to the side wall and project out in the furnace for a distance of 3 feet or 4 feet, making it necessary to take the boiler out of service, allowing it to cool, and then put men in the furnace to break down the slag. The two boilers equipped with bin and feeder system are also provided with hearth screens which are located a slight distance above the operating floor level. In these boilers, in some instances, the slag would collect on the screens in a mass 6′ to 8′, 5′ or 6′ wide and approximately 2′ thick. The boiler equipped with unit fired system is not provided with hearth screens. And in the installation of all three of our powdered coal boilers the center line of the boiler drum is 44′ 3″ above the operating floor, or 60′ 3″ above the bottom of the ash pit. This means that it is about 45′ from the bottom of the ash pit to the lower boiler tubes, and you can readily conceive that it is quite some task to install scaffolding and thus provide means to remove slag from the side walls or to work on any portion of the interior of the furnace.

We have made considerable study of the cause of the side wall slagging and have reached the conclusion it is partially due to the wet coal. When the dryers are installed we expect the coal to burn with a shorter flame travel so that the partially burned carbon will not adhere to the side walls, thus forming slag. Our boilers are fired from both ends and we have been experimenting by cutting out the burners nearest the side walls and find that this very materially reduces the amount of slag collecting on the side walls. We now plan some slight changes in all three of the boilers, and one of the changes contemplated is to eliminate the side burners. We feel that with these changes next winter, with the use of the dryer, we will have very little trouble from the slag collecting on the furnace walls.

We have been very much more pleased with the unit fired system than with the bin and feeder system. So much so, that recently we have placed orders for three additional boilers each rated 1950 H. P., all three of which will be equipped with the unit fired system. As mentioned previously, the screw feeders in our bins and feeder system have given considerable trouble and the manufacturers have agreed to replace these feeders with a more up-to-date powdered coal feeder system, four of which have been installed and are working very satisfactorily. I will add that the new boilers on order will be equipped with air preheaters with sufficient heating surface to heat our primary and secondary air up to a temperature of from 300° to 500°, depending on the rate at which the boiler is being operated. The manufacturers advise it is not safe to use extremely high temperature air through the pulverizers and we expect to mix this preheated air with cold air so that the resulting temperature will be in the vicinity of 250° to 270°, and with this temperature of air to the pulverizers, dryers will not be needed, since there will be sufficient heat in the air to dry the coal, even in its wettest condition, sufficiently so that it can be successfully burned with the unit fired system.

I wish to draw your attention at this time to what is meant by moisture in coal. All coals have a certain amount of inherent moisture and in addition surface moisture, such as moisture that might be on the surface of coal from washing or from a wet mine or from being wet with rain before delivery to the bunkers. We have found that with our powdered coal boilers we can successfully burn coal with either our unit fired system or with our bin and feeder system containing 1% or 2% of surface moisture and as high as 3% or 4% of inherent moisture, making a total of from 4% to 6% total moisture. The point that I wish to bring out is that to successfully use powdered coal through a bin and feeder system, the amount of surface moisture must be comparatively low.

At this time there is a new plant at Trinidad, Texas, just about ready to be put into operation, and they are planning to burn Texas lignite containing a total moisture of from 25% to 30%. Of this total moisture 15% to 20% is inherent in the lignite, and several carloads of this fuel were successfully burned in a powdered coal plant in the north by drying it to the point where the total moisture was from 12% to 16%. The success with which this new powdered coal lignite plant is put in operation will be watched with interest.

There is one important point about central station operation with the use of powdered coal that was not brought out in the paper this evening. I refer to the quickness with which the boilers will respond to increase in load. If necessary, a cold boiler can be fired and put on the line within thirty minutes and a boiler that has been dropped out of service around nine or ten o'clock in the evening after the evening peak can be put back on the line in the morning at 100% load within five minutes. If the powdered coal boilers are operated at 150% rating, the boiler output can be increased to 250% rating within approximately three minutes.

Up to the present time for central station operation the bin and feeder system powdered coal burning has been used more successfully than the unit fired system. One of the more usual types of furnace is the one that is described in the paper this evening. The powdered coal is delivered through burner firing vertical in the furnace and the flames sweep around the bottom of the furnace and then upward through passes of the boiler. This gives a long flame travel, allowing the coal particles to come in contact with the air to complete combustion so that the carbon is completely burned before reaching the boiler tubes. To offset this long flame travel there is a burner now on the market for use with unit fired system in which the coal and air are intimately mixed as they enter the furnace and also given a whirling motion. Recently I had the opportunity to witness some of these burners in operation and they burned with comparatively short flame and, from data available, the combustion was complete before the gases reached the boiler tubes. Our new boilers will be equipped with this type of burner.

While we had considerable trouble in getting started with our powdered coal system, I do not want to leave the impression that we are disappointed, and from what I have learned most plants can expect some of these troubles in starting. We are convinced that powdered coal will be an ultimate success for central station use.

THE CHAIRMAN: Mr. Frost has told us something we didn't know, that the Public Service is going so extensively into this matter. Are there any other members or guests present who wish to speak or to ask any questions. I understand we have some other Public Service officials here. Mr. Stewart, will you say something?

MR. STEWART: As Mr. Frost has just told you, we have had lots of trouble with the preparation, distribution, and burning of powdered coal during this past winter, and I think our boiler-room men appreciate the fact that all is not easy sailing, as we were led to believe by the reports from some of the other large generating plants.

In the first place, I would state that between direct fired system and storage system, my preference would be the former, for the following reasons: The unit system is much lower in initial cost, equal efficiency can be gained under normal operation, flexibility in operation is just as easily obtained, maintenance is much less, distribution is much simpler and the hazards are materially less.

Our experience has been that the direct fired system would handle coal of a high moisture much better than the storage system for the reason that no powdered coal is traveling thru piping without being carried by air. This prevents the choking of pipes and eliminates the necessity of screw or other types of feeders. There are no hazards in the direct fired system, as is the case in the excess air vents from cyclone separators; there is no chance for lean mixture of coal and air which is more explosive than the heavy mixture; there is not much chance for spontaneous combustion in the piping, as in primary air piping of the storage system. There are numerous reasons for preferring the direct fired system and I think I have told you the principal ones.

Getting back to the troubles experienced this past winter, it appears to be the opinion that with any air sweeping of the mills by hot air extracted from around the walls of the furnace the powdered coal would be well dried, but such was the case only to a certain extent. Instances have been shown, when coal runs to 8 and 9% moisture, that you can expect trouble to the extent of the fire going out, although some feeders would take care of it better than others. The direct fired system would handle it, when the storage system would fail. Satisfactory operation could not be obtained unless the coal contained 3% or less moisture; this being total moisture as fired, inherent moisture not making any material difference in the burning on either system.

Other troubles were derived from clinkering on furnace walls. When 18,500 sq. ft. boilers are installed, with 11,000 cu. ft. combustion chamber, you can readily realize if you have clinkering, the boilers have to come out of service more frequently; and on boilers of this size, it takes almost three days to get them back in service. The boiler has to come out and stay out one day to cool; scaffolds have to be built in the furnace, clinkers removed and furnace cleaned, which takes two days more. You can readily understand that this is not profitable and the longer run you can get out of the boiler the better. Several reasons for clinkering can be explained: First, from furnace walls having been built of refractory materials. When the burners are located too near the sidewalls, impingement of the coal causes it to adhere to the refractory and cake, giving a spongy clinker. Second, molten coal will run down the side walls from a hot to a cool zone and adhere to the refractory. If either of these forms, then the fly ash settles thereon and causes the clinker to build up until the weight on the walls is enough to cause it to bulge and possibly fall. Another clinker will form on the first and second rows of boiler tubes if the combustion space is too small and the flame travel insufficient. Before complete combustion takes place, unburnt carbon and ash will fuse and bridge across the tubes and if not properly looked after will cut the draft thru the passes, creating a pressure in the combustion chamber and burning up the refractory. These clinkers will form more readily with moist coal or with low fusing ash coal.

There are so many kinks in our powdered coal installation to be remedied this fall before winter load to overcome the troubles we have had, that I could keep on talking for a considerable time, just giving you an idea of all the minor troubles that are not expected, prior to the installation. However, when you consider the efficiency obtained from this installation as against other coal firing equipment, it is certainly worth investigating before an installation is made.

Just to give you an idea of the results that are obtained by powdered coal, take the Lakeshore Station of the Cleveland Illuminating Co. On their recorder boiler room logs they show 90% boiler efficiency. Suppose the combustible left in your ash could be cut from 28% to ½ of 1%. Would it be worth while?

We are about to install three more boilers approximately 19,300 sq. ft. heating surface; this includes water-cooled front, rear and side walls in place of refractory and screens in bottom of furnace to absorb the radiant heat in this section. These will be fired with dried coal which has already passed thru a dryer, and will not have above 2% moisture as fired, being fired direct from the mill to the furnace. I think it is an ideal powdered coal installation. Flexibility is obtained by the installation of a spare mill which is not large and easily repaired. I should say that at some future date, with our powdered coal installation, we will be able to furnish some very interesting figures as to results obtained, or I am very badly mistaken.

I enjoyed Mr. Penfield's paper very much indeed and sincerely hope that he has success with his installation.

The Chairman: Is there anyone else who wishes to ask any questions?

Mr. Graham: I would like to say a few words, if I may; I have had some experience with pulverized coal, and I have been throughout the United States studying this type of equipment, and, while I apreciate Mr. Penfield's paper, there are several points about which I cannot exactly agree with him. First of all, Ihowever, I *do* agree with him regarding the storage system. It is far from being an excellent system. I read an article in "Power" recently of a "slight" explosion in a storage system plant which killed a man. The Editor of "Power" made several suggestions regarding protection in such a plant and the elimination of the cause of these explosions. He went on to say, for instance, that the clothes of the men working in the plant should be of non-inflammable material, but he forgot to say that gas masks should be used, asbestos clothing (carefully fumigated daily) and asbestos hats, with a rain coat effect attached so that the hair would not be singed off the back of the neck; also asbestos gloves and fire extinguishers carried. If that's the case, the storage system is really not the thing.

The unit system offers a system which can be depended upon for continuity of operation.

I do not agree with Mr. Penfield that unit mills are made in capacity from 500, to 10,000 pounds only. There have been mills made up to 50,000 pounds. I cannot agree with Mr. Penfield in his classification of mills. He only mentions three types. I believe there are four types of mills,—attrition, chopping, rolls and impact mills.

I cannot agree with him on the subject of impact. What is impact? In a nail hammer that has been used by carpenters for many years, the part that comes in contact with the nailhead is nearly as smooth, after years of operation, as it was when it was sold from the shelf in the hardware store, and right here I wish to say that striking a nail with a hammer is "IMPACT." There are some mills which Mr. Penfield classed as impact mills, which I do not agree with him are impact mills.

I consider the ball mill is an impact mill, because the balls cascading in the mill strike the shell an impact blow. Others, claimed by Mr. Penfield as impact mills, are really chopping mills. They depend upon the fixed chopping element in the mill to chop the coal in the same manner as is done in cutting cornstalks, hay or straw for cattle feed.

I might add that 95% of the fine material reduced in the world today is done in a ball tube mill. The cascading of the balls in the mill and their falling upon the shell of the mill is impact, and the sliding of the balls over the shell as the mill is revolved is attrition.

I cannot agree with Mr. Penfield on the cubic feet of space required for proper combustion. That is dependent on many other things which have to be considered. I have seen pulverized coal plants with perfect combustion having only 1.3 cubic feet of furnace volume.

Mr. Penfield has touched very little on the subject of fineness. He says that the United States Government, the Bureau of Mines, says that fineness is not necessary. I have along with me all of the bulletins of the Bureau of Mines and I do not think they will agree with him. Look at page 15 of Technical Paper No. 316. It says: (referring to a coal-burning test in which 78% passed through 200 mesh screen):

> "The efficiency of test (1) is somewhat low on account of high flue-gas temperature caused by slag accumulating on the front row of the boiler tubes. This slag accumulation started at the bridgewall and gradually rose until at the end of the test it reached within three or four feet of the first steam drum, so that seenty-four per cent of the spaces between the tubes on the slagged portion were closed."

Does this not show that fineness is necessary?

I have with me also the latest book on combustion which contains a very good paragraph on powdered coal which says:

> "The first attempt to utilize powdered coal was made by Neipce in 1818, but this installation, as well as that of Henchel in 1831 failed, probably on account of the relative coarse coal particles used."

In other words, the finer you grind your coal the better. What I consider the most practical mill on the market today grinds coal so that 95% will pass through a 200 mesh screen. This will give you perfect combustion.

Then again, there are different means and methods employed in making your oxygen with your coal. Some of the manufacturers take their coal and throw it into the combustion chamber at a high velocity and endeavor to mix the oxygen with coal there. In other words, they change the combustion chamber into a mixing chamber. The proper place to mix coal and oxygen is before it gets to the combustion chamber. This is done in a ball tube mill, without screen, if air flotation is employed. If air at a low velocity is drawn through a ball tube mill while the coal is being ground you get a fine mixture of oxygen and coal which is delivered to the boiler as a carbureted fuel at a low velocity, giving you perfect combustion.

Take the automobile engine, for example: If you would endeavor to put gasoline into your automobile cylinder on one side and endeavor to mix air with it on the other, you would not get very far with it. But, if you have a carburetor, and your carburetor mixes the proper proportion of air and gasoline and you deliver this to your automobile cylinder, perfect combustion is obtainable. The same principle is applicable to powdered coal and your combustion chamber.

Mr. Stewart has stated that the velocity of the primary air should be low. That is very true. Most of the mills, with two exceptions, have a static pressure at their burners from 3½ to 12 inches. In other words, it is necessary to have this much pressure in order to shoot the coal great lengths in your combustion chamber to mix it. One mill on the market works against a static pressure and depends upon its mixing the coal with the air, as Mr. Stewart describes, by admitting the cold air into the furnace, but with systems of that type the cold air goes to the bottom, lowers the temperature of your flame and causes the fusing of your ash.

Mr. Stewart also states that the Cleveland plant is running with 90% efficiency. At the Lakeside plant the boiler manufacturer guaranteed 94.5% overall efficiency with a $25,000.00 penalty for every per cent below that amount.

Another thing that is necessary to consider in the pulverized coal mill is its maintenance cost. Mr. Penfield says that the average maintenance cost runs from four to ten cents per ton of coal ground. I don't agree with him. The cost of operating some fifteen plants with ball tube mills show that the maintenance cost of this type of mill is one-third of a cent per ton ground. I have seen mills of the chopping machine type that cost twenty-six cents per ton of coal ground.

Mr. Frost has stated that trouble is experienced when more than four to five per cent moisture is found in the coal. That is only partially true. I have seen mills operate with forty per cent moisture. The average for mills of the unit system is around 7½ per cent.

Mr. Stewart: I wish to say that if we dry our coal to four per cent, we get better results, and I believe under the storage system operation is better.

Mr. Graham: That depends entirely upon the type of mill used. I have seen mills where coal was taken from outside storage in winter time run with twenty per cent moisture without any difficulty. But, I do admit that as the moisture content goes up the capacity of all mills drops down.

Mr. Stewart: How much of that twenty per cent is surface moisture?

Mr. Graham: About seventeen per cent. I had a conversation with Dr. Peabody some time ago when I was last in New York on the subject of moisture in coal handled by pulverized coal mills, particularly with reference to the ball type mill. With that particular type of mill, without a screen, you can handle almost an unlimited amount of moisture. Of course, the grinding capacity of your mill is diminished as your moisture content is increased. The efficiency of your mill in this case can be increased by the utilization of preheated air. Preheated air passing through a mill naturally takes out the moisture that is brought into the mill with the coal when it enters for grinding. The amount of moisture which can be absorbed and taken out of a mill varies inversely as the square of the preheated air temperature.

I haven't had this experience myself, but Dr. Peabody has stated that in mills of the ball tube type satisfactory results are obtained with 500 degrees. Some plants are operating with preheated air passing through the mill between 350 and 400 degrees F, whereas others go as high as 500, which appears to be about the maximum.

It might be well at this time to compare pulverized coal with stoker installations. I have a personal letter here with me which might interest you in considering the progress of pulverized coal compared to stokers:

> I note you are interested in obtaining a good stoker account and, fortunately for us, we have disposed of our stoker business and are indeed surprised that a good live selling organization should even interest themselves in planning to secure a good stoker account.

The stoker competition, as well as the grief attached to stoker in our opinion does not warrant any good sales engineering company assuming an account of this kind.

THE CHAIRMANS Due to the unusual amount of discussion which the paper has aroused, I think Mr. Penfield should have the opportunity to say a few words in reply.

MR. HARTMAN: I might say here that the E-Z Opener Bag Company is not interested in the sale of any equipment. It has bought the equipment it wants, and is satisfied with the purchase it has made, and the statements of Mr. Penfield are based entirely upon the statements of salesmen selling this equipment, and if the salesman is wrong, he is a very poor salesman in misrepresenting his equipment.

MR. PENFIELD: The matter of classifying any piece of equipment is always open to a great deal of discussion.

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Mr. Penfield: The matter of classifying any piece of equipment is always open to a great deal of discussion.

Regarding the correctness of naming the so-called impact mill as such, perhaps it is best to leave that to the manufacturer of the mill. I might say that the word "impact" means the striking of one body against another. In the impact mills which I mentioned here tonight, and which were shown on the screen, the coal is dropped in front of the moving paddle, bag or peg, and the blow which the coal receives breaks it up into small particles. Whether that process could be called impact in the strictest sense of the word, is open to discussion.

Mr. Graham read an article from the Bureau of Mines concerning the fineness required. I have here Bulletin No. 237, issued by the Bureau of Mines, which reads as follows:

"The coal burned in the tests was not pulverized as finely as would have been thought necessary three or four years ago. Only about 65 to 70 per cent of the coal passed through a 200-mesh screen, about 91 per cent through 100-mesh, and practically all of it through a 48-mesh screen. In the past it was thought that to insure efficient combustion under power-plant boilers the coal must be pulverized so that 85 per cent of it passed through a 200-mesh and 95 per cent through a 100-mesh screen. The tests and subsequent experiments with coarsely pulverized coal indicate that, with this type of furnace and burners, it makes little difference what percentage of the coal passes through 100 and 200-mesh screen if nearly all of it passes through a 50-mesh screen. As long as all of the coal is so fine that the individual particles will stay in suspension in the gases, the coal can be burned efficiently; but as soon as the pulverized coal contains heavy particles which will not stay in suspension in the furnace gases, these particles fall to the bottom of the furnace where they smolder, and are largely removed unconsumed with the refuse. All particles of coal that pass through a 50-mesh screen seem to float in the surface gases and most particles that will not pass through this screen seem to fall to the bottom; this distinction, however, obviously depends on the depth of the furnace and the velocity of the furnace gases.

These are two main requirements as to fineness of coal that is to be used successfully in any given furnace: First,—All of the coal particles must be small enough to remain in suspension in the furnace gases: Second,—The path of the gases and the particles of coal must be so long that the coal is burned completely before the path passes out of the furnace; in other words, the coarsest particles of coal that will float in the gases must stay in the furnace long enough to be completely burned. The larger the space within the furnace, the longer will this path of gas and coal be and the better chance will the large particles of coal have to stay in the furnace for a long time and be completely burned. Therefore, the possibility of burning coarse coal depends on the furnace space.''

And in another Bulletin, No. 223—''In order to determine to what extent the boiler efficiency would be lowered with coarser coal, the two Raymond Mills were changed to deliver such coal during tests 32 to 35, inclusive. Comparison shows that the increased coarseness of the coal did not appreciably lower the efficiency. Completeness of combustion seems to be more a matter of proper furnace and burner design and of properly supplying air than of the fineness of coal. The fineness of the coal in these tests varied from 64 to nearly 94 per cent through a 200-mesh screen. Within this range quite as efficient results were obtained with the coarsest as with the finest coal.

The ability of a furnace to burn coarser coal means increased capacity of the pulverizing mill and decreased cost of coal preparation.''

MODERN METHODS OF CEMENT MANUFACTURE AND THE CONTROL OF CONCRETE MIXTURES.

By Thomas A. Mottram.

Read Before the Society, September 13, 1926.

Mr. President and Members of Louisiana Engineering Society:

When on my return to the city last Saturday from a business trip, I was told that I had been booked to talk to you on the "Modern Methods of Cement Manufacture" and on "The Modern Methods of Concrete Mixtures," I felt like backing up. This subject is a vast one and needs a good deal of thought to present in a clear and logical way, and, when we consider that there are some 88 steps or processes in converting the raw material into the finished product, we can appreciate the scope of the subject chosen for discussion tonight. But then I have with me a highly interesting film and what the talk may lack in interest will be fully made up for by the film. Again when I look around and see before me the leading engineers of the City and State, many of you using successfully the methods I am going to describe, I feel like that brave horse friend wife bet on. It got a bad start and trailed seven or eight lengths behind the field. She told me after the race that she had bet on a brave horse. He chased all the other horses around the track. I feel that I should be trailing instead of leading this discussion.

Concrete is a mixture of cement, water and inert material, called aggregate, which when allowed to set and harden produces a rock-like mass. Concrete is liquid stone. It looks and acts like stone. As a matter of fact when in 1824 Joseph Aspdin, a stone mason of Leeds, England, discovered or invented his cement he called it Portland Cement because of its resemblance to stone from the Isle of Portland, a building stone much used in Europe. The Romans built with concrete 2,000 years ago. They used it generally in foundation work. They knew nothing of reinforced concrete. We have concrete from the Castle of St. Angelo, Rome, tested at Lewis Institute, Chicago, showing a test of 900 pounds per square inch. The Romans experimented with concrete, trying to improve the product just as we are doing today and have in the past few years. We have gone after this in earnest in the last ten years and have accomplished a great deal in this short time. From examples we have we know that Roman builders did not agree nor did they all use concrete in the same way. In their effort to secure better concrete some Roman builders laid the concrete in layers, alternate layers being made with different stones. Others mixed a homogenous mass and dumped it into the forms without distinction as to layers. The builders of today use this method. With unscientifically manufactured cement, made from volcanic ash and lime obtained from burnt marble and haphazard mixing methods the concrete foundations of the Romans appear as substantial today as they were during the time of the Caesars. The markings from the form work are still plainly visible after 2,000 years. This cement made by mixing slacked lime with volcanic ash served their purpose well. It would harden under water a quality highly essential to modern building. We have no knowledge of cement making from the time of the Romans to the middle of the 18th century.

After its rediscovery the manufacturing methods developed rapidly. In 1756 John Smeatin created a cement that would harden under water. This cement was used in the foundation of the Eddystone Lighthouse off the Coast of England. Improvement were slow until 1824. In this year, Joseph Aspdin came along with his Portland Cement. Portland Cement is not a trade name. As we all know Portland is a kind of cement which distinguishes it from rubber cement, natural cement and other cementing materials. When we speak of Irish potatoes or sterling silver or Alice blue we bring up to our minds a kind of potato, a kind of silver in contradistinction to German Silver or Sheffield Plate. So with Portland Cement, it is a kind of cement. There are some 141 mills in 29 States, manufacturing cement. Forty years ago each manufacturer of cement made it according to his own ideas. In 1898, 91 different Portland Cements were being made under 91 different specifications. Today co-operation between the American Society for Testing Materials, the U. S. Bureau of Standards and others has resulted in uniform requirements. After study and experimenting a single set of specifications was established in this country in 1921.

All Portland Cements in this country are now manufactured in accordance with these specifications and the user is assured material meeting them, regardless of the name or the maker of the special brand. Although cement was first developed in Europe, the United States now is the largest manufacturer. It was first made in this country in 1872 by Daniel O. Saylor. Thos. Millen manufactured the first Portland Cement in Indiana, in 1876. He thought \$9.12 was too much to pay for imported cement. In 1897 the American mills exceeded the European. At present the imports are only about 2% of the domestic production. We make 200,000,000 barrels per year.

How Portland Cement is made will be shown in the film I have with me. Briefly Portland Cement is manufactured from various combinations of rocks, such as limestone and clay, or shale, cement rock and limestone, limestone and blast furnace slag, marl and clay. These are burned in kilns at 2,500° to 3,000° F. into glass hard clinkers and then ground into flour, until 78% will pass through a bronze sieve having 40,000 holes to the square inch. Such a sieve will hold water. I understand that the Louisiana Portland Mills being built on the Industrial Canal will use oyster shells and clay from the City Water Works. The Conservation Commission estimates that there are 600,000,000 cubic yards of shells available.

Now to go back to Concrete Mixtures. Concrete, as we have said is a mixture of cement, water and inert material, placed in forms in a plastic condition. This mass soon hardens due to a process known as the hydration of cement.

It is only in the last four years that we have gotten away from the arbitrary methods of proportioning the ingredients. Each ingredient has an important effect on the quality of the concrete.

We can not "design" mixtures. We say "design" and not proportion because each element of the problem is approached with a deliberate purpose in view guided by a rational method of accomplishment. The design of concrete mixtures involves the selection of materials and quantities to produce concrete of required properties with the greatest economy. In the past it has been customary to combine fine and coarse aggregate in more or less arbitrary ratios, the quality of the concrete being assumed to be governed solely by the amount of cement used. We specified concrete as 1:2:4 etc. We paid little attention to the amount of mixing water, size and grading of the aggregate, curing and other factors that are now known to be all important.

I have with me Bulletin No. 9 Structural Materials Research Laboratory, Lewis Institute, Chicago. Let me quote from pages 3 and 4. (See Bulletin 9 S. M. R. L. "Quantities of Material for Concrete," by Duff A. Abrams and Stanton Walker.)

This then is the water-ratio theory. Stated simply, all things remaining equal the strength of concrete is determined by the ratio of the volume of mixing water to the volume of cement so long as a workable mix is obtained. We know that, so long, as other conditions are maintained constant the strength of concrete is increased.

1st. Mixing the concrete drier.

2nd. Increasing the cement content.

3rd. Using coarser aggregate.

These or combination of these effect the amount of mixing water and therefore effect the strength of concrete.

In designing a mix we must look to the following:

1st. Size and grading of the aggregate.

2nd. Workability of the concrete (Slump).

3rd. The quantity of cement.

In grading the aggregate the "fineness modulus" method has been developed. This is defined as follows: "The fineness modulus is the sum of the percentages in the sieve analysis divided by 100, when the sieve analysis is expressed as percentages coarser than the following square mesh sieves.

Sieve No. or size:

100-50-30-16-8-4-3/8-3/4-1½.

A simple sieve analysis will give you the F. M. for an aggregate. A set of United States Standard square mesh sieves is used each sieve having a clear opening double the width of the next smaller size.

These are 100-50-30-16-8-4 meshes per linear inch and 3/8 inch, 3/4 inch and 1½ inch. The % of aggregate either by weight or volume coarser than each sieve is measured. The sum of these percentages divided by 100 is called the F. M. This is really only an index number showing the size and grading of the aggregate.

The workability of the concrete and quantity of cement are the other two factors. The last is self evident and we measure the workability by the slump using the slump cone with which we are all familiar.

Let me say a few words on sand, water, curing, mixing time and then I will show you the film the "Story of Cement."

Sand should have durability, cleanness, and be well graded. If we have any doubt about the sand being clean we should use the Colorimetric Test as described on pages 10 and 11 of the Portland Cement Association booklet "Concrete Data for Engineers and Architects."

Water should be good enough to drink. Tests have shown that impurities in water have little effect on the strength of concrete. The reason given is that the percentage of organic matter is small. I have noticed that water out of a sawmill log pond is unfit for use in concrete.

Concrete mixed with sea water (about 35% salts mostly sodium chloride) and cured in a moist room gave higher strengths than fresh water concrete at ages 3 and 7 days. At 28 days and over the strength ratios for sea water ranged from 80 to 88 per cent.

Air cured concrete mixed with sea water was lower in strength than similar fresh water concrete at 3 months, but showed a recovery in strength at later ages and gave strengths equal to that obtained with fresh water. It is not good practice, however, to use sea water in reinforced concrete.

Curing is very important. In the mixture we want as little water as possible, yet securing a workable mix, but when curing we want as much water as we can get. If we keep concrete damp for the first ten days we add 75% to its compressive strength. A longer time adds still more to its strength and hardness. You can see how important curing is.

The time of mixing is also very important factor. Concrete mixed for two minutes is 20 to 35% stronger than concrete mixed for 15 seconds. The mean variations for any set of specimens is less in the thoroughly mixed concrete. Furthermore, thorough mixing gives increased plasticity. The mix as coming out of the mixer appears creamy.

Discussion.

THE PRESIDENT: We all appreciate this interesting talk by Mr. Mottram and as it is a subject of so much interest to all engineers, it should bring out a good deal of discussion. The subject is now open for discussion and we would be glad to hear from any of you who are interested. There are a number of you here whom I know are particularly interested in the subject and I hope you will let us hear from you.

COL. GARSAUD: I suppose I will have to show my ignorance, but I would like to know how the hole is closed in the sack.

MR. MOTTRAM: I never looked at one very closely, but the flap inside, I think, automatically closes itself by the weight of the cement against it.

MR. ANDERSON: Mr. Mottram, in speaking of the manufacture of cement here in New Orleans quoted the fact they would use shells and clay obtained from two plantations up the Mississippi River. I understood they were going to use the silt from the Sewerage and Water Board plant.

MR. MOTTRAM: I understood that also and was much surprised when I saw in the paper they had bought these two plantations, and their reason for buying them.

MR. CRUMP: Prof. Gregory has given tests of pumping this silt over long distances.

MR. MOTTRAM: That was the original idea to use the silt from the Waterworks plant.

MR. DELERY: I think they are going to use silt from the Waterworks also. They bought it from the Waterworks to use it, that is the clay. They don't care much about the sand; they want the clay.

THE PRESIDENT: Mr. Delery, have you anything further you would like to say?

MR. DELERY: Mr. Mottram has said a good deal about the methods of rodding concrete cylinders carefully to make certain that it is done in a correct manner. Just so many roddings and done just so. When concrete is poured, especially into narrow forms we have found it highly desirable to rod it thoroughly while pouring, with a narrow 2″ x 1″ wooden bar. This removes the air and practically eliminates honey combs. We have 10″ and 12″ walls holding 12 ft. of water pressure without a leak. We used a simple 1-2-4 mix without lime or celite. We have used some celite in our reservoir walls to secure better workability. It was suggested by the agent that we cut down our cement on this account. I, however, promptly registered an objection to this as we are not using strictly up-to-date means for proportioning our water-cement ratio. In the walls of the reservoirs it helps the flow considerably. I wish to stress the importance of rodding the concrete in the forms to eliminate air.

Mr. Mottram: Do you use lime

Mr. Delery: No, but that probably would do just as well as celite.

Mr. Mottram: Lime makes it smooth and easy.

Mr. Delery: We have had no trouble at all.

Mr. Lassen: I want to tell Mr. Mottram about the concrete at our plant. We did use lime for a while in the reservoir walls. Mr. Delery meant that no lime was used in the filters. At first we did not use anything and we found the concrete did not give us the results as to workability. Our mixing plant is near the filters and we have to transport the concrete seven or eight squares to the reservoir site and by adding lime first and then later on celite we found that we could eliminate water from the mixture and we are getting very uniform results and better workability.

Mr. Mottram: You find celite and lime give you better mixture?

Mr. Delery: We get a better workability.

Mr. Mottram: We also cure concrete with several different methods of calcium chloride and other processes they use. My opinion is you do not get as good concrete in using those curing methods, such as calcium chloride, as you do if you use water. If you put down a concrete slab that is designed like the Illinois Slab of about 3,500 pounds concrete; if on the other hand you make 5,000 you can afford to lose some of your strength for the calcium chloride. We don't care about ad-mixtures. The best way to make waterproof concrete is to make a good mixture and spade it well. Admixtures honeycomb it.

Mr. Delery: About twenty years ago when every factory was making their own cement independently and everybody running tests and laboratories to see how it tested, the companies would send men around and a great trick was to put a little lime in the cement and run the strength up.

Mr. Mottram: It makes a thick mix and a very workable mix, about five to eight pounds.

The President: Mr. Hogg, you have had a lot of experience in designing reinforced concrete. We would like to hear from you.

Mr. Hogg: In designing, we simply use the recommended working stresses that are practical for standard field construction. The Dock Board has been trying to improve its field methods of proportioning in recent months, and Mr. McNiven and Mr. Crump can tell you more about that than I can. We so far have had no practical experience with the new specifications. We have two jobs, now under contract, in which the water cement ratio method of mixing has been specified, but no concrete has been poured on those projects.

Mr. Crump: All I can say is what Mr. Hogg states, that we have adopted the specifications in the last few months based on the water cement ratio, in which we specify not in excess of 7½ gallons to the sack for every batch. The time of mixing is one minute. On some of our more important jobs we have called for one and a half minutes, but as Mr. Hogg said, we have not yet had a job in the field completed in which these specifications were used. The specification is the same as was used on the Portland Cement Building in Chicago; that is readily the basis of it, and we understand it worked out very practically there. Furthermore, we think it ought to make a good specification. Mr. McNiven had some tests made on one of our jobs in which this was not specified, but the contractor kindly let him work out a few experiments.

The President: Mr. McNiven, will you let us hear from you?

Mr. McNiven: We have been trying out a modification of the water cement ratio mentioned in manufacturing concrete. We have obtained very good results with this method in the field and actual results compare quite favorably with the theoretical.

The contractors are becoming more interested in this method and co-operate with us in order to get the best results. We have made experiments on two jobs to demonstrate to the contractors the method of proportioning aggregates, and also to demonstrate the advantage to them in that more aggregate could be used than under the usual method. After these demonstrations they were quite satisfied to go ahead with the job under the new specifications. We use it now on all our large jobs, but not on the small jobs. I think Mr. Reiss could tell us how this method appeals to a contractor.

The President: I was going to call on Mr. Riess next for an expression from the point of view of the contractor.

Mr. Riess Mr. McNiven picks on me while at work, so I suppose he is going to pick on me now. The contractors have to adopt the negative attitude in all new methods the engineers bring out, because we have to act as a sort of buffer for them, as we do not want to go too far in one direction and not far enough in the other. Getting back to the time of mixing: Within a reasonable limit, we all know that proper mixing is all important. When the engineers get too far afield it is time for us to call a halt. That is the reason why Mr. McNiven changed his specification and why he has been picking on me.

The amount of water is all important and while I am no longer an engineer I do feel we should have a little co-operation in any method that tends to better construction. One thing which we all like to impress on our men and have uppermost in their minds, is the necessity of having workable concrete. We find it an advantage to have concrete with as little water content as is possible, because we get a denser and more satisfactory mix with the small amount of water. We have never yet offered serious objection to work along the lines suggested by the Cement Association and we are in sympathy with the idea. With proper co-operation on the part of the men who have charge of the methods, we can get fine results.

The President: The discussion seems to me to be more about the water cement ratio than anything else. If I understand Mr. McNiven correctly, he said that the contractors found by using the proper water cement ratio they could use more aggregate. I don't know whether I understood that exactly. Doesn't the engineer fix the proportions in the aggregate and the proportions of sand and cement regardless of the water ratio?

MR. McNIVEN: Maybe Mr. Mottram can answer that better than I can.

MR. MOTTRAM: No, water cement ratio is what governs the strength of concrete. It does not matter how much aggregate you put in the mixture. You get the same strength if you have workable mixture. If you tell the contractor you want 2,000 pound concrete in this part of the structure and 3,000 pound concrete in that part of the structure, and he does not get it, it is up to him; he put too much aggregate in his concrete. You must have a workable mixture. You can't get a harsh mixture. You tell a man to use 6½ gallons of water to a sack of cement, put as much aggregate as he can put in it; it is up to him to get a workable mixture that will give him the required strength.

MR. NEGROTTO: Is that now recommended by the Portland Cement Association? Will the question of mix be up to the contractor? In other words, the engineer will specify the 3,500 pound mix or 4,000 pound mix, and leave the question of proportion of the aggregate to the contractor? Is that what the Portland Cement people are now recommending?

MR. MOTTRAM: Yes.

MR. NEGROTTO: That is the percentage of concrete is controlled by the percentage of water for the cement?

MR. MOTTRAM: Yes. The contractors shied at it at first, but they are beginning to see its value.

THE PRESIDENT: Colonel Garsaud, will you let us hear from you?

COL. GARSAUD: Mr. Chairman you called upon several men associated with me and I think they have said all I could say on the subject. I haven't mixed cement in several years, but I was much interested in the discussion and I am interested in the new method, but I have left that part of field engineering so long ago that I can't tell much about it. I think the position our friend Mr. Riess stated is a fair one. I also have a leaning for the contractor. I think the Portland Cement Association has gone too far in its recommendations to let the engineer specify the strength of the concrete, 3,000 or 4,000 pounds, leaving it to the contractor to determine the aggregate. To leave that to the contractor is putting a big burden on him and I think that is one place where the contractors are right in calling a halt. It is going too far. That is my opinion, although I have not had enough experience in the new method.

The President: I don't like to slight the Dock Board. There are a good many of them. Mr. Young, maybe you can tell us something.

Mr. Young: I thought I was responsible for calling a halt on going too far with the new methods in so far as our contractors are concerned. Some time ago, I sent Mr. McNiven and Mr. Hogg to Chicago to a Concrete Institute Convention, and after they had associated with these Portland Cement people at this convention they came back full of new ideas which they wanted to try out on the contractors. I thought we would best go a little more slowly, and while Mr. Riess probably doesn't realize it, we gradually slipped this "new stuff" over on the contractors. We worked on it for some time among ourselves before we decided to spring it on the contractors. I remember that I instructed Mr. McNiven and Mr. Crump, who writes our specifications, not to use the new terms lest we should get the contractors unnecessarily wrought up, but I thought that we could so word the specifications that we could gradually put these new theories into practice without actually saying so in the beginning. After the contractors become accustomed to mixing concrete by the new methods we could word our specifications accordingly and this we are now doing. The contractors are beginning to appreciate the merits of the new theories and methods and they are co-operating with us in a very sincere way.

As a result, we are sure that we are getting concrete of a much better quality. We have endeavored to follow rather closely the methods and specifications recommended by the Portland Cement Association, which organization, in its efforts to promote the use of Portland Cement, is probably taking a more active interest than any other agency in the successful use of concrete as a building material.

THE PRESIDENT: I see Mr. Kohnke, Engineer for the Levee Board. We would like to hear from you.

MR. KOHNKE: I can't say much on this subject, Mr. Chairman. I have gotten rather out of the line of concrete in a way. We use comparatively little concrete in comparison to the Dock Board and other boards. Our biggest feat now is piling up mud and we are very much taken up with that, but my experience in concrete work has been along the old lines where the arbitrary mixtures were used. I am not so familiar with this idea, although I am trying to follow it, because I realize it is the coming thing, and I think Mr. Young is carrying on some very good work in experimenting along those lines.

THE PRESIDENT: I think Mr. Merrill specializes in steel designing, but like all other engineers he is interested in concrete, and we would like to hear something from Mr. Merrill.

MR. MERRILL: I cannot add anything. I specialize in steel designing, but I do a lot of concrete work in addition to all-steel buildings, as you can generally get concrete buildings cheaper. I have been using for some time this new theory. As Mr. Young has said, putting it over the contractor without his knowing it has been done. We have had two recent experiences with this. For instance, we had a building that specified concrete of definite strengths. We were not able to get the contractor to maintain the water cement ratio. He felt he had to have more water. When we tested the cylinders they were about fifty per cent of what we wanted, so we had to take the necessary precautions.

There is another point I might make. I do not know what the Portland Cement people have found, but I have found certain brands of cement, which as a whole tested up considerably above the A. S. T. M. standards, some well over 3,000 pounds, some even over 400 pounds. I find it is very hard to regulate the strength of the concrete which is made from cements testing this high so as to get a 2,500 pound concrete. Under ordinary conditions when the cement tests at about 400 pounds the concrete will test to 3,600 or 3,800 pounds. I don't know just what are the conditions that run the cement test so high, but using the cement which tests so much above the standard means that we do not prove where we are on the strength.

Mr. Mottram: All our tests are made with cement in the open market at Chicago. We buy four or five different brands and make them up and as long as the mill will follow the A. S. T. M. Standards, the Portland Association has no kick. If it falls below those requirements, we don't play with them.

Mr. Merrill: I have no kick on their running over.

Mr. Mottram: You might make up some mixture before, if you want to be sure. A job is generally sold by one mill.

Mr. Merrill: On the job I referred to, the first carload tested high, while the balance of the job tested close to the standard.

Mr. Mottram: Your mixer may have handled them differently.

MINUTES OF MEETINGS AND BUSINESS OF THE SOCIETY.

Minutes of the Meeting of the Board of Direction, September 13, 1926.

The meeting was called to order by President Hamilton and the following members and guests were present: Messrs. Lanphier, Fey, Garsaud, Moses and Muth.

The minutes of the previous meeting were read and approved and bills on hand were ordered paid.

The resignation of Mr. J. F. Thomson was accepted with regret.

Mr. F. P. Hamilton was elected delegate and Mr. E. C. Lanphier alternate for the American Engineering Council for the year 1927.

On motion, duly seconded, it was voted that beginning with the October meeting the Society will have the usual collation served in the lobby instead of at the nearby restaurant, and that the Secretary furnish this information to the Society when the next notices are mailed.

On motion, duly seconded, it was voted that the Tresaurer be authorized to open a savings account in the sum of $500.00 in the Canal Bank & Trust Company, which funds are to be taken from the present checking account.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

Minutes of the Regular Meeting of the Board of Direction, September 13, 1926.

The meeting was called to order about 8:10 P. M. with President Hamilton in the chair, F. A. Muth, Secretary, and 48 members and guests present.

The minutes of the previous meeting were read and approved.

Announcement was made of the action of the Board in changing the place for the serving of the collation with a view of increasing the spirit of sociability among the members.

The technical exercises of the evening consisted of an interesting paper on "Modern Methods of Cement Manufacture and the Method of

Control of Concrete Mixtures,'' by T. A. Mottram, Field Engineer, Portland Cement Association. This talk was illustrated with an interesting film on the manufacture of cement. An interesting discussion followed. A rising vote of thanks was then tendered the speaker.

The meeting then adjourned to the collation, which was served in Pitre's restaurant.

F. A. MUTH, Secretary.

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PROCEEDINGS
OF THE
LOUISIANA ENGINEERING SOCIETY

VOL. XII. DECEMBER 1926 NO. 6

CONTENTS

EDITORIAL NOTES AND COMMENT

Celotex. So rapidly has this remarkable material gained a place for itself in the building industry that we are coming to think of it as a generic term, like bricks or lumber, rather than as the name of a very special product. And yet Celotex is a very special material, the process of the manufacture of which and the uses of which form the subject of a very interesting paper by Mr. C. G. Muench, Vice-President and Plant Manager of the Celotex Company. The paper is published in this issue of the *Proceedings*.

Celotex is the result of a determined effort on the part of a certain man to produce a board of fibrous texture which would have definite characteristics. One of the most important of these characteristics was its thermal insulating property.

It is made from sugar cane fibre or *bagasse*, and with the continuous improvements which have been made in the details of its manufacture, the product has now been developed to the point where, with slight differences in the consistency and thickness of the material, it is placed upon the market in three grades, Building Board, Insulating Board and Box Board.

One of the most interesting developments in connection with this material is its use in buildings for the correction of or control of acoustic properties. For this purpose the material in certain definite thicknesses and sizes is bored with a large number of small holes and these boards are used for walls and ceilings in combinations to suit each individual case.

Not one of the least interesting incidental features connected with the use of bagasse for the manufacture of Celotex is the opportunity it affords to some sugar mills of improving the boiler efficiency. Selling the bagasse allows them to use oil exclusively for fuel, thus doing away with the use of bagasse entirely as fuel, thereby greatly simplifying boiler operations and increasing efficiency.

So rapid has been the growth in the demand for Celotex that the Company has perfected plans for the erection of a plant in Porto Rico. The output of this plant will supply the demand from the Atlantic coast and foreign countries, while the New Orleans plant will supply the balance of the United States.

Light and Vision. This was the subject of a very interesting lecture and demonstration by Mr. Sam W. Trawick, Illuminating Engineer of the New Orleans Public Service, delivered at the meeting of the Society, November 8, 1926. The lecture is not published in the *Proceedings* for the reason that, without the charts and experimental demonstrations, it would be impossible to do justice to the subject as presented by Mr. Trawick.

A point made by Mr. Trawick early in his discussion challenges one's attention and interest almost immediately. It costs as much to provide daylight by means of windows, sky-lights, etc., in our buildings as it would to supply the necessary illumination artificially. Artificial ventilation and artificial control of relative humidity added to artificial illumination has demonstrated that we may secure the highest degree of bodily comfort in public buildings, such as theatres, etc., without windows. Whether these same methods could be applied to our dwellings remains a question to be answered. One would have to take into consideration the hygienic and theropeutic value of sun-light, but doubtless even this could be reproduced by artificial means.

Mr. Trawick states that recent researches have shown quite conclusively that the average human eye can stand constant use without fatigue longer under *pure* yellow light than under any other tint or color. The green light, which we ordinarily consider restful, has been proven to be just the opposite, not only irritating but debilitating as well.

In a floor lamp for reading purposes Mr. Trawick recommends the use of two sixty watt inside frosted bulbs. This would appear to be a rather high intensity of illumination, but the eye would be subjected to less strain with this intensity than it would be with a low intensity.

Dissatisfaction with the present system of street lighting on St. Charles Avenue is being constantly voiced. From a personal study of the problem Mr. Trawick has reached the conclusion that the lights should be removed from the neutral ground and placed on the curb line. Each unit should be mounted on a goose-neck pole and should be from twenty to thirty feet above the ground. They should be of 20,000 lumen's capacity each, equipped with Bilux Refractors, and should be spaced three or four to the block.

The Mechanical Solution of Indeterminate Structures. Engineers designing the framework of buildings, trusses, arches, etc., of reinforced concrete have been forced to choose between approximate methods or an extended analysis of laborious character. The approximate methods commonly used are generally wasteful and sometimes dangerous. The computations involved in a mathematical analysis are difficult and voluminous and the theoretical solutions commonly employed have departed far from any evident relationship to the actual structure.

Professor George E. Biggs of Princeton University has developed and perfected a practical method of solving many types of indeterminate structures by the aid of elastic models made of cardboard or celluloid. These models may be sujected to minute distortions and the effects measured with gage and filar micrometer microscopes of the greatest accuracy.

The Deformater Gages are made by the Pratt and Whitney Company and are accurate to 0.00001 inch, while the microscopes and filar micrometers are made by Zeiss. The equipment is not bulky, and can be set us easily within the limits of an ordinary drawing board.

Professor Derickson has recently purchased a set of this apparatus for the Department of Civil Engineering of Tulane University. They are in use in a number of the larger universities of the North and East, but so far the only set in this part of the country is the one at Tulane.

It is in use by the engineering departments of the N. Y. Central R. R., the Illinois Central R. R., the City of Los Angeles, the Connecticut, Washington and Oregon State Highway Departments, the National Swiss Railway and others.

New Members. It gives us great pleasure to welcome to the privileges and activities of the Louisiana Engineering Society the following new members who have been added to the rolls through a very active campaign on the part of the Membership Committee:

Resident Members.

Samuel T. Adams, Superintendent of Fulton Bag and Cotton Mills.

Sam V. Applewhite, with J. W. Billingsley & Company of New Orleans.

Ralph C. Bailey, with J. W. Billingsley & Co.

Clarence N. Bott, General Contractor.

Sidney C. Calongne, President S. A. Calongne's Sons, Engineers.

John H. Coates, Assistant Engineer, Sewerage & Water Board.

Wallace C. Drennan, with New Orleans Public Service, Inc.

Gustave R. Dubus, Gus R. Dubus Machine Works.

Jules F. Dubus, Construction Engineer of the St. Rose Export Stations.

Peter A. Dubus, President P. A. Dubus & Son, Inc.

John V. Gaudet, Superintendent W. E. Winship Oil Refinery at Frelken, La.

Paul F. Hoots, Assistant Chief Engineer, New Orleans Public Service, Inc.

F. M. Ivichievich, Assistant Superintendent, Crescent Bed Co.

Roger B. McWhorter, Special Engineer, Orleans Levee District, on Spillways.

Carl G. Muench, Vice-President, in ch[illegible] of Engineering, Construction and Operation, The Ce[illegible] New Orleans.

Elbert G. Sandoz, Private Engineering Practice.

Edwin G. Starbuck, Contracting Engineer, Virginia Bridge & Iron Co.

George E. Vinnedge, Superintendent of Construction, City Park.

Elmer Williams. Contractor.

Transfer from Student to Resident Member.

J. M. Cracroft, Assistant Engineer, Bridge Department, City Engineer's Office.

Albert G. Wyler, Assistant Engineer, Department of Streets, City Engineer's Office.

Non-Resident Members.

Ray M. Law, Box 361, Pass Christian, Miss., Resident Engineer, Pine Hills, Inc.

Jack H. Perkins, Box 361, Pass Christian, Miss., Assistant Resident Engineer with Jno. F. Coleman Engineering Co.

Resident Associate Members.

Fowler B. Banton, Assistant Commercial Engineer, New Orleans Public Service, Inc.

Michael A. Cooper, Local representative Utica Heater Co.

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Salvador di Benedetto, Assistant Engineer, Orleans Levee Board.

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PAPERS AND DISCUSSIONS

THE MANUFACTURE AND USES OF CELOTEX INSULATING MATERIAL

By C. G. Muench.

Read before the Society October 11, 1926.

The architects and engineers need no longer approach the design of an important structure with a feeling of uncertainty about the heat insulation or the hearing conditions of the finished building. The science of heat insulation and acoustical analysis, together with the art of manufacturing insulating materials, as now developed, has made it entirely practical to obtain definite, predetermined and measurable results. Although the fundamental principles of heat insulation and acoustical correction have been established for a long time, it is only in recent years that any great progress has been made in the use and practical application of these principles. Up to ten years ago the use of thermal insulation had been almost entirely confined to high temperatures such as pipe covering, boiler lagging, etc., and low temperatures such as cold storage plants and refrigerators. It is true at that time there were some dwellings insulated, but these were exceptions, and while the architects and engineers were acquainted with the properties of insulating materials, the general public was ignorant of the benefits derived from their use. Whereas a few years ago insulation was a luxury, today it has become almost as important a part of building as windows and doors. In the colder climate it is now considered an absolute necessity and no one would think of building without the use of some form of insulation.

The widespread effect of insulation is beyond comprehension as it benefits the health, provides comfort and changes the manner of living and mental attitude of mankind. Years ago in the colder climates when winter came it was the custom to put on thick woolen underwear and heavy clothes, as a necessary protection in cold daughty houses. This is, however, a thing of the past for today winter clothes are almost as light as summer clothes and insulating materials have helped to bring this about as their use makes a warm comfortable dwelling where temperature conditions are uniform and moderate.

Thermal insulation can be divided into two separate and distinct classes, namely—High temperature insulation such as pipe covering, boiler lagging, etc., and lower temperature insulation used for all purposes where moderate and cold temperatures are dealt with.

Undoubtedly the first materials used by civilized man were such bulk products as straw, bark, leaves, saw dust, shavings, etc.,—but the earliest forms of commercial insulation intended for structural purposes were blocks, such as made from cork and mineral wool and a thin quilt made by stitching a layer of sea-weed between two thicknesses of paper. Both of these products are still being used extensively—the blocks chiefly for cold storage work and the quilt for dwellings. The sea-weed quilt was later on supplemented by quilts made from hair, flax, jute and other fibrous material, all of which are being successfully manufactured and marketed at the present time. They are efficient non-conductors, but due to their physical characteristics serve only the purpose of insulation.

About twenty years ago the production of flax felts was commenced and though somewhat coarse and crude they are efficient non-conductors and have some advantages not possessed by the quilt forms. In the felts the vegetable fibres are intertangled and matted in a wet condition so that after drying no paper is required to hold the material together and instead of being very filmsy they are semi-rigid and can therefore be handled in sheets.

The problem of selling the felts was difficult as the public was not educated to insulation and the produce was limited to only a very few uses. Dealers did not want to stock it as it was too hard and slow to move. These conditions brought about the inception of the first strong, rigid, attractive looking insulation board, called Insulite. This product is made from strong wood fibres produced as tailings from the screening process of the manufacture of wood pulp. These fibres are felted together and form a light, strong and rigid board.

This product opened up a large number of new uses for this kind of material, such as Plaster Base, Interior Finish, Roof

Insulation, and many other applications for which the softer forms were inadequate.

The production of this particular insulation board is, however, limited to the amount of screenings produced in the regular manufacture of paper. The men who were responsible for the successful production and marketing of Insulite realized these limitations and commenced a thorough and comprehensive search for a product to use as a raw material from which to manufacture an unlimited quantity of insulating lumber. After a year of investigation and experimenting with various materials, it was finally decided that sugar-cane fiber, or bagasse, showed the best prospects, and work was definitely begun to organize a company and build a plant. This was in 1920. Actual construction was commenced in 1921 and the plant was operating on a commercial scale in 1922.

The name Celotex was chosen from a large number suggested, as it has a descriptive meaning being derived from the words—Cellular Texture.

Celotex was not an accident, it was the result of a determined effort, on the part of a group of men, to produce a particular kind of board having certain characteristics and complying with definite specifications. These qualifications have all been realized in Celotex as it is being manufactured.

The physical strength of Celotex is more or less determined by the felting action of the fibers as there is no binding material used to cement or glue it together. The process of felting is best described by making a mental picture of the operation. For this purpose, use a small tank or mould 12″ square and 24″ high with a fine wire mesh bottom and set this upright into a larger tank containing about 18″ of water. Into the small tank pour the fibrous bagasse pulp and after thoroughly mixing, slowly lift the small mould out of the large tank. The water will drain out through the screen leaving a wet, mushy layer of intertangled fibres on the bottom. This layer, or mat, is further pressed and when dried has become a board which is light in weight, tough and strong.

The fundamental principles of manufacturing Celotex are not complicated. The bagasse is received from the sugar mill, transported to the baling machines by conveyor, pressed into bales weighing about 200 pounds and either shipped to the main plant for storage or piled at the sugar mill for future use. At the plant the bales are received in cars, unloaded onto a platform equipped with a conveyor where the wires are removed and then conveyed to a breaker which reduces the bales to pieces about the size of the original bagasse. From the breaker it is conveyed to a swing hammer shredder where it is torn to small pieces and discharged into a tank of hot water where it is violently agitated and then pumped to the cooker.

The shredded bagasse remains in the cooker about two hours. after which it is washed and refined to a pulp. The board machines form and press this pulp into a continuous sheet 13 feet wide, which is then dried. At the trimming end it is cut to sizes, piled on trucks and then loaded into cars.

While the process at the present time has been worked out so that it is comparatively simple and easily controlled, the first years were extremely trying, due to mechanical difficulties and the inability to handle and control certain stages of the operations. Trouble started in the very beginning with the handling of bagasse from the sugar mill. It first seemed advisable to blow the bagasse from the sugar mill into a large storage pile and then later on in the season bale it up and ship to the plant. This was the method used at the Southdown plantation during the grinding season of 1920 and 1921. The bagasse was blown into a pile successfully, but when the time came for baling, it was discovered that the standard balers on the market were not satisfactory and no company could be found who had a baler which they would recommend to bale bagasse. Three different types of machines were used with the same results,—the bales would be tight on the bottom and loose on the top. By modifying the feeding arrangement and doing away with the automatic compressor arms on the balers, it was found that a better bale was produced, but the machines were all built so lightly they were continuously breaking down.

An extra heavy, strong baling machine was designed and put into operation and this type has successfully handled the material since then. The average hay baler makes a bale that weighs around 60 pounds, whereas the Celotex baler produces a smaller bale that weighs between 200 and 250 pounds. It can be readily seen that there is an enormous advantage in having a heavy bale as less storage space is required and freight rates are lower. The new baling machines which will be put into operation this year will produce bales weighing between 300 and 350 pounds. The Celotex Company will operate twenty-four baling stations this season equipped with a total of 100 baling machines. About two-thirds of these are in operation and the other third for spares.

The total harvest of bagasse this season will amount to 100,000 tons of dry fiber or 200,000 tons of damp bagasse as it comes from the sugar mill. This is equivalent to 10,000 carloads, of which one-third is brought to the plant at Marrero and put in storage piles and the other two-thirds stored at the various sugar mills. The handling of this material during the grinding season requires about 1,500 men, practically all of whom have to be boarded so there will be no interference with the sugar mill operations.

All machinery and equipment used in connection with the baling is built extra heavy so as to eliminate the possibility of a break down that might, in consequence, shut down the sugar mill.

The average baling station at a sugar mill grinding, say 1,500 tons of cane per day, has four balers of which two are always in operation and sometimes three. The conveyor from the sugar mill passes directly over the balers and discharges the bagasse into a large hopper connected with the feed chamber of the baler. Three men operate a baler and produce bales at the rate of one every forty-five seconds. All engines driving balers and conveyors are the same size and make so as to be interchangeble throughout. Transmission machinery such as conveyor chain, sprockets, gears, bearings and shafts have been standardized so that they are all interchangeable and repair parts will fit any station.

In addition to the main conveyor, two smaller conveyors are used which carry the loose bagasse that falls off from the bales across the platform up into the main conveyor to be fed again into the balers.

The finished bales are either loaded directly into cars to be shipped to the plant at Marrero or are put on small cars, each of which are equipped with two platforms holding 13 bales, or 26 per car. Five of these small cars are loaded then pulled out into the field by a gasoline locomotive and stacked up into piles with the aid of locomotive cranes on caterpillar treads. These cranes have been found almost indespensible.

Originally elevating conveyors were used, but due to the fact that they could take material only from one point and deliver it to only one point, the operation was altogether too slow. A locomotive crane can pick up and deliver a load from any place within its radius and can readily be moved about. While the cost of a caterpillar crane is quite high, nevertheless it is warranted by the tremendous saving of labor. As an example—the first crane which took the place of an elevated conveyor, eliminated twenty men from the piling gang besides speeding up the work. These machines are also used for taking the piles down and loading the bagasse into cars for shipment to the mill. This phase of the work generally takes place during the time that the sugar mill is shut down.

The bagasse in the field is stacked in piles 60 feet wide, 100 feet long and 30 feet high, each containing 500 tons of fiber. Heretofore the piles have been left uncovered, but this year 50% of them are to be covered with large galvanized iron panels 10 feet square and laid on top of the piles similar to enormous shingles. They are fastened by large iron spikes 3 feet long driven down into the bales and the projecting ends are fastened to the sides of the piles with 3 feet spikes and cables. Experimental piles covered during the last season have demonstrated that the improved condition of bagasse which resulted, makes it easier to handle the bales in taking down the piles and also gives increased yield at the plant, therefore warranting the additional expense.

All bagasse is purchased from the sugar mill at a price that permits the buying of oil to replace the fuel formerly supplied by the bagasse and allows for a reasonable profit besides. This price fluctuates according to the cost of oil during the grinding season. It is also an important fact that the sugar house boiler plant can be operated more efficiently and therefore more economically on oil than on bagasse.

The boiler efficiency of the average sugar mill is quite low, on the bagasse burners about 55%, and on the oil burners 60% to 65%. This of course does not hold true of all mills, as some of them are quite efficient. By coverting the bagasse burning boilers into oil burners, with the proper type of furnaces, it is possible to increase this efficiency at least 10% and in some cases up to a total efficiency of about 70%. With the commencing of grinding there is usually an over production of steam inasmuch as the evaporating processes are not in full operation. The reverse is true when the mill stops grinding,—there is still a large quantity of juices to be evaporated so that other fuel is necessary to complete the run. By the use of oil these inefficient periods are eliminated as the steam production can then be adjusted to the requirements. The boiler house operation is simplified by the use of oil exclusively inasmuch as the furnaces are less complicated, do not become clogged with slag and require less attention in operation. It is therefore possible in practically all cases to cut down the boiler house crew by 50%. Steam and electricity for the baling stations are furnished from the sugar house power plant and a charge is made, at reasonable rates, based on the consumption.

In shipping bagasse to the plant almost any type of railroad car, except flat cars, can be used, but gondola cars are preferable inasmuch as they are easier to load and unload.

The bagasse after reaching the plant is unloaded from the cars into a long flight conveyor where the wires are removed and then conveyed to the breakers that tear it to pieces and deliver it to the shredders. The shredders reduce the small pieces to a fibrous state and discharge it into a tank containing boiling hot water where it becomes saturated and forms a coarse pulp. The consistency of this pulp, as it goes to the cookers, is about 2%, that is two parts of bagasse and 98 parts of water and while this appears very thin, nevertheless it is about as thick as can be successfully handled with open impeller centrifugal pumps. This is due to its stringy nature and the tendency it has to plug pipes, pumps, etc.

The cookers are long, horizontal, cylindrical tanks 6 feet in diameter with agitators running through the centers to keep the stock from settling. The cylinder is steam jacketed and well insulated so that the heat loss is not excessive. The raw bagasse is fed continuously into one end from the shredders and out the other end into the washers.

The washers consist of inclined perforated plates, having a scraper conveyor over the top. The stock passes onto this washer, the water drains through and the fiber is carried by the conveyor to the next compartment where additional water is added and again drained off. This process is repeated four successive times so that by the time the fiber reaches the end of the washers all of the soluble matter loosened by the cooking process has been rinsed out. It is then stored in large tanks ready to be refined.

The function of the refiner is to take the fibrous bagasse, cut it and tear it to pieces thereby reducing it to a pulp so that it can be felted into a sheet. These refiners are like huge coffee mills, having a cone-shaped plug that revolves inside of a stationery cone-shaped shell. Both the plug and the shell are filled with tool steel bars between which the fibres are torn to pieces and refined. The mixture of fiber and water at about 2% consistency as it coms from the washer tank is fed into the small end of the refiners, passes between the bars and out of the large end. Due to the difference in diameter between the small end and the large end, there is a considerable amount of pumping action which assists the stock to flow through. To properly prepare bagasse for making Celotex board requires four successive passages through these refiners. One board machine requires four refiners so that with four board machines 16 refiners are required, each taking 150 HP. or a total of 2,400 HP. Our first plans contemplated using one and not more than two refiners per machine, but it was discovered that the individual bagasse fibers were so very hard and tough that it took about twice as much power to reduce it as was originally planned. The refining process requires many times as much power as any other operation and has therefore been the object of a great deal of experimenting with the view of reducing this. Up to the present time, in spite of the fact that a large number of various types of machines have been experimented with, it has been found that no matter what type of machine was used, practically the same amount of power was consumed to produce a certain result. The refiners now in use are an improved type of a standard machine used for paper mill work, but due to the extremely hard service required in refining bagasse, the machines were re-designed to get greater strength and to simplify repairs and replacements.

Celotex is treated to resist moisture and for this purpose an emulsion of rosin size and sulphate of alumina are added, during the process of refining. The reaction of these two chemicals form resinate of alumina on the fibers and after the board is completely dried this forms a slight film over the fibers which repels water and stops the capillary action. It is the general opinion that the rosin size has some binding qualities, but this is not the case as the quantity used is so small that it is impossible except by chemical analysis to identify it in the board. Two boards made, one without the rosin size and alum and done with rosin sizes and alum appear exactly the same and have exactly the same physical characteristics except when placed in water the untreated sample, due to capillary action, will become water-logged and sink within a short period of time, whereas the treated board will float practically indefinitely. This is one of the most important features of Celotex without which it would be totally unsuccessful and limited only to a small percentage of its present uses. The question of the reaction of rosin size and sulphate of alumina has been the source of probably more research than any one item in connection with Celotex. While these chemicals have been used in the paper industry for years, they have always behaved in very peculiar ways, and although a great deal of research work has been carried on, the causes and reasons for this erratic behavior has never been discovered.

The results accomplished by the use of rosin size and alum in the paper industry are somewhat different than with Celotex. In the paper industry these two chemicals perform the function of sizing or flattening down the fibers and smoothing the surface and also preventing the too rapid absorption of ink, but in Celotex they are used to make the board water resistant and in this capacity their behavior is very sensitive and undependable, giving variable results under apparently the same conditions.

The Celotex Research Department have been working on this problem for about three years and are now first beginning to get encouraging results indicating that some of the mysteries of rosin size and alum may soon be cleared up.

To produce the same quality of product at all times it is desirable to maintain all manufacturing conditions uniform. This, however, is difficult where raw materials vary. Bagasse received fresh from the sugar mill behaves entirely differently from bagasse which has stood in the pile for a year. Old bagasse refines and waterproofs more easily, but is more difficult to felt on the board machines and also to dry than fresh bagasse. It is therefore necessary to change operating conditions and to keep the fibrous stock the same.

To judge the condition of the pulp preparatory to going to the board machines is a different problem for the operators, for the appearance, feed texture and everything may indicate that it was satisfactory, but when it was made into board it would be found to be either too fine making a lumpy board, or too coarse producing a weak, strawy board. To overcome this difficulty and make this observation more accurate, a device was perfected which is termed a Freeness Tester. This apparatus tests the prepared pulp stock for its felting qualities and the rate at which it will drain, giving this result in figures. While instruments similar to this are used for testing paper pulp, none of them would operate on bagasse stock, so that the test had to be modified and the apparatus changed to suit the different nature of Celotex stock. This test had become so important that the adjustment of refiners and other portions of the operation are all gauged by the reading of the Freeness Tester. These tests are made every half hour and chalked up on a blockboard where the operators can see them.

The stock, after being refined, is stored in concrete chests and kept agitated to permit settling. These chests contain about four hours supply for the board machines so it is possible to shut down the cooking, washing and refining equipment for a few hours for minor repairs and the board machines can continue to operate. The chests, owing to their large capacity, also serve to make the stock more uniform.

Probably the most important step in the whole manufacturing process is the forming of the board where the pulp is changed from a liquid into a damp board of uniform thickness and continuous length. This operation is accomplished on machines designed especially for this purpose and which are composed of two distinct parts, the mold rolls and the presses.

The mold rolls are 6 feet in diameter and 13 feet long covered with wire mesh screen and form the front end of a vat into which the thin pulp is admitted. The water passes through the screen and leaves a thick layer of pulp adhering to the surface. After leaving the mold rolls, this thick soggy sheet is carried between two heavy woolen felts down through the presses where it is successively squeezed until it finally emerges a finished sheet ready to be dried.

The presses consist of seven pairs of rolls each of which press the board a little more than the one preceding it until the last set of extra heavy rolls which gave it the final squeezing. These last presses are 26″ in diameter on the ends and crowned 1/16″ so that the diameter is 26⅛″ in the center. This crown compensates for the deflection caused by the 160,000 pound pressure exerted by the springs on these rolls and is necessary in order to produce a sheet of uniform moisture content.

Enormous quantities of water are used in forming the board as the pulp enters at 2% consistency, is then thinned out in the head box to ½% and finally emerges at 50% moisture content. This means that for every pound of fiber in the head box there are 199 pounds of water of which 198 pounds are removed by the machine, leaving one pound of water for every pound of fiber that enters the dryer. Based on the present rate of machine production, this means that 1,500 gallons or 6 tons of water per minute are drained and squeezed out by each board machine.

The capacity of the dryers establishes the possible production of board as no more Celotex can be made than what can be satisfactorily dried. The usual board dryers are built from four to eight decks high and intended to accommodate sheets only, but in making up preliminary estimates it was discovered that there was a trimming loss of about 7½% which could be eliminated by handling a continuous sheet through a long dryer. A four-deck dryer 200 feet long, when made in single line becomes 800 feet long and as no company could be found who were willing to build a dryer this size, it fell to the Celotex Company to build their own. By placing two or more board machines in tandem and running the sheets produced by the rear machines under the front machines it is possible to pass two or more continuous sheets through a dryer at one time, that is have a multiple deck dryer operating with continuous boards.

The two dryers now operating are 800 feet long and each accommodate 2 sheets 12½ feet wide or the production from four board machines. There are 160,000 feet of 1¼″ pipe coils in each dryer being supplied with steam at 175 pounds pressure and 100 degrees superheat. The sheets are carried through the dryer on 3″ diameter rollers spaced 6″ centers equipped with sprockets and driven by a steel chain. In these dryers there are three banks of steam coils, one below the bottom sheet, one between the two sheets and one above the top sheet. Large Multivane fans provide constant circulation of vapors through the dryer and as temperatures are maintained around 300 degrees there is no necessity for admitting fresh air. At these temperatures water vapor is a stable gas and is preferable to air as a circulating medium for the reason that it has a higher specific heat and also has no tendency to brown or char the board.

The board as it now comes from the dryer is in exactly the same condition as if it were dried at a lower temperature with air. If air alone were used in the dryer the board would come out slightly browned and the fibers very much weakened. The discovery of this fact has made it possible to increase the capacity of the dryer about 100%, were it not for the use of water vapor the temperature would have to be maintained around 200 degrees.

One of the first troubles encountered with the dryer operating at these temperatures was with the lubrication of the tubular roller bearings. These rollers were originally equipped with ball bearings, but due to the extreme temperature and violent circulation through the dryer it was impossible to maintain any lubrication in the bearing. As the dryer is operated continuously there is no opportunity to lubricate these bearings except on Sunday, when the plant is shut down, and by Monday noon practically all of the lubrication had evaporated so that the balance of the week these bearings were running without lubrication. Scores of devices for oiling were designed, discussed and discarded, but as one double deck dryer contains 3,600 rollers or 7,200 bearings to put any oiling devices on this equipment would be out of the question. The only solution seemed to be in finding a bearing that would operate under these high temperatures without lubrication and this appeared rather hopeless. Every possible type of bearing was considered and six months were spent in experimenting and testing every kind and type procurable. All were tried, no matter whether they looked good or not and finally a bronze sponge impregnated with graphite was discovered that seemed to have some possibilities, but being very soft wore out rapidly. After considerable experimenting it was discovered that by enlarging the bearing surface, making the bearing itself self-aligning and polishing up the end of the shaft that this type of bearing would not only stand a temperature of 350 degrees, but that the temperature could be raised to 500 or 600 degrees. This bearing has been adopted as standard and all of the dryers have now been changed over from ball bearings to the special graphite impregnated bearings. Not only has this type of bearing proven satisfactoy in operation, but it is exceedingly simple to install and takes only a moment to change. The perfection of this detail has made possible the use of higher temperatures such as can be obtained by direct fired oil furnaces and the dryer in the new plant, now under construction, will be heated in this manner instead of with steam coils. With this type of heater the capacity of the dryer is expected to be about 20% greater than were it heated by steam.

The new dryer is 1,000 feet long and three decks high so that three machines can be placed in line.

The board on emerging from the dryer is practically bone dry so that it necessary to spray the surface with a small amount of water in order to give it the proper moisture content after which it is ripped to width and then cut to length. The original trimming equipment consisted of saws, but later on knives were perfected and adopted so that all the difficulties encountered with the use of saws have been eliminated. The knives run at slow speed and have emery wheels attached directly to them for keeping them sharp. The most difficult problem in connection with the trimming apparatus was the design of the knife for cutting the board to length as this had to be designed so that it could be readily changed to meet different speeds and different lengths. This consists essentially of a revolving knife mounted on a carriage traveling on a track at right angles to the moving sheet. To cut square with the sheet the track sets at such an angle that the carriage in its passage across is also moved forward at the same speed at which the sheet is traveling. The track is pivoted at one end and can be adjusted to any angle required to correspond to the speed of the sheet. The original cutters were arranged with mechanical trips for stopping and starting the cutting apparatus, but this has been superseded by electric switches, solenoids and magnetic clutches. Incidentally the electric mechanism is considerably more accurate than the old mechanical arrangement and in spite of the fact that it is more complicated is much easier to operate and maintain.

Every possible precaution is taken to insure the shipment of nothing but perfect board, and for this purpose an elaborate Inspection Department is maintained. Samples from three parts of each sheet being produced are taken every hour and tested for tensile and bending strength, thickness, density and waterproofing, and any board not fulfilling the requirements is rejected. A record is kept of the contents of every carload shipped and from this it is possible to get not only the record of tests, but also samples of the actual board shipped out. The value of this elaborate system is not in the records kept and information derived therefrom, but in the high standard of quality it demands from the operators.

Inasmuch as the manufacture of Celotex requires an exceptionally large amount of power and steam, the boilers and power house present an extremely important and interesting problem.

In a paper mill drying is done on heated cylinders which use steam at about 5 pounds back pressure, but owing to the difficulty of drying Celotex, it is necessary to use steam at 180 pounds pressure to get the necessary temperatures. A paper mill uses exhaust steam for process work where with Celotex live steam only is used.

The daily consumption of fuel oil for manufacturing and drying Celotex is 800 barrels per day. With this large expenditure, every precaution is taken to produce steam as economically as possible. The boilers are completely equipped with flowmeters, draft gauges, CO2 recorders and recording thermometers, and the daily power house report gives their efficiency together with the distribution of steam to various parts of the plant and consumption of oil. The average daily efficiency for the boilers runs between 71 and 73%, and in spite of the fact that manufacturers show tests on similar boilers running from 78 to 80%, our experience leads us to believe that an efficiency of around 73% is all that can be expected under regular operating conditions.

At the present time the power plant consists of nine horizontal water tube Heine type boilers having a total rating of 3,750 HP. and varying in size from 250 to 750 HP. each. Of this total rated capacity, about 2,500 HP. are in regular operation, producing around 4,000 boiler HP. The make up for feed water is treated with the Cochrane hot process softener to remove the silt and scale forming salts, and all of the condensate from the dryers is returned direct to the boilers by a motor-driven triplex plunger pump.

The main power generating unit is a 2,500 KW Curtis turbine operating condensing and an auxiliary 300 KW noncondensing unit. In addition to 2,500 KW supplied by the generator, 600 KW is purchased from the New Orleans Light & Power Co. The new plant, now under construction, will require approximately 2,000 KW to operate, and in view of these additional requirements it was decided to purchase all of the power from the local central station, and a contract was therefore entered into covering electric requirements for the next five years. It may seem strange to you that an industry of this size should purchase its power instead of making it, but the problem was carefully analyzed before the decision was made. The chief reason for not erecting a new up-to-date power plant at this time was the large number of changes taking place in the design of power plant boilers and fuel burning equipment. In five years a good many of these changes will have been tried out so that it will be possible to make a better decision on just what type of apparatus is best adopted to our conditions.

An anlysis is being made at the present time to develop the most economical combination of power producing units and dryer heaters. It is possible to heat the dryers either by high pressure steam coils or by oil fired air heaters and power can be produced either by steam generators or oil engines. Our idea is to generate steam at around 500 pounds pressure, pass this through a turbine or a reciprocating engine exhausting at about 180 pounds and using the exhaust steam for drying. In this manner only about two-thirds as much steam would be required as consumed at the present time by the condensing turbine and dryer both operating at 180 pounds pressure. Another promising arrangement, under consideration, is oil engines and oil fired drier heaters. The result of this analysis will be adopted for the new plant now under consideration in Porto Rico.

In the manufacturing process there is always a tendency to increase the number of products manufactured and some of these propositions are so alluring that it is difficult to refrain from taking them up. It has been a policy of the Celotex Company to adhere strictly to the manufacture of Celotex so that at the present time there are only three kinds of Celotex made, namely Building Board, Insulation Board and Box Board. Each of these materials are made according to definite and certain specifications and no variations are permitted. The difference in these three classes is the density.

Insulation Board, which is the lightest, is used for rerigerator cars, household rerigerators and roof insulation.

Celotex Building Board is slightly denser, considerably stronger and firmer and used for all general building purposes.

Box Board is very hard and tough and although it has good insulating qualities is intended only for the manufacture of boxes.

These materials are produced in sheets of standard size and shipped out either wrapped or unwrapped.

Comparatively speaking, Celotex does not appear to be a strong material. When the term strength is used by the laymen he refers to properties of that material which enables it to stand abuse or large forces before it breaks.

One material is stronger than another when it can stand more punishment and heavier loading without breaking. It is the function of the engineer to analyze the loading and forces acting on a material and to study their effects and the stresses set up and in his conclusions uses such terms as tensile strength, compressive strength and shear strength. The sides of a wood frame building are subjected to different stresses from those set up in the columns and other parts of the same building and it is necessary, therefore, to investigate these stresses in order to find out why the sides fail. Whether wood sheathing or Celotex shething is used, the stress is set up by wind pressure or by settling, having a tendency to distort the building, and it is the resistance to distortion in this case that must be compared.

For a comparison of relative strength between wood sheathing and Celotex as sheating, wall sections have been made up and tested for their resistance against distortion. Robert W. Hunt & Company of Chicago conducted tests on two wall sections 4x8′. Frames were built of studdings spiked to upper and lower sills, these frames were 4 feet high and 8 feet long. The ends of the 2x4 studs were securely fastened to the sills and the Celotex nailed over the studding on one test frame and 6″ dressed and match sheathing on the other frame. The lower sill was clamped rigidly to the base of the testing machine, then a pull was applied to the top sill in the direction of its length by means of a yoke which straddled the frame and measured by a dynamoter. The forward movement was measured at each 200 pound increase applied. At 1,200 pounds Celotex insulating lumber had moved 1/100 of an inch out of plumb, while wood sheathing moved 3¾″ out of plumb. At 1,600 pounds the wood sheathing had moved 5½″ and then collapsed, while the Celotex frame had moved only 4/100 out of plumb. The test was continued on the Celotex framing until at 2,600 pounds the movement was 42/100″ and the studding pulled up from the lower sill and the test was discontinued.

This test has been continued a great number of times before architects, engineers and contractors. There is nothing mysterious which gives these results as it is plain to see that it is simply a case of the large sheets of Celotex giving diagonal bracing which the narrow lumber does not furnish.

A Celotex dealer in Iowa reported that a building under construction and sheathed with Celotex was struck by a cyclone, and while the force of the storm blew down trees, porches and numerous structures, it did not even move or distort, by a fraction of an inch, the walls sheathed with Celotex. Similar demonstrations of the structural strength of Celotex have been recorded from numerous other parts of the country.

Its resistance to compression is far greater than other types of insulating material, and this fact makes it possible to use it directly over concrete roof decks with standard roofing laid directly on the Celotex. Softer materials would be liable to puncture and would not stand the abuse in application. The average weight that Celotex would be required to support as roof insulation would not exceed 10 pounds per square inch. Under this load the reduction in thickness is between 2 and 3%, which would be about 5/100 of an inch for three plys.

While the bending strength of Celotex is not as great as that of wood, parallel to the grain, it is ample for the use to which it is put. It is possible to walk over Celotex nailed over wood floor joists. In this particular case the stresses are largely tensile and the tensile strength of Celotex is well over 250 pounds per square inch.

Inasmuch as Celotex is used a great deal as a base for plaster, the question of bond between the Celotex and plaster is important. Tests by Robert W. Hunt & Company show that the average bonding strength between Celotex and Gypsum plaster is over 800 pounds per square foot. In all these tests the failure was not between the Celotex and plaster, but within the Celotex itself. The average plaster load of a ceiling does not exceed 5 pounds per square foot, so that the factor of safety would be over 150. This is also many times as great as the bond between plaster and wood lath. For general application, Celotex is nailed with 1½" galvanized roofing nails, spaced about 4" centers. Under these conditions, Celotex will stand an excess of 750 pounds per foot before the board will pull away from the nails.

The thermo-conductivity of Celotex insulation is .33 BTU per square foot per inch thickness per hour per degree difference in temperature Farenheit which is approximately the same as pure cork board. Celotex, however, is considerably stronger and can therefore be applied under conditions where cork could not be used.

The standard specifications for the manufacture of Celotex that have been adopted and revised from time to time are rigidly adhered to and all material that does not conform to the specifications is rejected. Due to the precautions taken in the manufacture, it is a rare instance where any of the board is made over again, and as a rule the average material produced is at least 25% better than the specifications call for.

As Celotex is made from bagasse, the question is sometimes raised as to whether or not it does not contain sugar, and if so whether it may not afford food for vermin, such as rats and mice. The sugar of the juices left in the bagasse by the milling process ferment into either Alcohol or Acetic acid and has disappeared from the bagasse long before it enters the manufacturing process of Celotex. Even if a small amount of sugar were still left in the bagasse, the cooking and washing would remove all of this. In this connection it might be stated that Celotex board after having passed through the dryer at 350 degrees F. is a completely sterile product and contains absolutely nothing of food value for rats, mice or other vermin, and such vermin will only attack Celotex when food on the opposite side attracts them, in which case they gnaw a hole through in much the same manner as they do through wood or plaster. The fibrous texture of Celotex seems to be of such a nature that rats and mice do not attack it for building nests, but actually carry paper and other material from considerable distances instead.

The Celotex Company has made an intensive study of the attack of white ants on Celotex in various parts of the country and have received co-operation from the U. S. Department of Agriculture and various institutes of industrial research. The result of the investigations leads to the conclusion that Celotex is not attacked by the terranean group of white ants, that is the ants that live above ground. Celotex, however, is attacked by some of the subterranean groups. It was found that the subterranean groups of white ants did not show any tendency to attack Celotex where wood was present nearby. As Celotex is generally applied on wood, there are no indications of the Celotex being attacked and its resistance to the action of white ants is definitely superior to most woods.

While it is not claimed that Celotex is fireproof, it does, however, burn slowly, and in actual use has demonstrated its ability to check the rate of combustion. The seriousness of any fire depends primarily upon three factors—1st, the amount of combustible material that enters into the fire; 2nd, the general design of the structure with reference to fire stop partitions, etc.; 3rd, the rate at which these materials burn. Building materials should contribute as little combustible gas as possible and should burn slowly so as to give as much time as possible in which to extinguish the fire. Celotex is a valuable building material when viewed from this standpoint for the following reasons:

1st. Celotex does not flame readily, contains no pitch or rosin, generates practically no inflammable gases.

2nd. Due to the high insulating value it retards the passage of heat of the fire to combustible material beyond. There is a tendency to confine the fire to the room or origin and hold it there until the proper steps can be taken to put it out.

3rd. As it is applied in large sheets there are very few joints and no open joints or cracks through which flame can pass.

The heat which it is possible for a material of this kind to generate is a function of the weight and composition. A square foot of ¾″ pine has a value of about 21,000 BTU, whereas a square foot of Coletex has only about 4,800 BTU. The intensity of a fire with Celotex as sheathing would be a great deal less than with wood. An actual demonstration of the fire retarding qualities of Celotex was recorded in the fire of a house of which one-half was built in the ordinary manner with wood sheathing and plaster on lath. A recent addition to this house was built completely of Celotex used as plaster base on the walls and sheathing on the outside. Fire started in the basement at night and gained such headway that it was a mass of flames before the department reached it. After the fire was checked it was discovered that the damage done to the Celotex portion of the house was only about one-half of that done to the other portion of the house. A number of other instances of this kind have been noted, one case being in New Orleans. In all instances it appears that the Celotex had a tendency to confine the flames to a small area and prevent it from spreading as rapidly as it would have had it been constructed of ordinary materials.

Due to the physical characteristics of Celotex, its uses seem to be unlimited. The principal demand is, of course, for residential purposes where it is being used as sheathing, plaster base, interior finish, sound deadening, roof insulation. Besides this it is used for insulation in refrigerator cars, acoustial correction in auditoriums, halls, etc., household refrigerators, boxes, screens, mats for pictures and outside finish for summer cottages and semi-temporary buildings of all kinds. Correctly applied it is ready to perform and serve its purpose at all times. It has been estimated that the heat loss, due to poor insulation, in one year amounts to one hundred million dollars. This is a leak that cannot be stopped entirely, but each year is being reduced more and more.

In the industrial field, the biggest use probably for Celotex is for roof insulation. It has long been a problem to build a good roof and prevent condensation, but it is a simple matter now to build a concrete roof and over this apply say three layers of Celotex cemented together with asphalt and over this lay a standard asphalt or tar and gravel roof. The number of thicknesses of Celotex used depends on the temperature and humidity condition of the air required in the building. In spinning mills and industries of a like nature where high humidity is maintained by air conditioning apparatus, it is necessary to have the roofs well insulated in order to prevent condensation. On some of the larger mills, as much as one million feet, or about fifteen carloads of Celotex have been used in one installation.

In apartment houses Celotex finds use as plaster base and also for sound deadening in floors and partitions. Sound deadening is an exceedingly difficult problem as there are so many factors that contribute to the passage of sound from place to place. The Celotex Service Department furnishes data on the various methods of sound deadening for use with different constructions.

Celotex is especially well adapted for use in refrigerator cars for, due to its structural strength, there is no danger of it settling or tearing to pieces. The average refrigerator car requires about 4,000 feet of ½″ thick material and since commencing operations approximately 25,000 refrigerator cars have been lined with Celotex.

In some cases the cars were not entirely insulated with Celotex, but the total amount already furnished for this purpose is in excess of seventy-five million feet, or about 1,200 carloads.

The rough texture of Celotex makes it possible to apply any kind of Gypsum plaster directly to the surface. In the ordinary dwelling where insulation is desired it is therefore a simple matter to use Celotex in place of lath, nailing it securely to the studding and applying plaster in the regular manner. Another satisfactory application is to nail the Celotex directly to the studding on the outside and then put on either siding or stucco the same as over wood sheathing. In the South, where the winter conditions are not as severe as in the North and insulation does not apear as necessary, it does, however, add to the comfort during the cold weather and also protects against the beating rays of the sun in summer. In the average two-story house in the South the second floor, due to the roof being directly over it, is considerably hotter than the first floor and at night it takes longer for the upper floor to cool off. This condition can be easily remedied by either insulating the ceiling or the roof with one layer of Celotex with the result that the second floor will be as comfortable as the first floor and at night will cool off even faster than the first floor. In the cooler climates the effects of insulation are much more noticeable due to the extremes of temperature, the improvement of living conditions and great saving in fuel. The average difference in fuel consumption between the ordinary house and one insulated with Celotex is about 33 1/3%. The average additional cost in construction with Celotex is about 2%. There is no better investment to be made in any residence or dwelling than insulation. It does its work without any attention whatever and with no upkeep or operating expenses.

The Acousti Division of the Celotex Company is exceedinly interesting as they have developed acoustic correction to such a state that instead of being shrouded with a considerable amount of mystery is now a plain engineering problem.

Acousti board is made according to standard specifications and the various styles have certain definite sound absorbing factors. A Service Department is maintained which provides technical data and analyzes acoustic problems for architects and engineers. Celotex in its natural state has a co-efficient of .25. By drilling 400 ¼″ holes to each square foot, this is increased to .55. The basis for this co-efficient is an open area, in other words sound vibrations emanate from their source in all directions and those striking an open area pass outwards and disappear entirely. Those striking hard surfaces will be reflected causing reverberation. Those striking Acousti Celotex will be absorbed and deadened to the extent of 55% of the total volume.

Owing to the various shapes and designs of buildings, each one presents a different problem. With Acousti-Celotex being made in different styles with different co-efficients it is possible to make a large number of combinations to take care of any conditions that might arise.

The surface of Celotex is such that it can be decorated and handled to appear like almost any kind of building material. Some of the work accomplished in this department in conjunction with the Art Department is so well done and artistic that it is almost beyond belief that it originally was nothing but sugar cane. At the third annual Radio show in Chicago, the Celotex Company was presentel with a Silver Cup in recognition of the development of Acousti Celotex and the results obtained by the use of Celotex in broadcasting studios.

The possibility for the development of Acoustics is practically unlimited. There are thousands of places where correction is necessary and conditions are endured simply because the general public does not know that these conditions can be corrected and remedied. There are beautiful depots built of hard, sound reflecting materials in which the acoustics are so terrible that it is impossible to understand train callers, and the accumulation of noises, by reverberation, is almost deafening.

In this day and age conditions of this kind are unnecessary as with the proper application of Celotex, it can be entirely remedied. It will be only a question of a few years until acoustics will be considered in connection with the design of almost any type of structure such as office buildings, hotel lobbies, restaurants, schools, etc. It is predicted that this department of the Celotex Company will have an enormous growth the next four or five years. The growth of the Celotex Company has been so rapid that it has been only with difficulty that the production has kept pace with the sales.

The original layout for the Celotex plant provided for a production of 60,000 feet of board a day from one machine. Although in the spring of 1921 it looked difficult to even get 50,000 feet of board from this machine, by making various changes and improvements the production was increased to 150,000 feet in 24 hours. The original plans called for the final installation of ten machines at Marrero with a total of 600,000 feet. To-day four machines are producing 700,000 feet and by January first this will be increased to 1,200,000 feet. The present plans provide for four additional machines at the

Marrero plant to be installed at a future date and the new buildings are constructed with this in view.

Due to desirable conditions in Porto Rico and also the advisability of having more than one plant, it was recently decided to commence work on a plant located near San Juan. This plant will ultimately have six machines, two of which will be installed at once and the balance as the business grows. The production in Porto Rico will be shipped to the Atlantic Coast and foreign countries and the Louisiana production distributed throughout the balance of the United States.

The next five years will see great activity in the use of insulating lumber and right now it is more or less a problem of educating the public. In five years Celotex will have become a stable article and not be considered a specialty. The tendency will also be toward the use of thicker materials. At first thin paper was used, then came ¼″ quilts and now ½″ thick boards. The next step will be ¾ and 1″ thicknesses.

This, however, will be adopted first for the better class of buildings where people desire more insulation than used in ordinary houses. It has been said that we have passed through the Stone Age, Iron Age and Steel Age, and we are entering the Fiber Age, and this seems to be true.

The following list will give you a better idea of the magnitude of the Celotex Company. The figures on materials consumed are based on a production of 1,200,000 feet per day.

100,000 tons of bagasse consumed—this requires the consumption of 300,000 barrels of oil to take its place.

10,000 cars are used to carry this material from the sugar mill.

17 locomotive cranes with 50 feet booms for piling bagasse at plantations.

200 small cars.

15 gasoline locomotives, 2 regular steam locomotives.

25 miles of track owned by the Celotex Company.

A total of 25 baling stations are operated, each with commissary and boarding house.

500 men employed in the manufacture of Celotex at Marrero and about 100 regularly at the plantations with an additional 2,000 during grinding season.

Consumption of bagasse for 6 machines—35 carloads per day making 17 carloads of finished product.

800 barrels of fuel oil consumed daily.

Ten million gallons of water used per day.

During the year a total of 20,000 carloads of material was brought into the plant and shipped out.

The Sales Department employs 200 men that call on the dealers and customers.

2,000 sell and carry Celotex in stock.

The Advertising Budget for the year is one million dollars.

Discussion

THE CHAIRMAN: Gentlemen, this very interesting paper is now open for discussion. You will note that, from its engineering features, it is of interest to all of us, and besides it has a further interest as being a typical home product. Mr. Muench has brought out so many engineering features that it is hard to tell where to start on it. There is room for discussion by all of the engineers, but I am going to start it by asking Professor Robert if he will not discuss some of the mechanical engineering features.

PROF. ROBERT: I enjoyed this talk of Mr. Muench's very much and especially so because I was over his plant not very long ago, and it is a most interesting plant and I want to say that anyone who visits that plant will be more than repaid for the time he puts in, in the knowledge that he will receive. There is one thing I would like to ask Mr. Muench, and that is what is the difference in insulating value between insulating board and the regular building board?

MR. MUENCH: The insulating board has a transmission value of about .33 BTU and the building board .4. The reason the building board has not as high an insulating value is due to the fact that it is somewhat denser and stronger, but for all practical purposes there is very little difference. For refrigerator car insulation and roof insulation the fibers are refined somewhat coarser and therefore producing a lighter board. In connection with refrigerator car orders, the railroads test the insulation value so it is necessary to meet the specifications and give what the contract calls for. By varying the stock it is possible to make Celotex having various insulating values.

PROF. ROBERT: What I had in mind was this: Suppose that some man building a residence would like to get a little extra insulating value, could he use insulating board?

MR. MUENCH: We would not sell insulation board for this purpose. I will explain the reason why. Insulation board does not have sufficient structural strength for regular building purposes and although the finished job might be just as good and perhaps a little better from an insulation standpoint, we are trying to prevent insulating board from being used in the regular building business. We make insulation board only for use in refrigerator cars, in which case it is cut to special sizes as ordered and for industrial purposes. The industrial board is cut 3′x6′, which is too small for ordinary construction purposes, and it is used almost exclusively for roof insulation .

PROF. ROBERT: May I ask another question? The ordinary building board that is used for insulating roofs—take a roof, for instance, made of asbestos shingles, could that board be used as sheathing, and the shingles nailed directly to the board?

MR. MUENCH: No; Celotex is not sufficiently strong to hold nails in this manner. It is strong enough when nails are driven through into the wood, but it will not act as sheathing where it has to hold the nail. The better construction would be wood sheathing with Celotex underneath. The best construction would be to have Celotex on the ceiling underneath and in that way confine the heat to the smallest volume. That is the way it is done in most Northern houses.

PROF. ROBERT: You spoke of its use with plaster. How about Acme Cement?

MR. MUENCH: That is about the same as Gypsum plaster.

MR. DUPLANTIER: How about putting Celotex in a house already built?

MR. MUENCH: It would be a difficult matter to get the results unless the application was done right. If it is desired to keep the heat from the roof, Celotex could be applied on the inside of the rafters, which will give good results, or it can be put on the top of the second floor ceiling where it will keep the heat out. If the exterior is nothing but weather boarding on the outside, Celotex can be nailed over this and then apply metal lath and stucco over the Celotex. This application will make a well-insulated wall. Down here it appears a good many houses seem to be built simply for heat transmission—the inside is finished with lath and plaster, which is a good conductor, and the outside is metal lath and stucco, which is also a good conductor. In this type of house you could not hold the heat in if you wanted to. When a layer of Celotex is added to a wall of this kind, the fuel consumption is reduced 50 per cent and the house is made comfortable.

A MEMBER: Do you happen to recall the difference in heat conductivity between an ordinary plaster wall and a Celotex wall—a wall that you put Celotex in, in place of plaster?

MR. MUENCH: The addition of Celotex in a wall having sheathing on the outside and plaster on the inside would increase the efficiency about one-third and in some cases more, depending on what the outside structure was like. For instance: wood sheathing is full of cracks and joints through which the cold air can readily pass getting into the air space between the studding. This same wall, with the addition of a layer of Celotex, becomes absolutely tight and the efficiency might be increased as high as 50 or 75 per cent.

The basis of all vegetable matter is cellulose, which has the same chemical composition in one kind of fiber as in another. Wood, which is mostly cellulose, is subject to dry rot and other organisms of that kind just the same as other vegetable matter. Under ordinary conditions, as in residence construction, there is no reason why Celotex should not last as long as any other part of the building.

A MEMBER: I have noted that quite a few artists are using Celotex for paintings. Is Celotex as permanent as canvas for paintings, etc.?

MR. MUENCH: I do not know what the lasting qualities would be, although I have a few pictures in my own house. Cotton canvas should last longer than Celotex, as it is practically pure cellulose, although there is nothing in Celotex that could affect the oils, etc., in the paint any different than cotton.

A MEMBER: I was just wondering how you got plaster to adhere to Celotex.

MR. MUENCH: If you will look at Celotex closely you will notice that the surface is made up of fibers and small spaces between them. The plaster is very finely ground and seems to reach down between the fibers forming a bond with the surface of the board. It is hard to believe that a surface which apparently is as smooth as Celotex will make such an ideal bond. but this effect was brought out by the Gypsum plaster years ago in connection with some work done on Insulite. All plaster will not stick satisfactorily to Celotex. Gypsum plaster makes the strongest bond and is the kind we recommend for this work. Portland Cement does not make a good bond as apparently some of the water necessary for setting is absorbed by the board and therefore the cement directly in contact with the Celotex never sets properly. Cement-plaster, or stucco, applied directly to Celotex, will stick only in spots. Lime plaster is quite alkaline and affects the fiber and does not make a good bond.

MR. WEIL: You spoke about the resistance of Celotex to warping, when it is used as a base for plaster. Will the use of Celotex prevent cracking of plaster as now is the case when settlement occurs in a house?

MR. MUENCH: It will not prevent it entirely if there is any great amount of settling, as the joints are the weakest places and the cracks naturally take place there, so that a wall, instead of showing cracks in every direction, will simply show cracks at the joints. This, however, reflects on Celotex, as in practically all cases of this kind, in as much as the cracks are at the joints. the blame is put on Celotex, whereas the fault is really the settling of the building.

MR. MALOCHEE: Mr. Muench, have you any information about the material being manufactured by Mr. Mason at Laurel. Miss., out of wood refuse?

MR. MUENCH: I do not know much about it. I know he is making a pulp in the same manner that Prof. Anderson uses in making Puffed Wheat and Puffed Rice, which is by the explosion process. This process makes a nice fiber, but whether he is manufacturing board commercially or not, I do not know. I have attempted to get some samples, but up to the present time I have been unable. There is no reason why he should not make a good board out of wood, as it has a strong fiber and should make a nice material. In manufacturing, it is largely a question of having a dependable source of raw material and getting it in large enough quantities. Celotex, whether made out of bagasse, wood or some other material, is essentially an insulating lumber. There are certain materials which have high insulating value and we find that bagasse comes under this class and has other qualities in addition. You can go out and cut down the shrubs across the streets and make a pulp board out of them. However, to make a commercial product, it is first necessary to get the raw material in sufficient quantities and make it at a low enough price so that a reasonable amount of money can be spent for marketing. During the first year that Celotex was manufactured it cost more to sell it than to manufacture it.

THE CHAIRMAN: How long could this baled bagasse be allowed to stay out in the country before you have to use it?

MR. MUENCH: The bagasse when it gets to our plant is in bales, containing about 50 per cent water. The sugar that is still left in there starts up fermentation. This fermentation is accompanied by considerable heat, and as it is good insulating material, the heat on the inside accumulates and builds up until the temperature reaches a point where the bagasse begins to get brown. What we do is to pile it with about a six-inch space around the bales, so that the heat generated on the inside can get out of the pile. In a short time the piles become cool and at the same time they dry out. After the heat is gone and the moisture is dried out the bagasse is in condition where it appears as though it would keep almost indefinitely from then on. No apparent change takes place except on the outside of the pile where it comes in contact with moisture.

The first year we started piling in this manner we believed we had solved the method of handling the bagasse, as it was preserved very satisfactorily. The next year we did exactly the same thing, but the piles did not stand up as well and the sides would fall down. This last year, as you will remember, we had two very heavy rains, and the wind drove this rain into the sides of the piles, so that the bales became soaked and fell off. This bagasse that falls on the ground, while it looks dark, brown and spoiled, is in good condition provided it is used within the year, and after it has gone through the process you cannot tell it from other bagasse.

We have spent a lot of time investigating the feasibility of storing it under cover. The cost of buildings is so high that we cannot afford it and prefer to stand a reasonable amount of shrinkage loss. This year, as I said in my paper, we are going to cover a part of it with roofs for the purpose of keeping the moisture off the top bales and keeping it in better condition for the last part of the season. What bagasse is used in the beginning of the season will not be covered.

Mr. Young: When you use a great quantity of water and press that water out, can you use this water again?

Mr. Muench: This water is all used over again, being recirculated around and around, and the surplus is used in the washers and cookers, etc. That is what we call white water, because it has a white color. It is used to rinse out the bagasse in the washers.

Mr. Young: That cuts down the quantity that you have to pump from the river?

Mr. Muench: Yes. Our daily consumption is about 10,000,000 gallons from the river. We have a big settling tank where the sand and heavy silt is taken out.

Prof. Robert: When you break up your bales and send them to the shredder, don't you get a few tools and things along with them?

Mr. Muench: Yes; wires and monkey wrenches and everything else. Every Sunday we have a couple of truck loads of every kind of junk that is taken out of the cookers.

Prof. Robert: Will it go through the shredders?

Mr. Muench: Yes; they go right on through as the machines are built on the swing hammer type and are therefore practically foolproof. We operate 24 hours a day and therefore cannot afford to shut down at all.

Mr. Lanphier: Where will you get water in Porto Rico?

Mr. Muench: On the north side of Porto Rico, about 25 miles west of San Juan, there is a river of fairly good size. There is a hydro-electric plant up the mountain on this river, and there is a constant flow passing down all the time. I have not been down there, but I am going in about a week and then I will know more about it.

Mr. Todd: Is there any place where Celotex is used as cold storage refrigerator insulation?

Mr. Muench: I imagine so, but frankly it is not adapted to cold storage work further than where you are going to build knock-down coolers or something of that kind. If I were going to build a cold storage plant I would use cork board of some kind. because it is better suited for that particular kind of work than Celotex.

Mr. Griffith: You said the board leaving the machine comes out bone dry?

Mr. Muench: Leaving the drier, yes, it comes out practically bone dry.

Mr. Weil: You spray it; why is it sprayed?

Mr. Muench: It is sprayed for this reason: If the board is taken as it comes from the drier and loaded into cars, it reaches its destination almost bone dry. If this dry material is delivered on a job and applied in this condition, the board immediately picks up moisture, increases in length, and then starts buckling. When this occurs we have trouble on our hands from the owner, contractor and architect, and this is the reason for dampening the board. We have a sprayer to put on this film of water and then it goes to the saws and is piled on the trucks. The board is warm, and by the time that truckload gets to the car there are no visible signs of moisture any more. It has all disappeared as vapor into the fibers, so there is no sign of it and the Celotex gets to its destination with just the proper amount of moisture. That is done with paper, lumber, and a number of other things, where you have to bring your material back to natural condition.

Prof. Robert: The peculiarity is the fact that it absorbs that water and still leaves the board waterproof?

Mr. Muench: Yes; that is the strange thing. All you can do is to make it dry and then put the proper amount of moisture back in again.

Prof. Robert: That is also done in wood work?

Mr. Muench: Yes. It is something that has really only been developed in the last eight or ten years. We had a difficult time in the beginning when Celotex warped because it was too dry.

Even now we have to watch conditions up north in the cold climate where there is practically no moisture in the air in the winter time. Any board lying around gets bone dry, so we have to take extra precautions to see that it is dampened well before it is put up. We recommend that board that is going to be used for a plaster base be sprayed with water the day before it is going to be used, and then be put in a pile and allowed to stand. In that way it reaches its longest length and the only thing that can happen is for it to shrink, and that does not distort it.

MINUTES OF MEETINGS AND BUSINESS OF THE SOCIETY.

Minutes of Board of Direction, October 11, 1926.

The meeting was called to order with President Hamilton in the chair and the following members were present: Messrs. Fey, Lanphier, Fox and Muth.

The Minutes of the previous meeting were read and approved and bills on hand were ordered paid.

A communication from the Secretary of the Louisiana State Board of Engineering Examiners was read advising that the term of office of Prof. Derickson as a member of that Board had expired and requesting that the Society take steps to furnish the Governor with a list of names from which selection of a member could be made. On motion, duly seconded, the President of the Society was authorized to furnish the Governor with a list of names from which to fill the vacancy.

There being no further business, the meeting adjourned.

F. A. MUTH, Secretary.

Minutes of the Regular Meeting of the Society, October 11, 1926

The meeting was called to order about 8:10 p. m., Mr. F. P. Hamilton, President, F. A. Muth, Secretary, and 58 members and guests present.

The Minutes of the previous meeting were read and approved.

Reports were received from the Chairmen of committees present.

The technical exercises of the evening consisted of a most interesting address on "The Manufacture and Uses of Celotex Insulating Lumber," by Mr. C. G. Muench.

The address was followed by interesting and profitable discussion. The speaker was then tendered a rising vote of thanks.

The meeting then adjourned to the usual collation.

F. A. MUTH, Secretary.