



**The
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Society**

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The Proceedings of the Louisiana Engineering Society

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MARCEL GARSAUD

PROCEEDINGS

OF THE

LOUISIANA ENGINEERING SOCIETY

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EDITORIAL NOTES AND COMMENT

Our New President. At the Annual Meeting of the Society, January 10, 1925, Colonel Marcel Garsaud was unanimously elected President for the year 1925.

Col. Garsaud is a native of Louisiana, born in New Orleans, May 29, 1881. He received his primary and high school education in the public schools of this city, and graduated from the College of Technology of Tulane University in 1903 with the degree of Bachelor of Engineering in the Civil Engineering Course.

Shortly after graduation Mr. Garsaud began work as an assistant engineer with the Sewerage and Water Board and was engaged in sewer design and construction. He followed this line of work for four and a half years, the next three years being devoted to private practice and construction work. This was followed by an experience of two years in contracting work on highways and as engineer in charge of several important investigations and reports.

From 1913 to 1917, he was chief engineer for Hampton Reynolds engaged in the construction of highways, buildings, pumping stations, wharves, levees, drainage canals and many similar projects.

When the United States entered the World War in 1917 Mr. Garsaud offered his services and was commissioned as Major in the Corps of Engineers. He was in general charge of the completion of the sewerage and water systems at Camp Pike, Arkansas, as well as other engineering work incident to the establishment and operation of such a camp. He was discharged in October, 1919 with the title of Lieutenant Colonel of Engineers.

For the next five years Col. Garsaud engaged in the practice of general engineering and contracting as a member of the firm of Hackett and Garsaud.

In August, 1924, he was made Chief Engineer of the Orleans Levee Board, a position which makes him responsible for several new and important developments, such as the sea-wall along the Lake Shore, and new measures of flood protection and control.

Col. Garsaud is a member of the Building Code Board of Appeal, and has been for a number of years a most active and efficient member of the State Board of Engineering Examiners. He was the first President of the National Council of State Board of Engineering Examiners, is a member of the Society of American Engineers and is Colonel of Engineers in the Reserve Corps.

A member of the Louisiana Engineering Society since 1905, Col. Garsaud has had experience and been of service in all its varied lines of activity. Under his able guidance it is destined to enjoy one of its most successful and prosperous years.

Other Officers for 1925. Mr. Farrar P. Hamilton, member of the Board of Direction, having been elected to the Vice-Presidency, Dr. D. S. Elliott was elected to fill his place on the Board.

The other members of the Board of Direction are Charles McD. Kerr, E. S. Lanphier and John S. Barelli.

Frank A. Muth was re-elected Secretary and Walter Moses Treasurer.

Highway Location. Mr. Carpenter opens his paper on this subject with the very pertinent suggestion that engineers and others responsible for the location of our principal highways should avail themselves of the experience and the methods which have been developed over a period of many years in the location of railways.

Other phases of the subject discussed are mileage, volume of traffic, grades, the character of the traffic, alignment, railway crossings, alignment in passing through towns or cities and safety of operation.

The location itself is the one permanent feature of the road and all due allowance should be made for future development, such as the necessary widening of the roadway, strengthening of bridges and other structural features, reduction of grades and lengthening of tangents.

The proper locating of highways like many other engineering projects, particularly in our Southern States, is very apt to be decided by political considerations rather than by engineering and economic principles. This is just another illustration of the advisability of having engineers in control of the policies to be adopted as well as in charge of the technical details of the problem.

The Smoker. If noise is a fair criterion by which to measure one's enjoyment of a festive occasion, then everyone must have had a glorious time at Kolb's on the evening of January 10th. The keynote (not musical) of the evening was noise. Everybody made some kind of a noise. So great and so continuous was the din that the quiet and sober gentleman who was chosen to act as toastmaster could not make himself heard in order to

introduce the speakers. The meeting was thus deprived of the pleasure of hearing some of the carefully prepared impromptu speeches which some of the participants doubtless had up their sleeves. The toastmaster had also prepared some very witty remarks with which to introduce the speakers, and these too were wasted.

The Society had the pleasure of entertaining as its guests Col. C. McD. Townsend, U. S. District Engineer; Commandant H. A. McClure, U. S. Naval Station; Col. Jas. H. Frier, Commanding Officer, 87th Division, U. S. Army, and Col. H. C. Boyden, Official Lecturer of the Portland Cement Association.

A jazz band, engaged by the committee as a part of the evening's entertainment, succeeded in proving to the satisfaction of its leader as well as to all others that it was no slouch itself when it was a question of making a noise. A very charming feature of the entertainment was contributed by Miss Marian Draper and her dancing partner, Miss Hazel Verges, who presented two attractive dance numbers, gracefully executed and artistically costumed.

According to Mr. Muth, the attendance at this smoker was the largest in a number of years, there being 141 members and guests present.

For the first time in many years there was absent from the smoker one who has always been its leading spirit and the chief promoter of its fun and jollity, "Ole K." He did not forget us, however, and sent in the following telegram from Chicago, where he was detained on business:

Louisiana Engineering Society,
Care of Kolbs' Restaurant,
New Orleans, La.

Sorry I cannot be with you tonight, boys. First time in many years. Feeling it keenly. Have a good time with plenty of pep. Love to all.

OLE K.

Another whose smiling countenance and gay spirit was missed at the entertainment was Charles M. Kerr. He also sent us a message from Oklahoma City:

Am marooned in this burg and can be with you only in spirit. Hope that this will not be the only brand avail-

able, however, and that you will "hit it up on all six." Give my regards to the tout ensemble. Keep out of jail if possible.

CHARLES KERK.

The Olsen Membership Prize. Fifty-three new members were added to our lists during the past year, twenty-five of whose applications were obtained through the activities of Mr. William Bres Gregory. Mr. Gregory was therefore awarded the prize of \$50.00 contributed by Mr. Ole K. Olsen to give added zest to the campaign for membership.

Making allowances for resignations and deaths, the net increase in membership was thirty. The average net increase for the past ten years has been twenty-one.

The total membership of the Society is now 378, of which number 207 are residents of New Orleans.

A Copy of the Humphreys and Abbot Report for the Society's Library. Col. A. M. Shaw has made a number of efforts to secure a copy of this valuable report for our library. He finally enlisted the support of Congressman James O'Connor, who took the matter up with Major General Taylor, Chief of Engineers of the Army. General Taylor secured a copy of the report and transmitted it to Mr. O'Connor. In his letter of transmittal General Taylor makes the following statement, in part:

"In reply, I would say that this book, which, for a great many years, has been a standard work on hydraulics, has become very scarce, but in view of the value of the book and the interest which the Engineers Society of the State of Louisiana has in the Mississippi River problem, I am forwarding to you one of the few copies which we have in order that this book may be made available to the Engineers of Louisiana."

It may be of interest to note that the full title of this book is:

"Report upon The Physics and Hydraulics of the Mississippi River; upon the Protection of the Alluvial Region against Overflow; and upon the Deepening of the Mouths; based upon Surveys and Investigations made under the Acts of Congress directing the Topographical and Hydrographical Survey of the

Delta of the Mississippi River, with such Investigations as might lead to determine the most practicable plan for securing it from inundation, and the best mode of deepening the Channels at the Mouths of the River."

Submitted to the Bureau of Topographical Engineers, War Department, 1861.

Prepared by

Captain A. A. Humphreys

and

Lieut. H. L. Abbot

Corps of Topographical Engineers, United State Army.

"I approve much more your method of philosophising, which proceeds upon actual observation, makes a collection of facts, and concludes no further than these facts will warrant."—Dr. Franklin to Abbé Souliave.

The thanks of the Louisiana Engineering Society are certainly due to General Taylor for the donation of this volume; to the Hon. James O'Connor for his kindly offices, and to Col. Shaw for his finally successful efforts to secure the book.

Owing to its great value the Report will be left in charge of the librarian, but may be had for reference upon application to her.

The "Plain Business Man" and the Engineer. The caption to this paragraph has been selected after reading an item which appeared in the December, 1924, issue of "The Nation's Business," the official organ of the National Board of Commerce. Our attention has been called to the article by Mr. H. M. Gould, Assistant General Manager of the Department of Street Railways, City of Detroit. This is the article:

I sat one evening listening to two fairly successful engineers, one of whom is now a business executive, discussing the present state of the engineering profession. They agreed that a competent engineer is likely to be found working for a plain business man who is not an engineer.

"I can hire a fairly good engineer," declared one, "for less money than I'm obliged to pay a first-class stenographer. Of course such an engineer won't have much imagination or initiative, but he will do what he's told accurately and acceptably."

The other engineer remarked that he is sending his two boys to a college where they will get an old-fashioned cultural course—mostly Latin and Greek—largely for the purpose of diverting them from a line of study which might lead to a degree in engineering.

Both declared that an engineer will not ordinarily go far because he is too busy doing one routine thing which can easily be done by another younger engineer whenever he gets tired of it.

I was astonished that engineering could be held in such low esteem by those within the profession. Is the trouble that there are too many engineers? Certainly it isn't that they are lacking in fundamental intelligence. Army tests applied to officers during the World War showed that engineers were not only at the top in the intelligence scale, but 60 per cent ahead of medical officers at the bottom of the scale. I wish other business men and engineers would write and tell me their impressions of opportunities or lack of opportunities in engineering work at the present time.

This country is pre-eminently the home of big business and the business man, whether he be just plain or whether he be complex, is the standard by which we measure success; and the unit in terms of which we measure success is the dollar.

By this token the business man will always be more of a success than the engineer for the reason that the end and aim of his life is to make money. This is true whether he is running his own business or whether he is an executive or manager for a corporation.

The engineer is a professional man and the nature of his work is such that it is rather the usual thing for him to work on a salary basis.

There are engineers and engineers! In the exceedingly careless way which prevails in this country of bestowing professional titles upon men, the profession of engineering is the worst sufferer, unless it be that of the college professor.

Confining our attention to those men who through education and experience are really entitled to call themselves engineers, is the situation with them so different from that in other professions, or even from that in business?

There are poor engineers, good engineers and geniuses. Are there not poor business men, good business men and big busi-

ness men? Are not the routine workers just as much a part of the system as the men at the top?

It would seem, therefore, that the first of the "two fairly successful engineers" quoted above has fallen into the bad habit, not at all unusual with business men, of employing for the engineering features of his projects the cheapest labor he can find. Your business man will often pass the really competent engineer by in favor of one less competent because he thinks he sees an opportunity thereby of increasing his profits on the deal. Big business, so called, has many sins of commission to its discredit in this respect.

Our second "fairly successful engineer," who is sending his two boys to a college where they will get an old-fashioned cultural course—mostly Latin and Greek—is probably doing a wiser thing than even he himself appreciates. If his boys develop thereby imagination and initiative, a modicum of Latin and Greek will not keep them from being engineers if they feel the call to that line of endeavor. In the estimation of many of us, it may even make them better engineers. Perhaps if their father had had more Latin and Greek in his youth, it might have stimulated his imagination to an appreciation of the real values in his own profession, which he now appears to hold in such low esteem.

Many of our most distinguished engineers have had the advantage of just this type of education.

Doubtless there are many engineers who occupy positions in which they are engaged largely in routine work. Is this not equally as true in the case of the business man? Thousands upon thousands of them are engaged in routine work of a particularly onerous and tiresome character. The engineer has opportunities to go as far as his ambition and his capabilities will carry him. Even the business man cannot do more than that.

There may not be as many dollars at the top of the hill for the engineer, but he has other compensations and satisfactions which come from the consciousness of service to others, and from the fact that his training and his experience enable him to contribute to the welfare and progress of his community

through the more efficient utilization of its natural resources. He is a builder and, as has been well said, "the act of building is its own best reward."

There are *not* too many enigneers. Reports from students of the future economic development of this country indicate, on the contrary, that in a few years to come there will not be enough engineers. And this in spite of the seemingly large numbers being turned out from our schools of engineering each year.

It is ridiculous to feel that the profession of engineering is in any such pitiful condition as would seem to be indicated by the article in question. Engineers of the right sort hold their profession in high esteem. Since the World War there has been a considerable amount of questioning and of adjustment in the profession of engineering, just as there has been in all lines of human endeavor.

And the engineer is slowly but surely coming to the point where he will take a larger share of the financial returns from enterprises and projects to the success of which his work is the largest contributing factor. He is working out his own salvation in his own way.

He can view with pride the achievements of his profession and its contributions to the progress and development of civilization in the past; he can have the satisfaction that comes with the realization that he, by his own efforts, is contributing to its advancement in the present; and when he wants to dream, he can let his imagination (a quality which he is far from lacking) lead him into the illimitable possibilities of the future.

New Members. Through the activities of the membership campaign, Mr. Gregory being the greatest contributor thereto, the Society has recently elected a very large number of new members. We extend to them all a hearty welcome and trust that they may all take an active part in its affairs.

The man who gets the most out of the Louisiana Engineering Society is the man who puts the most into it.

Resident Members.

Walter J. Barnes, with New Orleans Public Service, Inc.

Harry D. Bowles, member firm of Copp & Bowles-Co.

Frank P. Broussard, with Lukens Steel Company.

Roger E. Chestnut, with Board of Commissioners, Port of New Orleans.

Charles Davis, with Board of Commissioners, Port of New Orleans.

George J. DeGarmo, student of Engineering and Instructor, Tulane University.

Archibald Lee Dunlap, Assistant Professor of Mechanical Engineering, Tulane University.

Francis Willis Gavin, District Manager, Truscon Steel Company.

Lafayette F. Griffith, Superintendent Line Department, New Orleans Public Service, Inc.

Edward C. Hyatt, with City Engineer.

Charles Johnson, with New Orleans Sewerage and Water Board.

George R. W. Lewis, with New Orleans Public Service, Inc.

Thomas Smith, Jr., with New Orleans Public Service, Inc.

Reinhard A. Steinmayer, Assistant Professor of Geology, Tulane University.

Wayne Dudley Stewart, Portland Cement Association.

Charles McD. Townsend, Corps of Engineers, U. S. A.

Bryson Vallas, Assistant City Engineer.

Resident Associate Member.

Edward R. Greenlaw, President, Greenlaw Truck and Tractor Co.

Junior Members.

John S. Burke, with New Orleans Public Service, Inc.

John Walter Emrich, with New Orleans Public Service, Inc.

Edwin Frank.

Gilbert Tesla Gray, with New Orleans Public Service, Inc.

Robert James Kuhn, with New Orleans Public Service, Inc.

Charles Rene Maduell, with Board of Commissioners, Port of New Orleans.

Student Members.

Salvador di Benedetto,
Percy L. Bernstein,
Lester B. Clark,
James Murray Cracroft,
Edwin E. Elam
Charles Julius Fritchie,
Vic F. Hartel,
Edmund Favre Hughes,
E. Lawes Kleinpeter,

Francis A. Landrieu,
Leo Levy Lowentritt,
J. F. Nunenmacher,
Philip Phillips,
Everett G. Roessle,
Lewis Monroe Shelton,
Joseph F. Thomson,
John Mort Walker,
Albert G. Wyler.

All Senior Engineering students in Tulane University.

PAPERS AND DISCUSSIONS

A DISCUSSION ON HIGHWAY LOCATION.

By J. C. CARPENTER,

Assistant District Engineer, U. S. Bureau of Public Roads.

Read Before the Society, December 8, 1924.

The engineers of this Society are to be complimented on their interest in the important and timely subject of highway location. It is a theme that deserves profound study and one that this professional organization may profitably discuss and apply in the interest of the public.

It is the common impression that modern highway location follows railway practice. We would be fortunate if this were true. The modern highway location is too often influenced by local opinion and property division lines. Imagine a crack railway locater following a section line to avoid property damage, or running a trunk line down the main street of a village so that the patrons might stop at the Main Street drug store for a cold drink.

As more highways are built we may expect an approach to the ideals that were handed down to us by a century of railway builders. One billion dollars invested annually will soon bring to light the glaring errors in highway location and convince the public that they should have the best location possible for this enormous investment.

Few of us will be called upon to participate in the laying out of a State system of highways. The federal aid laws have practically solved that problem. But the determination of locations between control points on the state system will be important factors in the development of a system of well located lines of travel.

The Federal Aid System as now laid out is to be threaded through designated control points which have been established by agreement between the states and the federal government. It is conceded that the control points thus established have been well selected and the system of roads which is contemplated will adequately serve local through traffic.

The present problem is to link up these control points with locations founded on the best practice in highway location.

There is a large mileage of local roads outside of the state systems, and the same principles of location apply to it.

I will indulge in a few generalities before getting down to business. Mileage is the first and foremost factor of service. Build to get somewhere, and open up lines of traffic. Once the way is opened between two centers of trade, we will be obliged to maintain communication. But in opening up these lines of traffic the location must be so planned that alignment and ruling grades will be suitable for all reasonable requirements of the future.

The volume of local traffic will undoubtedly control the design and to a certain extent the location. Heavier expenditures will be required near large centers of population, and gradually diminish as the volume of traffic falls off. Volume of traffic will control the design of safeguards. Heavy traffic roads must be made foolproof, whereas warning signs may be made to serve on light traffic roads. A traffic census is an invaluable asset in the design of roads and every state highway department should have a well planned system of recording traffic.

One of the primary considerations in location practice is the ruling grade. Reasonably low grades are desirable, and the question always resolves itself into what is reasonable for a specific case. Horse-drawn traffic is not the controlling factor that it was in the early days of road building. At one time 12 per cent grades were considered the maximum limit on account of safety in descent. Now we consider a 4 per cent grade the safe grade for a car descending with motor declutched. For Louisiana topography it is conceded that a 5 per cent maximum grade is reasonable. There is no economy in reducing a grade below 3 per cent unless the expenditure involved is very light. Trucks usually change from high to low gear at 4 per cent and passenger cars at 6 per cent. Reduction of rise and fall on grades of less than 3 per cent has little value so far as operating costs are concerned.

Cost maintenance of shoulders and ditches as well as gravel surface increases rapidly on grades over 5 per cent. This factor alone would limit the grades to this maximum in this State. Where light soils are encountered lower grades may prove eco-

nomical even though the first cost is high. Intermediate grades require careful study to determine the most economical layout.

Reduction in distance and total rise and fall is desirable on heavy traffic roads. This applies to all of the federal system. It is hard to place a money value on this feature. Using ten cents per mile as the expense of operation the capitalized value of a saving of one foot in distance of 100 vehicles per day results in \$14 per annum. A saving of one mile would mean \$14,000 on the same basis. This does not consider drivers' time and other important factors.

The nature of the traffic has some bearing on the question. At a hearing on location in an eastern State one route was about eight miles longer than the other, but passed some beautiful scenery and points of historic interest. The advocates of the longer route spent the larger part of their allotted time in praising the scenery on their route. When the opposition started their argument then introduced a prosperous farmer who lived beyond the junction of the two routes. He said, "My trucks average two round trips to town every day of the year. I have five colored drivers, who are not particularly interested in scenery or history." The shorter route was adopted.

Distance should never be increased between fixed points in order to reduce grades below a reasonable maximum. Short grades above the maximum may be used in connection with long lower maximums to improve alignment, provided the grades can be later reduced when more funds are available.

The most important feature of location is alignment. Safety to traffic governs alignment cost. So far as detailed alignment is concerned, cost of traffic operation has no practical effect. It is far better to use a steeper grade with good alignment than a poor alignment on a flatter grade.

The first requirement is a good map of the territory to be covered. If topographic maps are not available, such as U. S. Geological Survey sheets, or soil survey maps, a quick traverse with stadia methods will be well worth while. On this map locate the control points and draw a straight line between them. Obviously the most direct location is the one which comes closest to this ideal line. Natural barriers such as mountain ranges, rivers, and swamps, will pull the line to right or left. In ordi-

nary easy rolling topography the principle of straight line location is generally sound. This may appear to be academic, but the policy outlined should be followed in all preliminary investigations.

Having determined upon a reasonable routing the following principles apply to detailed location. Long tangent locations are desirable. Necessary curvature should be as light as possible. The 500 feet radius curves is about the sharpest that should be tolerated, except in mountainous country. A six degree curve (955' radius) is considered a reasonable maximum for flat topography. Such curves make reasonable speeds safe and speed up traffic. Grades on sharp curves should be compensated. This feature should not be important in Louisiana for there is little reason for sharp curvature. Reverse curves should have an intervening tangent and curves in the same direction should be flattened and combined or else have a long intervening tangent. Bridges, underpasses, railway crossings, and road intersections should have at least 100 feet of tangent approach.

Aside from these mechanical features the location should be fitted to natural conditions. Ridge locations are preferable in this State, unless the distance is materially increased. A roundabout location may be justified if swampy land intervenes on the direct line. The importance of through traffic will usually decide this issue. A southern exposure is sometimes of great value and worth some additional length.

Where railways parallel the main highways a desirable location is away from the railway. Adjacent to population centers, the location should be far enough away from the railway to allow development on both sides of the highway. Outside of towns a desirable spacing is five miles.

All railway grade crossings should be eliminated if possible. The desirable method of elimination is by relocation of the highway where two crossings of the same railroad are in existence. If a town is to be served, a spur line with a grade crossing for local traffic is better than two grade crossing for through traffic.

Where it becomes necessary to cross the railway, separations are desirable. Good designs for these structures are es-

sential. A badly located underpass or overhead crossing is almost as dangerous as a well protected grade crossing. If topographic features will not allow a grade separation, the crossing should be protected by warning signs, automatic or manual signals, gates, or watchmen. The crossing should be at a 90 degree angle, and on a level grade on the highway with good sight distance along the track.

One of the most important features of highway location is the alignment through towns and cities. Where the main street of a village lies in the direct line of location, is amply wide and straight, there is little excuse for detouring. But where the main street is narrow, requires several angles to swing onto it and will be badly congested with the highway traffic it is poor engineering and short-sighted judgment to route a through highway along it. Local funds usually control these locations. Arguments against such locations are: Traffic increases, and with congested parking, accidents occur. Police control in small towns is inadequate to cope with the situation. As traffic grows, business people learn that the through highway in front of their door is a menace rather than a blessing. The only argument for the location is that the local people want their main street paved, and local tradesmen have the false idea that their business will prosper if the highway is close to them.

A side street location allows wider right of way on account of lower property values, encourages the segregation of business peculiar to a highway, such as garages and filling station, at a point removed from the business center, and allows through traffic to pass on a location where there is little parking and consequent danger.

The Third International Road Congress in 1913 concluded that, "As a general principle it is better that new main roads be constructed to pass outside rather than through towns, and where an existing main road passing through a town is unsatisfactory for through traffic, it is often better, in preference to widening an existing narrow main road through the center of a town, that new roads should be planned according to the principles of the science of town planning."

This policy was adopted in France many years ago. The Dupont Highway through eastern Delaware was laid out on

this principle and the towns along it have grown and prospered without having the main street on a through highway. Maryland has recently built detours around some of the small towns to avoid congestion and accidents. Had the original location been away from the main street a better alignment could have been obtained at much less expense and trouble.

Safety of operation of motor vehicles requires that the vertical and horizontal curves be designed for 500 foot sight distance. A car traveling thirty miles an hour covers forty-four feet per second. Assuming two seconds to apply the brake and 5.5 seconds to stop the car, the distance traveled is $121+88$ or 209 feet. This contemplates good surfacing and prompt attention, and leaves only 82 feet as a factor of safety on a 500 foot sight distance. This is an allowance of one second for each car. With 200 feet vertical curves for breaks of grade of 2 per cent or less, and 50 feet additional length for each additional 2 per cent difference of grade, this sight distance can be obtained on vertical curves.

In planning highway developments it should always be borne in mind that the location is the one permanent feature of the road, if properly made. Grades can be changed as funds become available, and structures may be removed and strengthened to carry heavier traffic. But once a good location is adopted, property develops along it and is almost impossible to change the location. Wide right of ways adjacent to cities are essential to prevent restriction of future development. Alignment should be so planned as to direct traffic to the proper centers of large cities, and to by-pass through traffic.

Where alignment is correct, grades reasonable, and structures fairly permanent, the cost of the related construction may be spread over a long time of payment for these on the permanent features.

In planning any highway liberal allowance must be made for the development of future traffic, each individual location must be considered as an important location on a larger transportation system, and the public must be served satisfactorily.

Discussion

THE CHAIRMAN: We have heard the very interesting address by Mr. Carpenter on the subject of highway locatoin, and I know that Mr. Carpenter will be glad to answer any questions which may occur to our members present.

COL. SHAW: The speaker has touched on the similarity of highway location problems and those of railway location. This was particularly interesting to me for the reason that I have had a feeling that in the past highway engineers have not made as full use as they might of the work that has been done by railway location engineers. I was particularly interested in the remarks on the use of compound curves. Everyone who has had anything to do with railway maintenance knows that a compound curve in the track is an abomination and is to be avoided if possible. In my own experience, I do not recall ever having located but one compound curve, and this was in an especially difficult crossing of the Sierra Madre mountains. If such curves usually can be avoided in railway location in the mountains, it should be practicable to avoid them in highway location unless the governing conditions are exceptionally severe.

I would like to ask the speaker if he does not find that in projecting a location through a fairly rough country it pays to take and plat topography quite in detail and to project a fairly accurate "paper location" of the line before attempting to stake it out on the ground? In railway work, I have always found that it is easier (and cheaper) to run trial lines on paper than on the ground; provided, of course, that the topography has been taken with due regard to both detail and accuracy.

MR. CARPENTER: That is true. I think one of the first things is to map the county project a true line and see if you can get through on it, or work out each way from it.

In rugged sections it is essential to have contours. We desire contours on curves of more than six degrees, if the topography is rough or there is anything that would warrant sharp curves. As a general rule, the State submits the topography to justify sharp curves. That is not exactly the point you have in mind. What you mean is the actual location of the road. You can save a whole

lot of time by making a contour map in new locations through rugged country where you do not have the property lines to contend with.

A great deal of new location was done through the Blue Ridge Mountains of Virginia and North Carolina, and almost all done by railroad locaters, who located a preliminary line, developed a contour map and projected paper location.

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 FLOYD HAMILTON, (1919), Lake Charles, La.
 JACK HARRIS, (1924), Superintendent of Construction, Harrisonburg, La.
 JOHN LOVEJOY HENNING, (1919), 525 Kirby St., Lake Charles, La.
 FREDERICK McH. HILL, (1919), Monroe, La.
 SAMUEL A. HONAKER, (1922), Civil Engineer, 615 Jordon St., Shreveport, La.
 GEORGE P. HOPKINS, (1922), Contractor, Gulfport, Miss.
 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.
- XAVIER KRAMER, (1911), Consulting Engineer, McComb, Miss.
- JULES A. LORIO, (1921), Gelsmar, 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, (1923), Forest Engineer, 2219 Broadway, Beaumont, Texas.
- HENRY A. MENTZ, (1915), Consulting Engineer, Magnolia, Miss.
- JULIAN DUNBAR MONETTE, (1921), Resident Engineer, State Highway Department, Calhoun City, 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, 476 Clinton Ave., Brooklyn, N. Y.
- WILLIAM H. RHODES, (1922), Maintenance Engineer, Oklahoma Highway Commission, Oklahoma City, Okla.
- W. B. ROBERT, State Highway Engineer, Baton Rouge, La.
- FRANK L. ROE, JR., (1920), Omega, Madison Parish, La.
- J. F. ROSS, (1922), County Engineer, Crenshaw County, Box 175, Luverne, Ala.
- FRED E. SMITH, C. E., (1916), care Texas Construction Co., Box 197, Houston, Texas.
- JOHN A. SALMEN, (1911), Vice-President, Salmen Brick & Lumber Co., Ltd., Sildell, 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, 1023 Leontine St., New Orleans.
- GEORGE SELMAN, (1908), Surveying and Engineering, Box 596, Monroe, La.
- HOBART D. SHAW, (1917), City Engineer and General Practice, Gulfport, Miss.
- ELMER E. SHUTTS, (1918), Lake Charles, La.
- JOHN A. SILSBEE, (1915), Consulting Petroleum Engineer, Okmulgee, Okla.
- WILLIAM LUKE SIZEMORE, (1923), with J. W. Billingsley, Jonesville, La.
- JULIUS SLOVENKO, (1924), 1834 S. Millard Ave., Chicago, Ill.
- T. BAKER SMITH, (1919), Houma, La.
- JOHN Y. SNYDER, (1918), Engineer, 1210-1211 Merchants 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.

- ROBERT WOLCOTT, (1923), Manager, Lukens Steel Co., 626 S. Peters St., New Orleans.
 JOHN K. WOOLF, (1922), Manager, Texas Office, Doullut & Williams Co., Inc., 1106 Second National Bank Bldg., Houston, Texas.
 CHARLES J. WYLER, (1919), Principal Assistant Engineer, A. M. Lockett & Co., Ltd., 530 Jackson Ave., New Orleans.
 LOUIS J. WYLER, (1922), Superintendent, Lukens Steel Co., Box 320, New Orleans.
 SAMUEL YOUNG, (1911), Chief Engineer, Port Commission, No. 1 Canal St., New Orleans.
 HENRY L. ZANDER, (1898), Civil Engineer, 821 N. Rampart St., New Orleans.
 ANTHONY M. ZIBILICH, (1922), Assistant Superintendent, U. S. Lighthouse Service, 969 Willson Drive, New Orleans.

NON-RESIDENT MEMBERS.

- JAMES R. ADAMS, (1911), Lake Providence, La.
 FELIX L. ALCUS, (1922), with L. T. Alcus & Co., Ltd., Pearl River, La.
 LEWIS SCHERCK ALCUS, (1922), 7445 Maple St., New Orleans.
 EDWARD A. ARPIN, (1918), Florence, 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, Grange Lane, Jamaica, B. W. I.
 MERRILL BERNARD, (1917), Civil Engineer, Crowley, La.
 JOS. M. BING, (1917), Consulting Engineer, 53 Hamilton Terrace, New York City.
 A. L. BLACK, (C. M.), with Ford, Bacon and Davis, Inc., 58 Sutter St., San Francisco, Calif.
 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.
 JOHN CALLAN, (1918), care W. F. Biggs Engineering Co., Volunteer Bldg., Chattanooga, Tenn.
 H. D. CAMERON, (1914), Superintendent, Tulsa Light & Power Co., Tulsa, Okla.
 THEO. F. CHENET, (1922), Resident Engineer, Arkansas Highway Commission, Batesville, Ark.
 L. C. DATZ, (1906), Chief Engineer, Memphis Power & Light Co., 16 S. Second St., Memphis, Tenn.
 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.
 A. D'HEUR, (C. M.), Vice-President, Pacific Oil Co., 79 New Montgomery St., Room 543, San Francisco, Calif.
 WILLIAM F. EBLEN, (1916), 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., 350 Woodruff Co., 350 Woodruff Ave., Toledo, Ohio.
 FLOYD HAMILTON, (1919), Lake Charles, La.
 JACK HARRIS, (1924), Superintendent of Construction, Harrisonburg, La.
 JOHN LOVEJOY HENNING, (1919), 525 Kirby St., Lake Charles, La.
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- 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, Woodward, Wight & Co., 3215 Palmyra St., New Orleans.
- RAYMOND P. BASSICH, (1923), Manager, N. O. Blue Print & Supply Co., Inc., 824 Union St., New Orleans.
- R. H. BAUMBACH, (1911), Manager, Eugene Dietzgen Co., 316 Camp St., New Orleans.
- JOSEPH BRENNAN, (1920), General Superintendent, 400* Caruth Court, 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.
- GEORGE B. GIBSON, (1921), 2103 Painter St., New Orleans.
- GEORGE J. GLOVER, (1916), General Contractor, 1032-1035 Whitney Bldg., New Orleans.
- JULES GODCHAUX, (1899), 221 Golchaux 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.
- A. A. KEITHER, (1919), 234 S. Scott St., New Orleans.
- JOHN McINERNEY, (1920), Construction Superintendent, Detroit Free Press, Detroit, Mich.
- EDWARD T. MALLOY, (1920), 1211 N. Hagan Ave., New Orleans.
- EDWIN L. POWELL, (1914), President, New Orleans Coffee Co., 1531 Exposition Blvd., New Orleans.
- JOHN J. STEADHAM, (1912), Supervisor, Bridges and Buildings, N. O. & N. E. R. R. and N. O. T. Co., Room 308 Ross Bldg., Hattiesburg, Miss.
- F. W. STEVENS, (1909), Manager, New Orleans District Sales Office, Allis-Chalmers Mfg. Co., 719 Malson Blanche Bldg., New Orleans.
- JAMES W. SPENCE, (1921), President, Cresartile Roofing Co., Inc., Lopez and Julia Sts., New Orleans.
- HENRY H. WATERS, (1922), 715 Hibernia Bldg., New Orleans.

NON-RESIDENT ASSOCIATE MEMBERS.

- CECIL A. EBY, (1922), Box 1085, Shreveport, La.
- LOUIS G. FLOWER, (1922), care of Layne & Bowler Co., 1510 McGowan Ave., Houston, Texas.

RESIDENT JUNIOR MEMBERS.

- HENRY HESTER BATE, (1921), Civil Engineer, Huasteca Pet. Corp., Tampico, Tampas, Mexico.
- J. J. BULLUING, (1915), Market Street Power House, New Orleans.
- JOHN S. BURKE, (1925), Distribution Engineering Department, New Orleans Public Service, Inc., 8219 Neron St., New Orleans.
- F. FOWLER CASE, (1922), Draftsman with Sewerage and Water Board, 823 Arabella St., New Orleans.
- DONALD C. DUPLANTIER, (1922), Assistant Engineer, New Orleans Public Service, Inc., 1326 Lowerline St., New Orleans.
- JOHN WALTER EMRICH, (1925), Civil Engineer with New Orleans Public Service, Inc., 250 City Park Ave., New Orleans.
- EDWIN FRANK, (1925), 2375 Laurel St., New Orleans.
- JAMES L. FULMER, (1923), with Cumberland Telephone and Telegraph Co., 2238 General Pershing St., New Orleans.
- LOUIS KAUFMAN GOOD, (1923), Material Clerk and Labor Foreman, Box 1109, Monroe, La.
- HORATIO L. GILBERT, (1917), Surveyor, 602 Queen and Crescent Bldg., New Orleans.
- GILBERT TESLA GRAY, (1925), with New Orleans Public Service, Inc., 1321 Nashville Ave., New Orleans.

WALTER HOLLOWAY, (1923), Distribution Engineering Department, New Orleans Public Service, Inc., 911 Common St., 34 Washington Ave., Ocean Springs, Miss.

MAURICE F. HUNT, (1919), 3629 Chestnut St., New Orleans.

S. DOUGLAS JACKSON, (1916), 326 Ward Bldg., Shreveport, La.

JOSEPH W. JOACHIM, (1919), President and Manager of Home Ice Co., 5117 Prytanla St., New Orleans.

WILHELM EMIL Koch, (1913), Civil Engineer, 2627 Coliseum St., New Orleans.

ROBERT JAMES KUHN, (1925), Electrolysis Engineer, New Orleans Public Service, Inc., 529 Washington Ave., New Orleans.

CHARLES RENE MADUELL, (1925), Engineering Department, Board of Commissioners, Port of New Orleans, 5650 Ada Place, Lawview, New Orleans.

ALEX H. McCOMISKEY, JR., (1919), 2837 Carondelet St., New Orleans.

GORDON J. McLEAN, (1924), Assistant Engineer, New Orleans Public Service, Inc., 1544 Henry Clay Ave., New Orleans.

EDWARD M. NABERSCHNIG, JR., (1923), Works Superintendent, Southern Cotton Oil Co., Gretna, La., 3206 St. Peters St., New Orleans.

ROBERT A. PIERPONT, (1915), Engineer, The Celotex Co., 1036 Napoleon Ave., New Orleans.

CHARLES L. RITTENBERG, (1923), Draftsman, with Dock Board, 2634 Marengo St., New Orleans.

CLIFFORD HOEY STEM, (1914), Sales Engineer, 7933 Willow St., New Orleans.

S. A. THEARD, (1920), Assistant Engineer, Louisiana State Highway Commission, Baton Rouge, La.

NON-RESIDENT JUNIOR MEMBERS.

G. O. ALLAIN, JR., (1916), Division Plant Engineer, Cumberland Telephone & Telegraph Co., Nashville, Tenn.

G. C. BADGER, (1913), Superintendent of Engineering and Construction, Grinnell Co., of the Pacific, 453 Mission St., San Francisco, Calif.

JOHN L. EBAUGH, (1922), Drexel Institute, Philadelphia, Pa.

E. C. GRAVELY, (1918), Design Engineer, 602 Sewerage and Water Board Bldg., New Orleans.

C. A. IVES, JR., (1922), Louisiana Highway Commission, 256 St. Philip St., Baton Rouge, La.

JACOB F. MULLER, JR., (1912), Plant Superintendent, Muller Furniture Manufacturing Co., Ltd., 3731 Canal St., New Orleans.

HERBERT P. NATHAN, (1913), Mechanical Engineer, Southwestern Engineering Corporation, 632 Lafayette Ave., Culver City, Calif.

JAMES KILBOURNE PETRIE, (1924), Natchitoches, La.

J. B. REYMOND, (1922), 709 Main St., Baton Rouge, La.

CARL SCHNEIDER, (1916), Superintendent, Municipal Repair Plant, 7711 Plum St., New Orleans.

LUCIEN J. TROXLER, JR., (1915), Assistant Radio Engineer, Camp Alfred Vall, 55 Bergen Place, Red Bank, N. J.

STUDENT MEMBERS.

MICHAEL CHARLES ABRAHM, 816 Cherokee St., New Orleans.

R. L. ATKINSON, 312 Audubon Blvd., New Orleans.

SALVADOR DI BENEDETTO, 4526 St. Claude Ave., New Orleans.

PERCY L. BERNSTEIN, Tulane University, New Orleans.

LESTER B. CLARK, 6318 S. Robertson St., New Orleans.

JAMES MURRAY CRACROFT, 1539 Exposition Blvd., New Orleans.

WALTER COOKE, 2728 Louisiana Ave., New Orleans.

EDWIN E. ELAM, 1131 Cadiz St., New Orleans.

CHARLES JULIUS FRITCHIE, Slidell, La.

VIC F. HARTEL, 1001 Prytanla St., New Orleans.

E. C. HAWKINS, 7919 Panola St., New Orleans.



W. T. HESS, 7917 Burthe St., New Orleans.
 ARTHUR M. HILL, 1322 Arabella St., New Orleans.
 EDMOND FAYRE HUGHES, 2126 Robert St., New Orleans.
 E. LAWES KLEINPETER, 2210 Nashville Ave., New Orleans.
 FRANCIS A. LANDRIEU, 1113 N. Rampart St., New Orleans.
 LEO LEVY LOWENTRITT, 1620 Audubon St., New Orleans.
 HAROLD E. MEADE, 119 Audubon Blvd., New Orleans.
 ARTHUR J. NAQUIN, JR., 524 Audubon St., New Orleans.
 J. F. NUNENMACHER, 4915 Baccich St., New Orleans.
 PHILIP PHILLIPS, 2428 General Taylor St., New Orleans.
 ASHLEY HURT ROBINSON, 1735 Palmer Ave., New Orleans.
 G. P. ROBBINS, JR., with Allis-Chalmers Co., 1816 Magnolia St., Dallas, Texas.
 EVERETT G. ROESSLE, 1019 Leontine St., New Orleans.
 JOSEPH HENRY SAUCIER, 2616 Ursuline St., New Orleans.
 S. B. SCHWARTZ, Assistant Superintendent, Maginnis Cotton Mills, New Orleans.
 LEWIS MONROE SHELTON, 4915 Baccich St., New Orleans.
 JOSEPH F. THOMSON, 139 S. Genols St., New Orleans.
 JOHN MORT WALKER, JR., 6039 Prytanla 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.....	207
Non-Resident Members.....	79
Associate Members.....	20
Non-Resident Associate Members.....	2
Junior Members.....	25
Non-Resident Junior Members.....	11
Student Members.....	33
Total.....	378

MINUTES OF MEETINGS AND BUSINESS OF THE SOCIETY.

Regular Meeting of the Board of Direction, January 10, 1925.

The meeting was called to order with President Robert in the chair and the following members present:

Messrs. Garsaud, Lanphier, Hamilton, Moses and Muth.

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

The resignations of the following were accepted with regret: Edw. W. Bres, R. O. Comer, A. C. Davis, John L. Ebaugh, Jr., Wm. H. Rhodes.

Letter from the Treasurer was read advising the Board that a Motor Lien Certificate of \$1,000.00 had matured and he requested authority to reinvest this fund. On motion duly seconded it was voted to authorize the Treasurer to reinvest this money and the Secretary was instructed to so advise the Treasurer by letter.

The matter of award of the Ole K. Olsen Prize Fund for the member bringing in the largest number of new memberships was brought up by the Secretary and award of \$50.00 was made to W. B. Gregory, Jr., as he was credited with twenty-five memberships.

The annual reports were read from the Board of Direction, Treasurer, and Secretary, and the Secretary was instructed to read them at the meeting of the Society which followed.

The meeting then adjourned.

F. A. MUTH, Secretary.

Minutes of Annual Meeting of the Society, January 10, 1925.

The annual meeting was called to order about 8:10 P. M. with President Robert in the chair and twenty-four members and guests present. Minutes of the previous meeting were read and approved.

The Secretary read the annual reports of the Board of Direction, Treasurer, and Secretary. On motion, duly seconded, it was voted that these reports be received and that the officers for the year 1924 be thanked for their services.

Announcement was made that the \$50.00 prize of the Ole K. Olsen Prize Fund was awarded by the Board to W. B. Gregory, Jr., as he was credited with twenty-five new members. On motion, duly seconded, it was voted that Mr. Olsen be advised of the award and that he be thanked for the Prize Fund which he had so generously donated.

Ballots for new members and for officers for 1925 were opened. There were 100 formal ballots cast for members and the following were elected:

Resident Members.

Walter J. Barnes,
 Harry B. Bowles,
 Frank P. Broussard,
 Roger E. Chestnut,
 Charles Davis,
 George J. De Garmo, Jr.,
 Archibald Lee Dunlap,

Francis Willis Gavin,
 Lafayette F. Griffith,
 George R. W. Lewis,
 Thomas Smith, Jr.,
 Reinhard A. Steinmayer,
 Wayne Dudley Steward,
 Charles McD. Townsend,

Bryson Vallas.

For Reinstatement, Resident Members.

Edward C. Hyatt,

Charles Johnson.

Resident Associate Member.

Edward R. Greenlaw.

Junior Members.

John S. Burke,
 John Walter Emrich,
 Edwin Frank,

Gilbert Tesla Gray,
 Robert James Kuhn,
 Charles Rene Maduell.

Student Members.

Salvador Di Benedetto,
 Percy L. Bernstein,
 Lester B. Clark,
 James Murray Cracroft,
 Edwin E. Elam,
 Charles Julius Fritchie,
 Vic F. Hartel,
 Edmund Favre Hughes,
 E. Lawes Kleinpeter,

Francis A. Landrieu,
 Leo Levy Lowentritt,
 J. F. Nunenmacher,
 Philip Phillips,
 Everett G. Roessle,
 Lewis Monroe Shelton,
 Joseph F. Thomson,
 John Mort Walker, Jr.,
 Albert G. Wyler.

There were 111 formal ballots cast for officers and the following were elected for the ensuing year:

Mareel Garsaud, President.

Farrar P. Hamilton, Vice-President.

F. A. Muth, Secretary.

Walter B. Moses, Treasurer.

Orlando P. Adams, Director to serve three years.

The meeting then adjourned to the Annual Smoker held at Kolb's Restaurant, which was much enjoyed by all.

F. A. MUTH, Secretary.

Special Meeting of the Board of Direction, January 10, 1925.

A special meeting of the Board of Direction was held after the meeting of the Society. President Robert was in the chair and the following were present: Messrs. Garsaud, Lanphier, Hamilton, Moses, Muth.

Dr. D. S. Elliott was unanimously elected Director to serve the unexpired term of Farrar P. Hamilton, who was advanced to Vice-President.

The meeting then adjourned.

F. A. MUTH, Secretary.

ANNUAL REPORT OF THE BOARD OF DIRECTION.

Year 1924.

New Orleans, La., January 4, 1925.

To the Members of the Louisiana Engineering Society:

Gentlemen: Your Board of Direction begs to report that during 1924 there were held eleven regular and two special meetings or a total of thirteen meetings of the Board for the transaction of the business of this Society.

Our Technical Papers Committee has given us an excellent program of very high grade papers.

Our Library Committee has done very excellent work and a number of books suggested by the members have been added during the year. The Committee has also provided keys to the library, which the membership has been notified can be secured from the Secretary by making a deposit therefor.

The Membership Committee has done good work, and during this year attention was again invited to the Ole K. Olsen Prize Fund of \$150.00. With the permission of the donor, the fund was divided into two parts, that of \$100.00 which was awarded for the year 1923 to Charles M. Kerr and another prize of \$50.00 which was announced would be awarded to the member securing the largest number of new memberships during this year. The award will be made at an early meeting of the Board.

The increase in membership this year has been most gratifying in that a total of fifty-three were elected. Of course, as usual there have been a number of resignations and adjustments, and with two deaths the net increase amounts to thirty members. It may be of interest to note the net increase during the past ten years:

1915.....	36	1920.....	11
1916.....	26	1921.....	11
1917.....	5	1922.....	41
1918.....	11	1923.....	11
1919.....	28	1924.....	30

The Publication Committee has given us six very excellent issues of the Proceedings during 1924. This Journal has a much wider influence than its circulation would lead one to believe. Numerous requests are made from the different parts of the country for copies or re-prints of articles which have been published therein. The maintenance and continuance of the Journal, however, depends largely upon the number of advertisements included in each issue. We are justly proud of this Journal and our Editor, Professor Douglas Anderson, who deserves the highest praise for the high quality and tone of this magazine. It forms a very powerful factor in the interest and enthusiasm of our Society, and every member should do what he can to secure advertisements to main-

tain the high character of the Proceedings. More advertisements are needed to keep the Journal on a firm financial basis. The Committee on Publications Division B has done good work this year, yet we are hopeful great gains will be made next year.

The financial statement shows that the Proceedings reserve fund has decreased \$120.26.

Splendid work has been done by the Special Committee appointed by the President to confer with the representatives of the other Engineering Societies and the Louisiana State Board of Engineering Examiners to investigate and report on further legislation relating to licensing of engineers.

Attention is called to the financial condition of the Society. Our investments are well placed and amount to \$3,700.26. The general reserve fund amounts to \$3,368.11, and the Proceedings reserve fund has a balance of \$1,127.41. The Treasurer's report shows a cash balance on January 1, 1925, of \$769.87.

In conclusion, the Board wishes to thank the various committees and members of the Society for their co-operation and interest in carrying on so successfully the work of the Society.

Respectfully submitted,

JAMES M. ROBERT, President,
MARCEL GARSAUD, Vice-President,
F. A. MUTH, Secretary,
WALTER B. MOSES, Treasurer,
F. P. HAMILTON,
E. S. LANPHIER,
CHARLES M. KERR,
JOHN S. BARELLI,

Board of Direction.

ANNUAL REPORT OF THE SECRETARY.

Year 1924.

New Orleans, La., January 4, 1925.

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 1924.

During the past year the Board of Direction held eleven regular meetings and two special meetings; the Society held ten regular meetings with an average attendance of 48, maximum 74, minimum 28. One of the meetings of the Society was a joint meeting of the Local Section of the American Society of Civil Engineers, and the Society had the honor of having present Mr. C. E. Grunsky, President, and Mr. John H. Dunlap,

Secretary, American Society of Civil Engineers. The Society also had the pleasure of having Mr. L. W. Wallace, Executive Secretary of the American Engineering Council, address the membership.

The membership shows a steady increase from year to year. This year there has been a net increase of thirty members, although there were a total of fifty-three members elected and reinstated.

GRADE	On Roll Jan. 1, 1924	Elected	Reinstated	Transferred to	Transferred from	Dropped	Resigned	Failed to Qualify	Died	On Roll Jan. 1, 1925
Honorary	1	---	---	---	---	---	---	---	---	1
Resident	191	26	2	1	2	3	6	---	2	207
Non-Resident	84	1	---	2	1	3	4	---	---	79
Associate	21	1	---	---	---	---	2	---	---	20
Non-Res. Associate	2	---	---	---	---	---	---	---	---	2
Junior	20	6	---	---	1	---	---	---	---	25
Non-Res. Junior.....	10	1	---	1	---	---	1	---	---	11
Student	19	18	---	---	---	3	1	---	---	33
Non-Res. Student..	---	---	---	---	---	---	---	---	---	---
Total.....	348	53	2	4	4	9	14	---	2	378

It is with great regret that we report the deaths of Major Frank M. Kerr on May 5, 1924, and Mr. Duncan Buie on June 5, 1924, both Resident Members.

The Treasurer's Report is submitted separately and shows a cash balance of \$769.87.

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

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 First Liberty Bonds.....	250.00
1—Motor lien certificate.....	1,000.00
Greater New Orleans Homestead certificate.....	750.00
Savings Account realized from the sale of certificates	1,250.26

Total.....\$3,700.26

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 have been held:

February 11.—Mr. Eugene F. Delery, Design Engineer, Sewerage and Water Board, spoke on the "Comparison of Pump Tests."

March 10.—Colonel A. M. Shaw, Consulting Engineer, spoke on the "American Engineer in the Tropics."

April 14.—Mr. C. E. Grunsky, President, American Society of Civil Engineers, spoke on the "Influence of Engineering on Social and Economical Progress."

May 12.—"Natural Gas Problem as Applied to the City of New Orleans," by Frank T. Payne, Engineer, Louisiana State Conservation Commission.

June 9.—"The A. C. Underground Distribution in New Orleans," by Mr. W. R. Bullard, Engineer with the Phoenix Utility Co.

Mr. L. W. Wallace, Executive Secretary of the American Engineering Council, Washington, D. C., gave an interesting talk on "The Work of the American Engineering Council."

September 8.—"The Story of the Motor Truck" (motion picture film), by Mr. E. R. Greenlaw.

Following the film there was a discussion of proposed change in the licensing law as related to engineers.

October 13.—"Water Purification," by Mr. John L. Porter, Director of Water Purification Stations, Sewerage and Water Board.

November 10.—"Principal So-Called Surface Indicators and Their Relation to the Occurrence of Oil," by R. A. Steinmayer, Assistant Professor of Geology, Tulane University.

December 8.—"A General Discussion of Highway Location," by Mr. J. C. Carpentier, Assistant District Engineer, U. S. Bureau of Public Roads, Fort Worth, Texas.

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

During this year an innovation was instituted in giving luncheons in a nearby restaurant in lieu of the usual collation which has heretofore been served in the corridor of the State Museum. At the restaurant the members have been enabled to fraternize and all reports received have been most favorable for continuing this plan for cultivating the social activities of our Society.

Another feature which has given satisfaction to the membership is the employment at our meeting of a uniformed watchman to watch the automobiles of the members attending the meeting.

The following is quoted from the October, 1924, issue of the Proceedings of our Society relative to the activity shown by this Society in connection with the revision of the Building Code:

"It is characteristic of the spirit of the Louisiana Engineering Society that it always stands ready to lend its co-operation and assistance to any public movement for the good of the city and community. It is not surprising, therefore, to find that the membership of the Society is

well represented upon the committees which have charge of the work of revising the building code of the City of New Orleans. Mr. F. A. Muth, Secretary of the Society, and engineer with the Lighthouse Department of the United States, has been given temporary release from the latter position in order to enable him to serve as secretary and technical expert of the Advisory Committee on Revision of the Code. Col. Marcel Garsaud is Chairman of this Committee, and the following Society members are on the Committee: A. S. Montz, R. G. Malone, Donald Derickson.

Professor Derickson is also Chairman of the Sub-Committee of the Louisiana Engineering Society, which consists of the following members: A. M. Shaw, J. F. Coleman, G. A. Seaver, A. B. Davis, W. T. Hogg, C. G. Cappel, G. P. Rice, John Riess, J. de Tarnowsky, E. F. Delery, J. L. Porter, F. A. Muth. Douglas Anderson is also Chairman of the Electrical Sub-Committee which is handling that particular phase of the revision."

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

Respectfully submitted,

FRANK A. MUTH, Secretary.

FINANCIAL CONDITION OF THE SOCIETY, JANUARY 1, 1925.

Assets:

Cash on Hand.....	\$ 769.87
Membership Accounts Receivable.....	796.00
Advertisers' Accounts Receivable.....	304.16
Investments	3,700.26
Expense of Delegates.....	9.54
Entrance Fees.....	10.00
	\$5,589.83

Liabilities:

Library Fund.....	\$ 553.32
Proceedings Reserve Fund.....	1,127.41
Ole K. Olsen Prize Fund.....	50.00
Building Fund.....	151.65
Accounts Payable.....	335.84
Dues in Advance, 1925.....	3.00
	2,221.72
	\$3,368.11

General Reserve Fund.

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
Total.....	\$3,368.11

General Fund, Year 1924.

Revenues:

Membership Dues.....	\$3,173.75
Smoker Account.....	272.50
Entrance Fees.....	246.00
Deposits for Keys.....	3.50
Cash (A. S. M. E.).....	25.00
1923 Dues Collected.....	11.00
Gain in Investments.....	100.00
	\$3,832.05

Expenses:

Subscription to Proceedings.....	\$ 686.00
Appropriation to Library.....	480.00
Losses on Non-payment of Dues.....	109.25
Secretary Account.....	420.00
Dues of Secretary.....	12.00
Printing and Postage.....	340.61
Refreshments	130.30
General Expense.....	122.82
Exchange	6.05
Smoker Expense.....	460.46
Dues, American Engineering Council.....	270.08
Auditing	50.00
1922 Balances, Closed, December 31, 1924.....	158.05
	3,245.62
	\$ 586.43

Proceedings Reserve Fund.

Balance from 1915.....	\$ 112.20
Balance from 1916.....	566.13
Balance from 1917.....	568.14
Balance from 1918.....	567.52
Balance from 1919.....	41.08
Total Balances.....	\$1,855.07
Deficit for 1920.....	221.98
	\$1,633.09
Balance from 1921.....	26.25
	\$1,659.34
Deficit from 1922.....	\$ 301.02
Deficit from 1923.....	110.65
Deficit from 1924.....	120.26
	531.93
Total Balance on Hand.....	\$1,127.41

Proceedings Fund, Year 1924.**Revenues:**

Advertisements	\$1,002.20
Subscription Members.....	686.00
Proceedings Sales.....	1.85
	\$1,690.05

Expenses:

Salary of Editor and Secretary.....	\$ 360.00
Printing and Mailing.....	1,192.47
Stenographer	73.00
Miscellaneous Expense.....	180.00
Losses on Cancelled Advertisements.....	4.84
	1,819.31
	\$ 120.26

Annual Statement of the Library Fund—January 1, 1925.**Revenues:**

Balance on Hand, January 1, 1924.....	\$ 492.62
Received from General Fund.....	480.00
	\$ 972.62

Expenditures—1924:

January 3—	
American Society, Testing Materials.....	\$ 10.40

February 12—

Eng. Pub. Co.....	2.00
G. Gus Pilie.....	4.00
Miss Carrie Freret.....	15.00
Railway Age.....	6.00

March 11—

G. Gus Pilie.....	1.00
Miss Carrie Freret.....	15.00

April 15—

Miss Carrie Freret.....	15.00
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May 12—

Tulane Press.....	15.00
E. J. Dreull.....	12.20
S. Boardman Pub. Co.....	1.25
G. Gus Pilie.....	4.00

June 10—

Miss Carrie Freret.....	15.00
J. B. Pierre.....	6.00

July 2—

Miss Carrie Freret.....	15.00
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August 11—

Amer. Society for Testing Materials.....	2.25
Miss Carrie Freret.....	15.00

September 8—

McGraw Hill Pub. Co.....	3.00
Globe Wernicke Co.....	4.40
Eugene Dietzgen Co.....	99.95

October 13—

Eugene Dietzgen Co.....	15.05
Miss Carrie Freret.....	15.00

November 10—

Electrical World.....	5.00
Miss Carrie Freret.....	15.00

December 9—

Engineering Pub. Co.....	2.00
Engineering and Contracting.....	4.00
American Society for Testing Materials.....	8.80
American Society of Mechanical Engineers.....	3.00
Miss Carrie Freret.....	15.00
Eugene Dietzgen Co.....	17.50
McGraw Hill Co.....	5.00

December 31—

Miss Carrie Freret.....	15.00
Electrical World.....	5.00

418.80

Balance on Hand, January 1, 1925.....\$ 553.82

Cash Account.

Receipts:

1922 Dues.....	\$ 3.00
1923 Dues.....	422.00
1924 Dues.....	2,464.75
1923 Smoker.....	20.00
1924 Smoker.....	240.00
1925 Dues.....	3.00
Entrance Fees.....	216.00
Luncheon	4.50
Proceedings Advertisers.....	1,038.94
Pin	4.00
Profit and Loss.....	25.00
Deposit on Keys.....	3.50
Delegate Expense.....	130.00
Proceedings Sales.....	1.85
Investment and Interest.....	1,163.80
	\$5,740.34
Add 1923 Balance.....	953.29
	\$6,693.63
Less Checks N. S. F.....	17.50
	\$6,676.13
Less Exchange.....	6.05
	\$6,670.08
Total Disbursements.....	5,900.21
Cash Balance December 31, 1924.....	\$ 769.87

ANNUAL REPORT OF THE TREASURER.

Year 1924.

January 1, 1925.

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 15, 1924, up to and including January 1, 1925.

Received from Secretary—	Deposited in New Orleans Bk. & Tr. Co.	Exchange Charged
Feb. 1, Memo 1 to 10.....	\$1,408.29	\$2.20
March 3, Memo 11 to 13.....	356.43	.80
April 7, Memo 14 to 15.....	312.98	.30

May 1, Memo 16 to 20.....	649.79	.40
June 2, Memo 21 to 23.....	325.98	.40
July 5, Memo 22a to 23a.....	235.21	.20
Aug. 5, Memo 24 to 27.....	350.53	.80
Sept. 3, Memo 28 to 29.....	100.97	.20
Oct. 6, Memo 30 to 31.....	161.93	.25
Nov. 5, Memo 32 to 33.....	257.39	.10
Dec. 1, Memo 34 to 35.....	152.04	.20
Dec. 23, Memo 36 to 37.....	265.00	.20
	\$4,576.54	\$6.05
Less Checkers Returned (N. S. F.).....	17.50	
	\$4,559.04	
Coupons Deposited January 9, 1924.....	135.92	
U. S. Certificate Redemmed January 9, 1924.....	1,000.00	
Coupons Deposited December 5, 1924.....	27.88	
	\$5,722.84	
Less Motor Lien Certificate Purchased.....	929.60	
	\$4,793.24	\$4,793.24
Less Exchange.....		6.05
		\$4,787.19
Balance on Hand as per Treasurer's Report, January 15, 1924.....		953.29
		\$5,740.48

Disbursements from January 3, 1924, to January 1, 1925.

January 3—

No.	Name—	Amount
1	J. S. Barelli.....	\$ 130.40
2	Miss Carrie Freret.....	15.00
3	G. G. Pilie.....	2.00
4	Simmons Boardman Co.....	3.00
5	Concrete Publishing Co.....	3.00
6	Tulane University Press.....	186.16
7	Jos. Levy.....	2.50
8	John Klorer.....	14.25
9	T. J. Corbrey.....	12.50

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No.	Name—	Amount
10	F. A. Muth.....	50.50
11	Miss Edna Doll.....	15.00
12	American Society for Testing Materials.....	10.40
13	R. J. Derbes, Jr.....	50.00
14	New Orleans Bank & Trust Co.....	3.00
15	G. W. Lawes.....	136.20
16	Engineering Publishing Company.....	2.00
17	G. Gus Pilie.....	4.00
18	Federated American Eng. Society.....	67.52
19	Jos. Levy & Bros. Co.....	36.60
20	N. O. Chess, Checkers & Whist Club.....	214.90
21	Tulane University Press.....	167.31
22	Miss Edna Doll.....	15.00
23	F. A. Muth.....	44.32
24	Miss Carrie Freret.....	15.00
25	French Cooking Restaurant.....	9.00

February 12—

26	Railway Age.....	6.00
27	E. H. Coleman.....	15.00
28	T. J. Corbrey.....	5.00
29	G. Gus Pilie.....	1.00
30	Boylan's Detective Agency.....	3.00
31	F. A. Muth.....	44.50
32	Miss Edna Doll.....	15.00
33	Miss Carrie Freret.....	15.00
34	French Cooking Restaurant.....	10.20
35	P. Kaul & Son.....	7.50
36	Chas. M. Kerr.....	100.00
37	Federated American Engineering Society.....	67.52
38	Boylan's Detective Agency.....	3.00
39	Tulane University Press.....	376.36
40	F. A. Muth.....	50.50
41	Miss Carrie Freret.....	15.00
42	Miss Edna Doll.....	15.00
43	French Cooking Restaurant.....	15.75

May 12—

44	Tulane University Press.....	18.50
45	E. J. Drenill.....	12.20
46	New Orleans Stencil Works.....	1.00
47	Farish Art Store.....	.90
48	F. A. Muth.....	45.20
49	Miss Edna Doll.....	15.00
50	Miss Carrie Freret.....	15.00

No.	Name—	Amount
51	Boylan's Detective Agency.....	3.00
52	Simmons Boardman Pub. Co.....	1.25
53	French Cooking Restaurant.....	11.25
54	G. Gus Pillie.....	4.00
June 10—		
55	Earle J. Christenberry.....	15.00
56	Mrs. M. Giglio.....	12.00
57	P. Kaul & Sons.....	10.00
58	Douglas Anderson.....	150.00
59	Boylan's Detective Agency.....	3.00
60	F. A. Muth.....	43.50
61	Miss Edna Doll.....	15.00
62	Miss Carrie Freret.....	15.00
63	French Cooking Restaurant.....	13.75
64	Tulane Press.....	157.55
65	Jacob R. Pierce.....	6.00
66	H. Salzer.....	3.00
67	G. Gus Pillie.....	2.00
July 3—		
68	Tulane University Press.....	25.85
69	T. J. Corbrey.....	17.00
70	Miss Edna Doll.....	15.00
71	F. A. Muth.....	42.00
72	Miss Carrie Freret.....	15.00
August 15—		
73	American Society Testing Materials.....	2.25
74	Miss Edna Doll.....	15.00
75	Miss Carrie Freret.....	15.00
76	F. A. Muth.....	41.00
77	Federated American Engineering Society.....	67.52
78	Tulane University Press.....	176.63
September 9—		
79	Tulane University Press.....	306.05
80	Miss Edna Doll.....	15.00
81	Miss Carrie Freret.....	15.00
82	F. A. Muth.....	43.50
83	McGraw Hill.....	3.00
84	Globe Wernecke.....	4.40
85	Eugene Dietzen Company.....	99.95
86	French Cooking Restaurant.....	11.25
87	Boylan's Detective Agency.....	3.00
October 17—		
88	Eugene Dietzen Company.....	15.05

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No.	Name—	Amount
89	American Engineering Council.....	67.52
90	T. J. Corbrey.....	8.00
91	Tulane University Press.....	8.00
92	F. A. Muth.....	43.50
93	Miss Edna Doll.....	15.00
94	Miss Carrie Freret.....	15.00
95	Boylan's Detective Agency.....	3.00
96	Victor Restaurant.....	26.35
97	Greater New Orleans Homestead Association.....	750.00

November 11—

98	Electrical World.....	5.00
99	T. J. Corbrey.....	7.00
100	Tulane University Press.....	80.50
101	F. A. Muth.....	44.50
102	Miss Edna Doll.....	15.00
103	Miss Carrie Freret.....	15.00
104	Boylan's Detective Agency.....	3.00
105	Victor Restaurant.....	16.40

December 9—

106	Tulane University Press.....	23.75
107	Engineering Publishing Company.....	2.00
108	Engineering Contracting Company.....	4.00
109	American Society for Testing Materials.....	8.80
110	American Society of Mechanical Engineers.....	3.00
111	Wm. T. Frantz & Company.....	4.00
112	F. A. Muth.....	49.40
113	Douglas Anderson.....	150.00
114	Miss Edna Doll.....	15.00
115	Miss Carrie Freret.....	15.00
116	Boylan's Detective Agency.....	3.00
117	T. J. Corbrey.....	5.00
118	Victor Restaurant.....	16.35
119	Eugene Dietzgen Company.....	17.50
120	A. G. Roberts.....	5.00
121	Mrs. N. J. Braud.....	25.00
122	McGraw Hill Publishing Company.....	5.00

Total Disbursements.....\$4,970.61

Recapitulation.

Total Receipts.....	\$5,740.48
Total Disbursements.....	4,970.61
Balance	\$ 769.87
Checking Account in New Orleans Bank & Trust Co.....	\$ 769.87
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 First Liberty Loan.....	250.00
1 Motor Lien Certificate.....	1,000.00
Greater New Orleans Homestead.....	750.00
Savings account realized from the sale of certificates..	1,250.26
	\$3,700.26
	\$4,470.13

Respectfully submitted,

WALTER B. MOSES, Treasurer.

REPORT OF THE LIBRARY COMMITTEE.

January 10, 1925.

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

Gentlemen: Your Library Committee begs to report as follows for the year just ending:

The suggestion made the previous Committee that the Library be moved from the Cabildo to a more central location was deemed inexpedient and consequently no action was taken in that direction. With the idea of making the books and periodicals more accessible a better shelf arrangement was adopted and the Secretary instructed to furnish members with keys to the Library on deposit of a small fee. A cursory examination indicates that 50 per cent more books were signed out of the Library than during the previous year, without any conspicuous loss of library property.

In connection with the usual routine of ordering new books, thanks are due to Eugene Dietzgen Company for cooperation. Grateful acknowledgment of cheerful assistance is made to Miss Carrie Freret, the Librarian, on whose shoulders fell most of the routine work and to whom credit is due for the good condition in which we find the Library.

A mimeographed list of books acquired by the Society during the current year will be subsequently furnished by the Secretary.

Respectfully submitted,

D. S. ELLIOTT,
MARCEL GARSAUD,
W. T. HOGG,
RALPH EARL,
Library Committee.

REPORT OF THE EMPLOYMENT COMMITTEE.

January 6, 1925.

Louisiana Engineering Society, care of Frank A. Muth, Secretary, Louisiana State Museum Building, New Orleans, La.

Gentlemen: As Chairman of the Employment Committee, permit me to make the following report for 1924:

According to my records I received 108 applications and during the year there were fifty-six vacancies, fifty-one 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.

REPORT OF THE AUDITOR.

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 1924, and as a result of this examination beg to submit the following report and schedules:

EXHIBIT "A"—Balance Sheet as of December 31, 1924.

EXHIBIT "B"—Fund Balances as of December 31, 1924.

EXHIBIT "C"—Cash Receipts and Disbursements.

SCHEDULE "ONE"—Accounts Payable.

EXHIBIT "A" shows in detail all assets and liabilities as they stood on the books December 31, 1924, and to the best of my knowledge and belief reflect the true financial condition of your Society on that date.

EXHIBIT "B" also shows in detail revenues and expenditures as applied to each fund with a net balance for each separate fund.

EXHIBIT "C" shows in detail all receipts and disbursements for the year under review, with a cash balance of \$769.87.

Membership.

The membership roll of the Society at the close of the year 1924 stood as follows:

Honorary	1
Resident	191
Non-Resident	80
Associate	19
Non-Resident Associate.....	2
Junior	19
Non-Resident Junior.....	11
Student	15
Total.....	338

It gives me pleasure to say that I have found all books and records correctly and neatly kept.

Respectfully,

R. J. DERBES, JR.,
Certified Public Accountant.

BALANCE SHEET.

January 1, 1925.

ASSETS:

Cash on Hand.....	\$ 769.87
Membership Accounts Receivable.....	796.00
Advertisers' Accounts Receivable.....	304.16
Investments	3,700.26
Expense of Delegates.....	9.54
Entrance Fees.....	10.00
	—————\$5,589.83

LIABILITIES:

Library Fund.....	\$ 553.82
Proceedings Reserve Fund.....	1,127.41
Ole K. Olsen Prize Fund.....	50.00

Building Fund.....	151.65
Accounts Payable.....	335.84
Dues in Advance 1925.....	3.00
	<u>2,221.72</u>

Balance General Fund.....\$3,368.11

EXHIBIT "A"

GENERAL RESERVE FUND.

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
	<u>\$1,059.16</u>
Deficit from 1919.....	62.93
	<u>\$ 996.23</u>
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
	<u>\$3,368.11</u>

GENERAL FUND YEAR 1924.

REVENUES:

Membership Dues.....	\$3,173.75
Smoker Account.....	272.50
Entrance Fees.....	246.00
Deposit for Keys.....	3.50
Cash (A. S. M. E.).....	25.00
1923 Dues Collected.....	11.00
Gain in Investments.....	100.00
	<u>\$3,832.05</u>

EXPENSES:

Subscriptions to Proceedings.....	\$ 686.00
Appropriation to Library.....	480.00
Losses on Non-payment of Dues.....	109.25
Salary of Secretary.....	420.00
Dues	12.00
Printing and Postage.....	340.61

52 *Proceedings of the Louisiana Engineering Society*

Refreshments	130.30	
General Expense.....	122.82	
Exchange	6.05	
Smoker Expense.....	460.46	
Dues Federated American Engineering Society.....	270.08	
Auditing	50.00	
1922 Balances Closed December 31, 1924.....	158.05	
		3,245.62
Balance for the Year 1924.....	\$	586.43

EXHIBIT "B"

ANNUAL STATEMENT OF THE LIBRARY FUND.

January 1, 1925.

REVENUES:

Balance on Hand January 1, 1924.....	\$	492.62	
Received from General Fund.....		480.00	
			\$ 972.62

EXPENDITURES—1924:

January 3—

American Society Test Material.....	\$	10.40
-------------------------------------	----	-------

February 12—

Engineering Publication Co.....	2.00
G. Gus Pilie.....	4.00
Miss Carrie Freret.....	15.00
Railway Age.....	6.00

March 11—

G. Gus Pilie.....	1.00
Miss Carrie Freret.....	15.00

April 14—

Miss Carrie Freret.....	15.00
-------------------------	-------

May 12—

Tulane Press.....	15.00
E. J. Drewill.....	12.20
Miss Carrie Freret.....	15.00
S. Boardman Publishing Co.....	1.25
G. Gus Pilie.....	4.00

June 10—

Miss Carrie Freret.....	15.00
-------------------------	-------

J. B. Pierre.....	6.00	
G. Gus Pilie.....	2.00	
July 2—		
Miss Carrie Freret.....	15.00	
August 11—		
American Society for Testing Material.....	2.25	
Miss Carrie Freret.....	15.00	
September 8—		
Miss Carrie Freret.....	15.00	
McGraw-Hill Publishing Co.....	3.00	
Globe-Wernicke	4.40	
Eugene Dietzgen Co.....	99.95	
October 13—		
Eugene Dietzgen Co.....	15.05	
Miss Carrie Freret.....	15.00	
November 10—		
Electrical World.....	5.00	
Miss Carrie Freret.....	15.00	
December 9—		
Engineering Publishing Co.....	2.00	
Engineering and Contracting Co.....	4.00	
American Society for Testing Material.....	8.80	
A. S. of Mechanical Eng.....	3.00	
Miss Carrie Freret.....	15.00	
Eugene Dietzgen Co.....	17.50	
McGraw-Hill Co.....	5.00	
December 31—		
Miss Carrie Freret.....	15.00	
Electrical World.....	5.00	
		418.80
Balance on Hand January 1, 1925.....	\$	553.82

EXHIBIT "B"

PROCEEDINGS RESERVE FUND.

Balance from 1915.....	\$	112.20
Balance from 1916.....		566.13
Balance from 1917.....		568.14

54 *Proceedings of the Louisiana Engineering Society*

Balance from 1918.....	567.52	
Balance from 1919.....	41.08	
	\$1,855.07	
Deficit 1920.....	221.98	
	\$1,633.09	
Balance from 1921.....	26.25	
	\$1,659.34	
Deficit from 1922.....	\$ 301.02	
Deficit from 1923.....	110.65	
Deficit from 1924.....	120.26	
	531.93	
Total.....	\$1,127.41	

PROCEEDINGS FUND YEAR 1924.

REVENUES:

Advertisements	\$1,002.20
Subscription Members.....	686.00
Proceedings Sales.....	1.85
	\$1,690.05

EXPENSES:

Salary of Editor and Secretary.....	\$ 360.00
Printing and Mailing.....	1,192.47
Stenographer	73.00
Miscellaneous Expense.....	180.00
Losses on Cancelled Advertisements.....	4.84
	1,810.31
Deficit for Year.....	\$ 120.26

EXHIBIT "B"

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS.

For the Calendar Year 1924.

Balance on Hand January 1, 1924.....	\$ 953.29
--------------------------------------	-----------

RECEIPTS:

1922 Dues.....	\$ 3.00
1923 Dues.....	422.00
1924 Dues.....	2,464.75
1923 Smoker.....	20.00
1924 Smoker.....	240.00

1925 Dues.....	3.00
Entrance Fees.....	216.00
Luncheon	4.50
Proceedings Advertisers.....	1,038.94
Pin	4.00
Profit and Loss.....	25.00
Keys	3.50
Delegates	130.00
Proceedings Sales.....	1.85
Interest	1,163.80
	5,740.34

Total Receipts.....\$6,693.63

DISBURSEMENTS:

Stenographer	\$ 69.00
Ole K. Olsen Prize Fund.....	100.00
Bills Payable.....	433.91
General Expense.....	118.32
Library	398.80
Auditor	50.00
Profit and Loss.....	17.50

Investments:

Motor League Certificate.....\$ 929.60
 Greater N. O. Homestead Association.. 750.00

	1,679.60
Proceedings Expense.....	165.00
Smokers Expense.....	450.46
American Engineering Council.....	270.08
Exchange	6.05
Pin	4.00
Postage and Mailing.....	1,020.28
Postage and Printing.....	270.46
Salary of Secretary and Editor.....	355.00
Secretary's Salary.....	385.00
Refreshments	130.30
	5,923.76

Cash Balance December 31, 1924.....\$ 769.87

EXHIBIT "C"

ACCOUNTS PAYABLE.**As of December 31, 1924.**

Miss Carrie Freret.....	\$ 15.00
Electrical World.....	5.00
Printing and Postage.....	70.15
Porterage and Lights.....	4.50
Double Cards for Smoker.....	10.00
Secretary's Salary (December).....	35.00
Stenographer's Salary (December).....	4.00
Printing and Mailing.....	172.19
Salary of Secretary and Editor (Proceedings).....	5.00
Miscellaneous Expense (Proceedings).....	15.00
Total.....	\$ 335.84

The Proceedings of the Louisiana Engineering Society

Published bi-monthly, February, April, June, August, October, December,
under the auspices of the Committee on Publication.

DOUGLAS ANDERSON, Editor.

The Louisiana Engineering Society is not responsible for any
statement made or opinion expressed in this publication.

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Quarter-page	15.00	10.00	4.00
One-eighth page.....	10.00	6.00	2.00

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LOUISIANA ENGINEERING SOCIETY

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Building, Jackson Square.

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PROCEEDINGS OF THE LOUISIANA ENGINEERING SOCIETY

VOL. XI.

APRIL, 1925

No. 2

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EDITORIAL NOTES AND COMMENT

New Additions to the New Orleans Filtration Plant. This city points with just pride to its system of water supply, excellent in design, construction and operation, and furnishing a quality of water for domestic and industrial purposes unexcelled in any part of the country.

The paper by Mr. Eugene F. Delery, published elsewhere in this issue, describes the technical features of the design and construction of the new filters which contribute a part of the purification system.

The present system of filters, ten in number, furnishes a joint nominal daily capacity of 40,000,000 gallons, which by over-loading can be, and quite frequently is, forced to 60,000,000

gallons. With the addition of eighteen new filters the total capacity will be increased to a nominal rating of 112,000,000 gallons per day. It is estimated that the completed system should be able to serve a population of 1,000,000.

The paper covers in a descriptive way the details of design of the filters and shows the methods used in the reinforced steel and concrete work.

Structural Steel. The March meeting of the Society was devoted to an address on "The Design, Fabrication and Erection of Structural Steel," by Mr. Lee H. Miller, Chief Engineer of the American Institute of Steel Construction. Previous to the meeting a subscription dinner was held at the Roosevelt Hotel in order to give the engineers, architects and contractors an opportunity to meet Mr. Miller informally. Mr. A. B. Davis of the Virginia Bridge Company presided at the dinner, which was a very pleasant affair. There were a few brief speeches and informal discussion of the subject of steel fabrication.

At the request of the Editor, Professor Donald Derickson, Head of the School of Civil Engineering of Tulane University, has prepared a brief account of the meeting, and this is published in this issue under the title of "Structural Steel."

At the request of the Secretary of the Society, Mr. Miller has also submitted an outline of the aim and objects of the American Institute of Steel Construction, which is published in this issue under that title.

A Spring Outing. At the April meeting a favorable vote was taken on the proposal to reinstate the Annual Outing as one of the activities of the Society.

In former days this function took the shape of a trip either by train or by boat to some conveniently located engineering project, thus combining both instruction and entertainment. The ladies were always taken along, and all of us have very pleasant memories of these outings as being one of the most enjoyable of the society's social activities.

In view of the fact that the engineering project and industrial plants which might be visited, have all been pretty

well inspected on previous trips, it has been suggested that we drop the instructional feature of the outing and make it purely a social affair.

If this view is adopted, a further suggestion, which appears to have considerable merit, would be to charter one of the large excursion boats operating on the Lake or on the River and go off for an all-day picnic.

The arrangements, however, are in the hands of a thoroughly competent committee consisting of Messrs. A. M. Lockett, W. T. Hogg, Lester F. Alexander and Ole K. Olsen. We know from very pleasurable experiences in the past what these gentlemen can do when they get together, so we can safely leave the proposition to them.

Due notices will be given at a later date.

An Ancient Definition of an Engineer. The Journal of Electricity, in its issue of January 1, 1925, quotes Marcus Vitruvius, who lived about 150 B. C., as giving the following qualifications for an engineer:

"He should be a good writer; a skillful draftsman; first in geometry and optics, expert at figures; acquainted with history; informed on the principles of natural and moral philosophy, somewhat of a musician; not ignorant of the sciences, both law and physics; nor of the motions, laws, and relations to each other of the Heavenly bodies.

* * *

A normal philosophy will teach him to be above meanness in his dealings and to avoid arrogance. It will make him just, compliant and faithful to his employer, and, what is of greatest importance, it will prevent avarice gaining an ascendancy over him, for he should not be occupied by thoughts of filling his coffers, nor with the desire of grasping everything in the shape of gain, but by the gravity of his manners and a good character, should be careful to preserve his dignity."

A Romance of the Steel Industry. All of us who ride in automobiles have doubtless heard of vanadium steel without paying much attention thereto, or stopping to think just what

it means. The following story is taken from one of the recent issues of "Research Narratives:"

VANADIUM

A CHEMICAL CURIOSITY PUT TO USE

"This silver-white metal appears to have derived its name from Vanadis, a goddess of Norse mythology. But the tales of mythology are no more romantic than the narrative of the search for vanadium, when once its possibilities for usefulness began to be perceived. The story of vanadium is a history of geographical exploration, scientific research and technical development, sustained by human pluck and persistence through great difficulties and many discouragements to ultimate success. The world is enriched by the victories of business foresight co-operating with scientific talent.

"The chemical element, vanadium, was discovered in 1801 by Del Rio, a mineralogist in Mexico, but practically for a century it remained in oblivion, being relegated to the specimen cabinets of mineralogical museums. It aroused the scientific curiosity of such eminent chemists as Wöhler, Berzelius, and Sir Henry Roscoe, who studied its chemistry without finding any practical application for it in the arts. In 1900 Professor Arnold, who was connected with the University of Sheffield, England, pre-eminent centre of the cutlery and tool-steel world, conceived the idea that this strange element might impart some beneficial properties to tool-steel. He experimented on a small scale in his laboratory and found that the addition of vanadium had wonderfully increased the cutting qualities of his steel. As vanadium was not commonly found in minerals, and was considered a rare element, costing much more even than gold, the knowledge of its useful properties in steel could not be readily commercialized.

"It was left to the adventurous spirit and commercial vision, inborn of the American business man, to overcome these obstacles. Two brothers, J. J. and J. M. Flannery, of Pittsburgh, having heard of this strange metal element and its stranger influences in steel, and being born and raised in the cradle of the American steel industry, Pittsburgh, conceived the idea of obtaining financial aid from a few of their business

friends, in order to make this element commercially available to the industry of their home town. They scoured all the world for possible sources of vanadium minerals. Finally, they succeeded in locating the richest and most unusual deposit of vanadium sulphide, a mineral known as patronite, in the Peruvian Andes, at an altitude of over sixteen thousand feet above sea-level.

"This discovery of the only known deposit of vanadium ore, while a stupendous task in itself, was only the beginning of the difficulties which the small company, organized by the Flannerys, had to face. They had to convince the steel-makers at home that the use of vanadium had salutary effects. American steel-makers had not heard of vanadium before. After they had convinced the steel-makers, the Flannerys were confronted with the problem of reducing the vanadium to metal out of the ore. No one had done this commercially before. Undaunted, they turned again to the world and obtained the services of the best suited men for the task. With full belief in the success of their undertaking, they devoted all their available funds to building up from the bottom the metallurgy of vanadium, by scientific research, with the aid of these men.

"For the very serviceable result, the world should thank the pioneering spirit of the Flannerys and their collaborators, for this result is one of the most potent metallurgical factors in the rapid progress of our industries, namely: 'Vanadium Steel.' Vanadium is an essential component of all high-speed tool-steel, which fashions all our machines of peace and war, big or small, from monster guns to automobile engines. Again, the stresses developed by our present tendency to speed could not have been overcome without the use of vanadium. It is for this reason vanadium steel is used largely in the construction of automobiles, aeroplanes, and railroad equipment. It has thus contributed immeasurably to our comfort and safety and to our rapid industrial advance.

"Where could we find a more romantic tale than that of the adventurous spirit and commercial foresight of a few business men who succeeded in discovering an isolated deposit of an unknown mineral at the top of the world, and in gathering together a coterie of scientific and technical talent to solve new metallurgical problems, thus founding a branch of

metallurgical industry, which has fortunately proved of such immense value to our modern civilization?

"Conveyed at first on the backs of Llamas and later by narrow-gage railways and trucks, from the perpetual snows of Andean heights, vanadium finds its way into the elevated temperatures of metallurgical furnaces. It imparts to steel qualities which make possible the cutting of metals at speeds so high that the tool glows at a red heat. Its possibilities for service to mankind have only begun to be explored."

OBITUARY
Resolution Upon the Death of
MR. E. W. CARR

E. Wheeler Carr, resident member since 1908 of the Louisiana Engineering Society, died in New Orleans Sunday morning, February 22, 1925.

Mr. Carr was born January 5th, 1879, at Brooklyn, New York, and was educated in the public schools of New York City and High School at Rochester, New York, and entered Cornell University, Class of 1902, Sibley College School of Mechanical Engineering.

In 1912 Mr. Carr went into Engineering and Contracting business for his own account, and since then has been known throughout Louisiana as an authority on Heating and Ventilating Problems, and also appraisal work for commercial concerns and for Underwriters.

He handled NoKol Automatic Oil heating for homes, which was the first automatic oil burner used in New Orleans.

He was also a member of American Society of Mechanical Engineering, and took an active part in the affairs of the local section. Member of Trinity Episcopal Church and Church Club of Louisiana. Also a member of Quitman Lodge No. 76, F. A. M.

Mr. Carr is survived by his widow, Mrs. Christina Isabel Carr, and a son, Edward Wheeler Carr III.

Whereas, in his death this Society has lost an able, upright member, respected and admired by all, and shares with his family the great loss which has been sustained,

THEREFORE, BE IT RESOLVED, That the members of the Louisiana Engineering Society place themselves on record as expressing their deep sense of loss in the death of their friend and colleague, and extend to his family their deep sympathy in the loss which has been sustained; and,

BE IT FURTHER RESOLVED, That as an evidence of the sincere sympathy and wishes of condolence of this Society to his family, a copy of these resolutions be spread upon the minutes of the Society and published in the official journal, and that a copy be sent to the family of the deceased.

J. S. BARELLI,
O. P. ADAMS,
A. M. SCOTT.

PAPERS AND DISCUSSIONS

STRUCTURAL FEATURES OF THE ADDITIONS TO THE NEW ORLEANS FILTRATION PLANT

By EUGENE F. DELERY.

Read before the Society, Monday, February 9, 1925.

In presenting this paper I shall endeavor to stick to the structural features, although it will be necessary to digress considerably to the hydraulic features, in order to bring out the reasons for many of the constructions shown.

Figure 1 shows a plan in which the existing filters are shown in dotted lines. The solid lines show the new work, below El. 32.00, the existing filters numbered 1 to 10 and the new filters numbered 11 to 28.

The nominal capacity of each of the filters, new and old, is 4,000,000 gallons per 24 hours, which can be, and now frequently is, forced to 6,000,000 gallons per day, or 50% overload. With the new additions the capacity will be increased to 112,000,000 rated and 168,000,000 forced capacity per 24 hour day. The new plant, at the present rate of consumption, should easily serve very much over 1,000,000 population. How long it will require to reach this point, is still conjectural, but with better transportation facilities, this should come sooner than most of us probably think likely.

Filters 11 to 20 are shown parallel and contiguous to filters 1 to 10, while filters 21 to 28 range along Sycamore Street. One pipe and operating gallery is shown between filters 11 to 19 and 12 to 20, which it serves. The other galleries, cross and intersect this one adjacent to filters 21 to 28. The pipe gallery of filters 21 to 24 is restricted by the existing Treated Water passage, while the gallery next, filters 25 and 26, contains part of the New Treated Water passage. This passage begins at Sycamore Street in a three passage entrance, beneath the sidewalk, fed by three 60" pipes from the Coagulating Basins, controlled by three butterfly gates, emerging into a 10 ft. main passage between filters

24 and 25, with its bottom at El. 16 and its roof at El. 32. Where it crosses the pipe gallery the roof drops to 27.5 ft. to allow the Wash Water pipe to pass. When it reaches a point even with the existing Treated Water passage, and begins to parallel filter 19, the roof again rises to El. 32, until it is about 10 feet from its end, where it rises to El. 36, to allow clearance for a 60" Sluice gate at wall 2a.

Let us now refer to *Figure 2*, which shows a section through the gallery between filters 11 to 20. This shows the operating floor at El. 32, the pipe gallery with its floor at El. 16, the tops and walks of the filters at 32, the filter bottoms at El. 19, the floors of the Equalization Basins at 12, and the bottom of the floors of these at 11. Equalization Basins, with floors at El. 12, exist beneath all filters. Filters 11 to 19 have a common Equalization Basin, as also filters 12 to 20. Both communicate with the Equalization Chamber, beneath the floor of the pipe gallery, to which the effluent pipes of filters 11 to 20 discharge. This communication is established through passages next filters 19 and 20, controlled by stop planks operated in the pipe gallery. Ordinarily, these two Equalization Basins discharge to a Fore-bay, or chamber, at the Panola Street end, which in turn discharges to the suction chamber of the High Lift pumps. Stop planks, operated from the floor at El. 22, above the Fore-bay, and reached from the inspection gallery at 24.25 in the pipe gallery, allow the Equalization Basins and Equalization Chamber to be either cut off from the Fore-bay or regulated in their flow to the Fore-bay.

There is no Equalization Chamber beneath the floor of the Pipe Galleries of filters 21 to 28, but opposite filters 21, 22, 25, 28, will be found valve regulated 36" pipes establishing communication between these Equalization Basins and the Basins under filters 11 to 20 and these under the existing filters 1 to 10. A 36" valve regulated line runs under the new Treated Water passage and under the pipe galleries of filters 24 and 25 connecting the Equalization Basins under filters 21 to 24 with that under filters 25 to 28. We thus have complete intercommunication between Equalization Basins giving the greatest flexibility of operation, and maximum storage capacity.

The floors of all the new pipe galleries are at El. 16. The floors of the pipe galleries of filters 21 to 28 are supported directly on piling, with soil beneath the floor.

The pipe galleries of filters 11 to 20 and 25 to 28 intersect, but the part of the pipe gallery of filters 21 to 25 below El. 27.5 is cut off by the new Treated Water passage. The space above 27.5 and 31.36, at this point, serves to pass the Wash Water and auxiliary pipes between these galleries.

The top of the filter walks of the old and new filters line up is at El. 32. The operating floors of all the new filters, at El. 32, intercommunicate directly and, opposite filter 22, by dropping one step, communicate with the operating gallery of filters 1 to 10. All operating floors are situated directly above the corresponding pipe galleries.

At the Panola Street end there is a covered colonnade connecting the operating floors of filters 1 to 10 with that of filters 11 to 20, at El. 32. This colonnade and its floor are used to cover a storage room, with its floor at El. 24, which floor in turn covers a 24" Wash Water loop line between the existing and new pipe galleries.

In *Figure 1* we see next filter 20 a large pit with its floor at El. 10.4. This serves to take care of the Wash Water pump and its appurtenances. This opens to a smaller pit with its bottom at El. 9, in which will be set a 4" Constant Duty sump pump, and a 10" Special Duty pump arranged to couple up with the 10" individual drain pipes from all adjacent Equalization Basins and the new Treated Water passages, each provided with its own valve and blank flange. This last provision is to prevent any possible contamination of filtered water. At filter 22 we find a sump which takes drainage from the present filters and itself drains to a sump at filter 21, which takes the gallery drainage. This is provided with a 4" Constant Duty pump for gallery drainage, and a 10" Special pump for connection to the 10" drains from the Equalization Basin and from the existing Treated Water passage. All drainage of any nature is discharged into the main drain pipe. All pump motors are located on and operate from the gallery floor at El. 32.

Unscannable

map

A walkway at El. 24, 25, next the filters, goes completely around the pipe galleries, and by making inspection easier, will likely make it more frequent. Stairs at frequent intervals lead from the operating floor to the walk at El. 24, 25, and ladders are provided between El. 24, 25 and to El. 16. At the gallery intersection, opposite filter 27, next filter 20, however, a special stair is provided to El. 16 in order to reach the Wash Water pump pit easily.

It will be observed that the short concrete column pedestals to El. 18 are uniformly spaced on 8-ft. centers, which is rigidly adhered to except at gallery intersections, and as all filters are 32' wide this spacing made for uniformity both of steel work and piping. In gallery 11 to 20 the column load is transmitted down through these to the short columns in the Equalization Chamber, and thence to the floor of the basin and from that to the pile clusters beneath, whereas in the other pipe galleries the pedestals transmit the load to the gallery floor and thence directly to the pile clusters beneath.

It is to be regretted that space will not allow the piping layouts to be shown clearly, as these called for very careful arrangement to best use the space at our disposal.

Light and stair wells are provided through the operating floor at El. 32 at frequent intervals. This floor was omitted for lack of space. At Eagle Street, along filter 21, is shown a passage for auxiliary pipes leading from Sycamore Street into the pipe gallery of filters 21 to 28, whence it reaches all other galleries.

The structural bents which support the piping and operating floor consist essentially of two 6" H beams with a 10" I beam to suspend the Treated Water pipes by double U straps and the Wash Water pipe on a C. I. saddle, while a 9" I beam across the top of the column supports the operating floor at 32. At points where there are stairs, beams extend from the columns to support the inspection walk. The only steel beams lengthwise the gallery occur at light and stair openings, and at gallery intersections.

The main auxiliary piping is arranged to be suspended from the 9' floor beam of the upper floor, with right angle branches

to the various regulating devices and gauges. This beam also supports the lighting system and radiator pipes. Operating boards and radiators are provided in the operating gallery.

In *Figure 2* we see the main drain line supported by concrete saddles on the floor of the pipe gallery, the Treated Water pipe suspended from the 10" beam, and the Wash Water pipe supported on a saddle on the 10" beam. All loads except the Drain line are carried directly on the columns to the piling. In figuring the floor at El. 16, special provision had to be made for the reaction due to the Y shaped fittings at the filter centers.

In the design of the Equalization Basin and foundation it will be noted that the usual groined arch has been discarded and a system of slabs and columns substituted. This not only gives more storage room, and less hydraulic losses, but is also cheaper to construct, and puts less useless load on the piling. There is, moreover, no side thrust due to arch action. It also enabled us to avoid a stratum of quick sand just below El. 11. A uniform column spacing of 8'x8' was adopted with four 13-ton piles on 2'-6" centers under each column. All piles were driven to a sand stratum and practical refusal. The walls were on piling proportioned to their loading. Everything was eventually carried to piling in all cases, even the outside steps.

The method of construction was to first drive the piling, then follow it to within a few feet of cut off, excavate and cut off, trim the earth the necessary distance, fill to within a few inches of cut off with a lean concrete, or well packed gravel, drive 1" square twisted dowells, in 1" holes in the pile top 15" deep, leaving its top 2" below the top of the slab, and use these dowells to support the horizontal steel of the slab. The two-way system of slab reinforcement was adopted throughout.

A few words regarding the governing conditions may not be amiss at this point. The total live and dead load per square foot on the filter bottom is 1100 lbs. or 70,400 lbs. per column, and the pressure on the equalization slab can amount to 1640 lbs. per square foot. Ground water may be expected to at least El. 13, and will probably exceed this. On the other hand, if there were no filter load and no equalization basin load and ground water to El. 19, a very considerable upward pressure would be exerted

on the Equalization floor from beneath. This necessitated careful calculation of the reinforcement for loads from both directions, care being taken to use the tensile metal of one condition as compressive steel for the opposite state of affairs. The same condition applies though in less measure to the filter floors, for with an empty filter, and water pressure to El. 21 in the Equalization Basin several feet of head is exerted on the bottom of the filter floor. This accounts for the four $\frac{1}{2}$ " square rods in the columns. These are only expected to act, when the column goes slightly into tension.

In the filter bottoms the two-way system was again used. In both the filters and Equalization Basins the governing factor was bend, due to the short spans and heavy loads. Under the columns resort was had to extra $\frac{3}{4}$ " square bars with hooked ends, shown in *Figure 3*. In this figure the reinforcement for

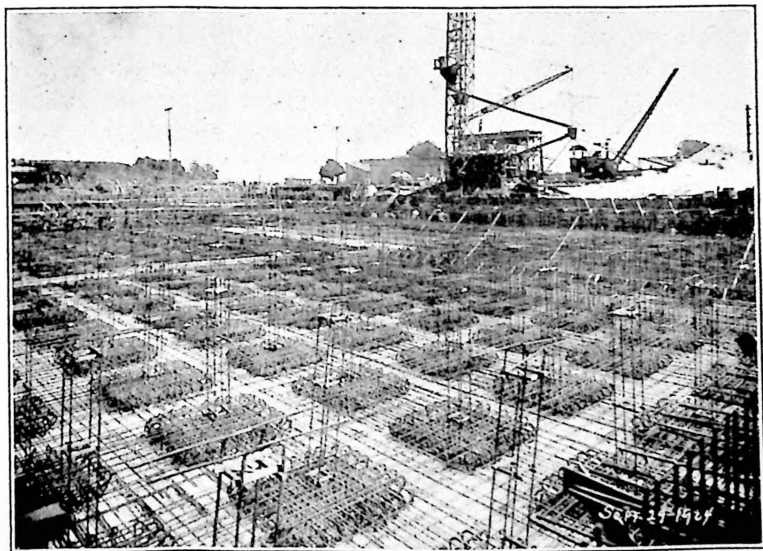


FIGURE 3

columns, Equalization Basins, Equalization Chamber slabs, and Equalization Basin walls is shown ready for concreting. This shows 100 tons of $\frac{1}{2}$ " and $\frac{3}{4}$ " square bars, which were concreted in in about five days. It would have been desirable to excavate

lower and use a thicker base under the columns, which would have saved considerable steel, but it would also have let us into a stratum of quicksand, hence the steel was much cheaper. Any one who has had to handle quicksand knows what was at stake.

The pipe gallery floors at El. 16 are also reinforced on the two-way system, for pressure from either above or below, with special provision for the drain pipe loads. The division walls between filters, naturally received pressure from either side, and are reinforced accordingly. The filter walls next the pipe gallery serve not only as filter walls but also transmit the gallery wind loads and roofs loads to the foundations. Of course, they only receive the filter load from one side. The exterior walls of filters and Equalization Basins must resist an earth load to El. 28 from the outside. The Earth resistance is not figured as sufficiently dependable to use as a balance against the water loads of the filters and therefore all walls are designed to resist these two loads separately and independently. The filter walks are built to act as beams to the filter walls, and the filter cross walks are designed to act as ties for these beams, thus tying all filters together, as a box. This system was used on all water passages and compartments; in fact, the whole structure is more or less a box of many compartments, tied together with a constrained system of reinforcement.

At El. 32 we have the Operating floor, and above this the walls of the gallery, 12" thick and so reinforced that those parts of the walls between openings act as pilasters to carry all wind and roof loads with wind figured as 160 miles per hour. An extension bearing plate is provided at the top of the wall to distribute the truss thrust along a sufficient length of wall instead of at a point. The span between walls is 27 ft. at filters 11 to 20, and 29' 6" at filters 28 to 29.

The roof will be of Terra Cotta, on 1½" pine sheathing, a close copy of the roof of the present filters, with towers at the Panola and Monroe Street ends. These towers while designed primarily for architectural reasons, will be used for secondary purposes, such as bath and locker rooms. The walls will be given a rubbed sand finish, with copings and trim to match the existing filters.

Figure 4 shows the three entrance passages to the new treated water passage, already described, which by entering beneath the sidewalk enables us to avoid an unsightly construction at this point. The treated water passage is first tapped by a 42" valve regulated pipe which feeds filters 21 to 24. At a point opposite the center of the present gallery and opposite filter 22 this pipe has a branch to a 42" sluice gate in the present treated water passage. A 48" sluice at the end of the present treated water passage at wall 22 also establishes communication between the two treated water passages, thus making it possible to feed either filters 1 to 10 or 21 to 24 from either or both of these passages. A 20" line from the new treated water passage feeds filter 25. Filters 26 to 28 are fed through a 36" line opposite filter 26, from a new treated water passage. Filters 11 to 20 are fed from the end of the new treated water passage by a 60" sluice at wall 2a through a pipe down the center of the pipe gallery. This pipe progressively decreases from 60" to 48", winding up a 48" line hydraulically operated with an 48" extreme emergency discharge valve to a 48" line to the Fore-bay. This valve while provided for special emergency, may never be called into service.

The drain lines of all filters rest on the gallery floor. The drains of all galleries connect and eventually discharge through a 48" line on Monroe Street to a 48" concrete line on Sycamore Street. Where the drain crosses through the new Treated Water passage it is run as a single piece, with no joints, which eliminates any chance of contamination.

Figure 5 shows the existing 48" drain, going through the Equalization Basin under filters 21 to 24. This will be removed, and all drain piping will run down the pipe gallery to Monroe Street. This figure also shows the existing treated water passage which threatened to let go when the earth pressure was taken away. By running a series of flat slabs clear across the Equalization Basin at El. 11, with the pile clusters through it, it was possible to hold the wall of the passage in place. Special arrangements had to be made in order to finish the Equalization Basin at this point, as this 48" pipe can not be removed until the new drain line is laid to Monroe Street.

It will be noted in *Figure 2* that there are no pipes in the Equalization Basin, and that no pipes protrude through the filter bottoms. This was made possible by the adoption of an improved type of grid filter, the strainer system of which, has shown the remarkable distribution efficiency of $99\frac{1}{2}\%$. As it is cheaper to construct than the usual filter, it will be adopted. The filter

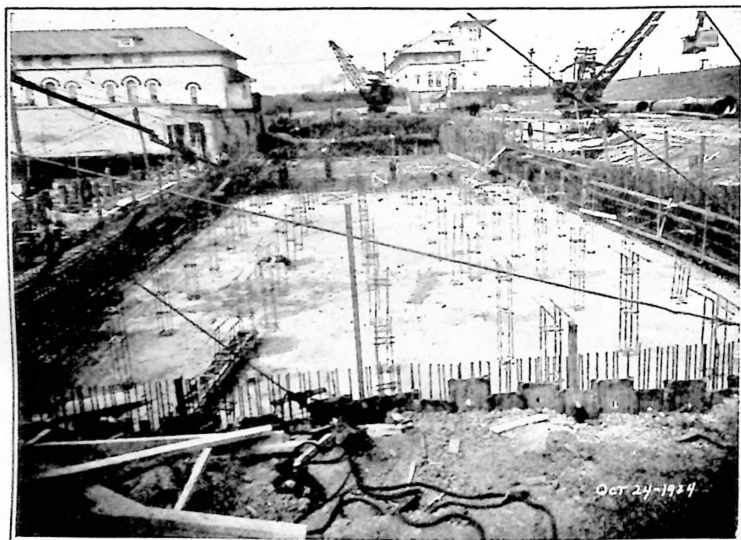


FIGURE 5

bottom is flat, with a grid of specially perforated strainer tubes. with the orifices turned down. These lie in an eighteen-inch bed of graded gravel above which is 30 inches of sand. The guttering is of the type generally used in large filters, and is like those of the existing filters. (See *Fig. 2*.) In operation, the strainer tubes discharge to the lower elliptical passage in the direction of flow, whence the effluent goes to the controller and discharges to the Equalization Basin. In washing the operation is reversed. The large, somewhat rectangular passage just above, serves as the influent to the filter, and as the drain passage when washing. The large Y shaped inlet and discharge casting shown, seems very special, but when it is considered that ten of these exactly

alike were required, it ceases to be a special, and approaches quantity production. In the cross gallery, while this casting was slightly different, there were eight alike.

As far as possible, and it was generally possible, a policy of making all fittings standard was followed. When this could not be done fittings for all filters were made duplicates of each other, with the object of securing uniformity as well as cheapening the cost. While some of the piping had to be gotten into very restricted space, this was everywhere sufficient, and it is believed that the piping is accessible and clear.

A feature, shown in *Figure 2* is the overhanging filter bottom adjacent to the existing filters. This was not directly intended, but was inherited through a combination of circumstances. While provision for future extensions was made in the design of the existing filters, it did not appear that sufficient piles had been provided to carry an extra half span, under the wall of the existing filters. It was therefore thought safer to make the new filters stand entirely on their own piling. Another obstacle presented itself in an existing 48" filtered water pipe on Monroe Street. This pipe was so close to the new filters that it was not possible to move them a sufficient distance to bring the wall of filters 11 to 19 down straight. As the overhang would never be loaded except when balanced by the rest of the filter load, it was discovered on figuring that this cantilever could be made strong enough, which was done. While the construction is unusual, it is felt to be safe but would not have been used except for unusual conditions.

The wash water lines of all filters intercommunicate, and any filter can be washed either from the existing wash water tanks or from the new wash water pump in the large pit next filter 20, or wash water can be gotten from the high pressure lines direct. The new wash water pumps can also be used to fill the existing wash water tanks in the present filters. The 30" wash water pump will be so arranged that it can draw water from either the Equalization Basin under filter 20, or that under 28, or both, and can pump either to the wash water lines, or to the 48" Filtered Water line to the Clear Water reservoir, or it can pump from the same 48" Filtered Water line to the wash water lines.

Figure 6 shows the condition of the scene shown in Figure 3 but on December 17, 1924. Since then a great deal of progress has been made even over Figure 6. All concrete was 1 cement, 2 sand 4 gravel. The consistency was gauged by what might be

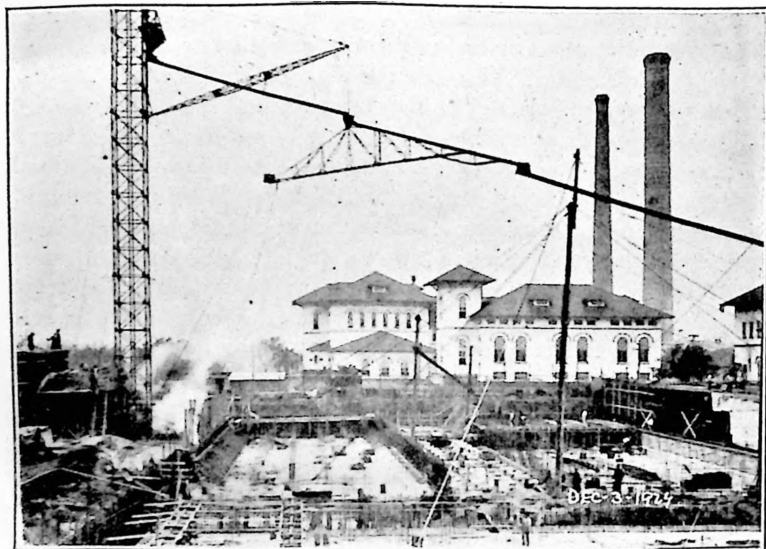


FIGURE 6

called the "visual method." Nevertheless, a fair consistency was maintained, with a probable slump of about six inches. Although advanced methods of mixing were strongly advocated by the writer, it was not possible to have them put into effect. All concrete was placed from a 120-ft. central tower permanently mounted on four piles, with measuring hoppers, fed from supply hoppers directly, these last loaded by crane directly from the storage piles, and the concrete was spouted directly into place at any part of the work. The cement was loaded on a platform in 30 bag lots and slung by a crane directly from the platform of the cement house to the mixer platform. As the tower had a movable discharge hopper, it was possible to so locate it as to get the proper chuting incline at any time. The outfit worked without hitch or hindrance and proved both reliable and economical.

Most of the steel was $\frac{1}{2}$ " square billet steel, the proportion of $\frac{3}{4}$ " steel being very small. As it was the general opinion of every one concerned that, as far as the initial slip was concerned, there was no difference between plain and deformed bars, plain bars were used, with a bending stress of 80 lbs. per square inch.

The prices secured on materials were at the very low point of the market, and by careful organization and the use of machinery wherever possible the labor cost was kept at a very desirable figure.

While I have not told you everything concerning this plant, for it is not yet finished, I believe that the principal facts have been brought out, and as the plant is wide open to your inspection at any time, I believe that those of you who may visit the present work will be able to follow through without any special trouble.

DISCUSSION.

PROF. DERICKSON: What did you do, Mr. Delery, in regard to the strength of your concrete?

MR. DELERY: Do you mean with regard to proportions?

PROF. DERICKSON: Yes.

MR. DELERY: We used 1-2-4 concrete and used the same old system of mixing it; what we thought it ought to be. I could not impress sufficiently upon the powers that be the importance of properly proportioning the water content. We put it in accordance with the regular practice.

PROF. DERICKSON: In the design of the side wall, was the earth pressure relied upon to partly balance the water pressure?

MR. DELERY: No. The water loads and earth pressure were figured independently. The earth was not depended on to counter-balance the water loads, in any measure, as this was not deemed safe practice.

PROF. DERICKSON: How was the earth pressure determined?

MR. DELERY: The standard formula $0.333 \frac{wh^2}{2}$, where w = 90 lbs. per cu. ft. was commonly used.

PROF. DERICKSON: What is the capacity of these filters?

MR. DELERY: There are 18 filters, each with a capacity of 4,000,000 gallons per 24 hours.

PROF. WILLIAMSON: What loading did you allow on the piling?

MR. DELERY: Thirteen tons.

PROF. WILLIAMSON: How long were they?

MR. DELERY: About forty feet. We had no trouble at all in getting a bearing.

A MEMBER: I should say your tower was rather high.

MR. DELERY: About 120 feet.

A MEMBER: It must be pretty wide. How do you reconcile that with the talk we had with Col. Boyd?

MR. DELERY: I wanted to arrange for correct proportioning of the water content but someone else had something to say about that. What we got was about a six-inch slump.

A MEMBER: Do you find a six-inch travels down without difficulty?

MR. DELERY: The slope is a little steeper than it really looks.

MR. NEGROTTO: Is it a steel tower?

MR. DELERY: Yes. The tower is set on four piles to make certain that we would not have any trouble with settling.

MR. DUSENBURY: For what population is that plant now designed?

MR. DELERY: I cannot tell you that precisely. Inasmuch as we will have twenty-eight filters instead of eighteen, it ought to last us a good while. We now have to force a forty million gallon plant to deliver sixty million gallons a day. That means that we could force a fifty per cent. overload except for the fact that we must have enough to fall back on in case of trouble. With these additions we will be well off for a long time. Still we thought twelve years ago a forty million gallon capacity would last us twenty-five years at least, but it did not.

A MEMBER: Is there any lime proportion used in the concrete?

MR. DELERY: No, we figured that the 1-2-4 concrete would give us sufficient water-proofing.

A MEMBER: No lime at all was used?

MR. DELERY: No, no lime at all. I thought for a while that we would use some, but we did not do it.

STRUCTURAL STEEL

By DONALD DERICKSON

To the layman structural engineering is an exact science based upon well known laws of mechanics and materials. Given the same data the same results will be attained. As the steel frame of a building progresses skyward he watches with interest the movements of the workmen and possibly thinks of them as poor insurance risks. He has, perhaps, a rather vague idea of the designer's part, but if he feels particularly well informed he is quite sure that it is based upon mathematics with the corresponding accurate and definite results. While this is true in part, unfortunately, it is not wholly true and there are many things pertaining to structural engineering which in general will be better understood in the future than to-day.

A study of one hundred and nine building codes of as many cities by the U. S. Department of Commerce in 1922 shows a remarkable disagreement in the floor loading to be employed in the same class of structures. Wind pressures to be assumed differ materially and the manner of determining the stresses resulting therefrom and the proportioning of the material to withstand the wind stresses differs even more so. In the absence of test data the safe bearing power of soils is a matter of judgment and personal opinion, and so far as the writer knows, there is no magic formula that will give the load capacity of piling to any degree of certainty. Primary stresses are sometimes based upon assumptions which are not realized, allowance for impact is made with the full knowledge that it is approximate, and secondary stresses in building construction are allocated to the factor of safety. Many column formulas yielding different results have been used, more have been proposed and still the list is being added to. Many other things might be mentioned which contribute to the uncertainties with which the designer must content and he will deal with them properly or improperly in proportion to his integrity and ability as an engineer. These remarks should not be construed as

pessimistic. It is remarkable that the state of knowledge relating to structures is as far advanced as it is. Experimental stations, professional societies and engineers in all parts of the world through their contributions to the technical press are adding materially to the advancement of structural engineering.

From what has been stated it is natural that much diversity should exist in the building codes of cities and the practice of designers with the result that many a dollar has been worse than wasted in providing an excess of strength, for with it went an increase of weight, which in turn had to be provided for in the way of increased structural members and foundations.

Under the date of June 1st, 1923, the American Institute of Steel Construction published its Standard Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings. This specification has been adopted by the building department of many cities, and it has been recommended for the new building code of New Orleans by the committee of engineers charged with the framing of that section of the code. The American Institute of Steel Construction is an association of fabricators and it is stated that its membership embraces practically all of the reputable fabricators of the country. At the present time there seems to be a tendency to standardize about everything and sometimes it would seem that there is more consideration given to standard practice than good practice, but from the viewpoint of one who has given much time to the study and practice of structural engineering the action of the American Institute of Steel Construction in having its Standard Specification prepared by a committee outside of its organization, composed of some of the ablest talent to be found, has contributed greatly to the establishment of a uniformly better practice than has prevailed in the past. The high reputation of the gentlemen who prepared the specification together with the prestige of the organization incorporating it as a part of its standard practice will serve as good authority for the use of higher unit stresses than has hitherto been commonly employed. With three hundred million dollars worth of structural

steel furnished annually, the saving by uniform practice based on specifications written in the light of the most advanced knowledge may be expected to effect a decrease in the cost of steel construction which will be most welcome.

Before the Louisiana Engineering Society, on the evening of March 9th, Mr. Lee H. Miller, Chief Engineer of the American Institute of Steel Construction, delivered a paper on the "Design, Fabrication and Erection of Structural Steel." Previous to the meeting forty-seven representative architects, contractors and engineers took advantage of the opportunity to meet Mr. Miller at a dinner at the Roosevelt. The dinner was presided over by Mr. A. B. Davis of the Virginia Bridge Company, who saw to it that those interested were afforded a chance of talking with Mr. Miller. Mr. Davis called upon several for brief speeches, in which the gentlemen speaking expressed their pleasure in meeting Mr. Miller and an appreciation of the good work done by the institute which he represented. The dinner was a most pleasant affair, bringing together for a common purpose the steel fabricator, the contractor, the architect and the engineer.

After the dinner the meeting was held in what was formerly the Gold Room of the Roosevelt. The meeting was attended by over a hundred and forty persons from the local section of the American Institute of Architects, the Contractors and Dealers Exchange, our own Society and others interested in building construction.

In introducing Mr. Miller, Mr. Robert W. Wollcott, General Manager of the Lukens Steel Company in New Orleans and also President of the Contractors and Dealers Exchange, gave a very good idea of just what the American Institute of Steel Construction is and what it hopes to accomplish. He paid a tribute to Mr. Miller when he mentioned the high regard and esteem in which the Institute holds its chief engineer. Mr. Miller spoke at some length. He traced the history of structural steel from its beginning to the present time, showing the errors and misconceptions which have persisted with the accompanying extravagance in construction. He mentioned the unit stresses employed in some of the later steel designs which

are higher than the sixteen thousand pounds per square inch upon which the handbooks of the steel companies are based, and which has been accepted in the past, as the proper value. He described in much detail the derivation of the column formula as given in the specification of the American Institute of Steel Construction. A complimentary copy of the Specifications and Code of Standard Practice had been given to each of those present. Mr. Miller made frequent references to it as he explained various diagrams and other items, also pointing out the saving that would come from the use of a higher unit stress, an omission of the usual requirement that surfaces in contact be painted, and other things embraced in the Specification and Code. He alluded to the Final Report of the Committee on Stresses in Structural Steel of the American Society of Civil Engineers recently made public, (See Proceedings of the A. S. C. E. for March, 1925.) where a new column formula is proposed and unit stresses of twenty thousand pounds per square inch are recommended on the net section of tension members. At the close of his address he invited a discussion, but the hour was so advanced that an extended discussion was impracticable.

Mr. Miller's address was listened to with great attention. Coming at a time when the new building code of New Orleans is being formulated, his paper was of essential interest. At the conclusion of his address he was tendered a rising vote of thanks.

The subject of the Design, Fabrication and Erection of Structural Steel is so extensive that it is hardly possible to do it justice in one evening, and Mr. Miller was handicapped in having to cover much in a brief space. Probably each person present at the meeting thought of Mr. Miller's address from his personal point of view. The writer would have appreciated a discussion of the column formula in the light of test data rather than the theoretical derivation. He would have liked a discussion of the effect upon tension members of staggered rivet holes with a view to a uniform specification that would make proper provision for net section. The effect of connecting angles by one leg, the use of rivets in tension, the number of

rivets connecting through a loose filler plate, the size of angles to be used as stiffeners, the method to be employed in computing wind stresses in multiple story buildings as well as in mill buildings, these and other questions might have well been discussed, and it would seem that it might be well to cover them in the specifications or hand book of the American Steel Institute. The writer remembers the statement with which the late Mr. Theodore Cooper preceded his specifications, and it is realized that no set of specifications can be made to yield a perfect structure in the hands of the incompetent. The best type of engineer will in a measure be independent of a specification in a certain sense, otherwise there would be no advancement. It would seem, however, that where a specification is to be written into a contract or embraced in a building code, that specifications covering such details might lead to a more uniform practice.

The writer feels that the American Institute of Steel Construction has done much to advance structural engineering in formulating a specification which the fabricators are willing to accept and which is in accord with good practice.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION

By LEE H. MILLER

Modern conditions have made national existence dependent upon the capacity of the nations to mobilize their industrial resources in the event of a national emergency, and it is obvious that in the time of peace these industries should be capable of meeting the competition of the industries of other nations if they are to be of value in the emergency. Statements have been made by students of the subject, that the proper co-ordination of our various industries would reduce the living costs of every individual in the nation at least one hundred dollars per annum. This does not seem unreasonable, but if it is true that we are as a nation paying eleven billion dollars annually for the price of our individualism or failure to co-operate to reduce our industrial wastes, and should the subject ever become a matter of co-operation by legislative compulsion, we rapidly approach the fatal condition of government paternalism and communism. In view of what has happened in other countries, and what we can see at home, this phase of the question does not seem so far fetched as it may at first appear.

Under existing conditions a premium is placed on individualism and the responsible manufacturer, engineer or architect is constantly compelled to lower his standards to meet irresponsible competition, making the public and responsible firms the victims. 'Co-operative research and the establishment of safe uniform practices can alone check these conditions, and prevent the demoralization of our national industries on which we must depend in event of emergencies.' The fact that the United States has become a great industrial nation since the development of steel as a commercial product, has kept us free from the long-established traditions which have hampered the development of European countries. We have, however, been prodigal in our natural resources, which will some day become so depleted as to require careful conservation.

If we are to maintain our standards of living so far above the European standards, we must promptly realize the necessity of conservation.

The organization and program of the American Institute of Steel Construction resulted from the evidence of wastes which had been seen during our co-operation with the War Industries Board in procuring material for the emergency then existing. The program then formed and now being followed dealt only with such subjects as can be followed without in any way being illegal. Briefly, our purpose is to render to the users of structural steel, the greatest possible service in order that our product may be more economically used, and as a result the demand for it increased.

Our work is the first co-operative effort ever made to give the buyer of structural steel a maximum of value under clearly defined conditions that will enable him to know exactly what he can properly expect, and at the same time assure the manufacturers fair competitive conditions.

If we were to distinguish the iron age and the steel age, we will readily appreciate the necessity of co-operation in getting the use of structural steel on a uniform basis. There is nothing to indicate when the iron age started, but we know that the puddling process used at its inception is still in existence. It was nearly 1500 A. D. before the first masonry furnace enabled the development of a temperature that would melt iron, and this furnace resembled in principle our modern blast furnace. It was not until after 1855 that the Bessemer and Open Hearth furnaces made it possible to melt steel, and it was about 1885 that this was developed on a commercial basis. This development made it possible to roll structural shapes from a cast steel ingot. Previous to that time all structural shapes had been made of wrought iron. The process of manufacture consisted in rolling small bars from the puddled iron, and after assembling them into bundles welding them together by another rolling process.

The Carnegie Steel Company announced in the preface of their Hand Book of 1893 that they were eliminating all data relative to wrought iron which indicated the final transition from the iron age into the steel age. During this period of transition, there developed extensive technical opposition to the use of Bessemer steel because it had properties which made it brittle under certain conditions. This opposition resulted in the rapid development of the open hearth furnace, and at the same time brought about the necessity for regulating the use of steel in building codes due to the fact that the economy of the material was resulting in what we now call our modern skyscraper. In fact it was these developments in the transition from iron to steel that has resulted in the increased demand for technical colleges and technically trained men in every phase of industry.

Innumerable specifications came into existence, many of which were copied from one to the other with the result that we have in a few years developed such a wide range of requirements and so much individualism that it became possible to justify almost anything contemplated. In the meantime the metallurgical processes in the manufacture of steel have greatly improved the product with the result that at the present time steel is furnished with a precision both as regard to chemical and physical properties that is unknown in any other material of construction. It has become the most essential thing to modern civilization as we now know it, and without it we would lose practically everything that we consider essential. It performs with absolute precision within the elastic limit which is never approached in any modern construction work. The War Industries Board in their priority regulations referred to it as the master metal and more essential to our national existence than gold itself.

As the result of our co-operative efforts during the war, it was found that enormous wastes were taking place, which could be eliminated by proper industrial co-operative. The organization which was formed to assist the government dur-

ing the war was reorganized under the name of the American Institute of Steel Construction for the purpose of eliminating this waste, and promoting uniform practices.

In undertaking this work, however, it was realized that if the public were to be satisfied as to the sincerity of the work, talent would have to be selected which had no direct commercial connection with the industry itself. For this reason a committee from the leading talent in the academic, engineering and architectural professions was selected to prepare a Standard Specification on the Design, Fabrication and Erection of Structural Steel. This committee represents a combined experience of approximately one hundred and fifty years in an industry which is not more than thirty-five years old. The personnel of this committee is as follows:

GEORGE F. SWAIN: M. Am. Soc. C. E.—M. Am. Soc. M. E.—M. Inst. C. E.—M. A. R. E. A.—Past President, A. S. C. E.—Prof. of Civil Engineering, Harvard University.

MILO S. KETCHUM: M. Am. Soc. C. E.—M. A. R. E. A.—Dean of the College of Engineering, and Director of the Engineering Experiment Station of the University of Illinois.

E. R. GRAHAM: of Graham, Anderson, Probst & White, Architects, Chicago, Ill.

W. J. THOMAS: M. Am. Soc. C. E.—Chief Engineer, George B. Post & Sons, Architects, New York.

WILBUR J. WATSON: M. Am. Soc. C. E.—M. AREA—President, Watson Engineering Company, Cleveland, Ohio.

It was recognized in their deliberations that the misleading term of "factor of safety" is more the subject of the application of any recommended unit stress than the unit stress itself. They did not undertake to define the qualities and property of steel, which is the proper function of the American Society for Testing Materials, but restricted themselves to a definition of the uses of steel in connection with building construction.

(For additional information and formulae, see the Institute pamphlet "Steel Construction.")

Having completed the Specification, the Institute undertook the development of a Code of Practice, which would eliminate the innumerable sources of controversy and misunderstandings which have come into existence as a result of the numerous local conditions and individual specifications. This Code was developed and submitted to several hundred engineers, architects, technical magazines, and college professors, with a request that criticisms and suggestions be prepared to make the work fair to both the buyer and the seller. With this information the Code was rewritten and again submitted and the process continued until all of the criticisms had been satisfied. It was then submitted to legal talent and after being approved by the Board of Directors, was approved at the Annual Convention of the Institute in November, 1924.

In all of the work which the Institute has done, we have maintained close contacts with the U. S. Department of Commerce at Washington and have received from them invaluable co-operation in the work which we are doing. Technical papers have referred to both the Specifications and the Code of Practice as being among the most constructive efforts which have been undertaken by any industry; and this is evidenced by the fact that already more than thirty cities and states have approved the Specification as their building code requirements in connection with the use of structural steel.

The economies which will result are very evident and should enable the nation to save in the neighborhood of fifty million dollars annually in the cost of building construction. Technical journals have stated in editorials that it should in a very short time become the universal standard for the American Continent, thus enabling the architect or engineer to operate in all places on the same specification instead of being compelled to maintain an extensive library of the various building codes now existing.

The program of the Institute includes the preparation of a hand book to replace the numerous hand books now published by the various rolling mills, which will be fair to all of them,

and enabling the engineer and architect to save considerable time and many misunderstandings which now arise.

In the arrangement of the information regarding structural shapes, all of the essential data will be assembled in one place, eliminating the necessity of referring to several pages of existing data to find the information essential to proper design.

There are many subjects connected with the use of structural steel which will require technical research, and it is the purpose of the Institute to follow up these with a view of producing reliable information.

MINUTES OF MEETINGS AND BUSINESS OF THE SOCIETY.

Minutes of Board of Direction, February 9, 1925.

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

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

Correspondence was read relative to the Temple Bill providing for the completion of a topographical survey of the United States, and in view of the fact that through the efforts of individuals the support on this bill by members of the U. S. Senate from this State has been secured, it was voted that no further action be taken at this time in view of the short time elapsing until the adjourning of Congress.

The meeting then adjourned.

F. A. MUTH, Secretary.

Regular Meeting of the Society, February 9, 1925.

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

The minutes of the previous meeting were read and approved.

Announcement was made of the names of the members of the standing committees which were appointed to function for the year 1925.

Announcement was made as to the result of the expression of opinion by members of this Society and other engineers to whom letter of November 28th was issued by the President of the Society relative to the inclusion in the Building Code of a paragraph in regard to drawings being signed by registered architects and registered civil engineers. The following motion, duly seconded, was carried.

“Moved, That it is the sense of this meeting that the clause referred to in letter of November 28, 1924, signed by Mr. James M. Robert, President, be adopted in substance and that a committee of three be appointed to confer with the architects as to the final wording of the paragraph with the instruction to the Committee that the word ‘civil’ preceding the word ‘Engineer’ be omitted and that it be made clear that for the structural work only the signature of a registered civil engineer be required.”

Thereupon President Garsaud appointed the following committee to carry out the above:

MR. A. T. DUSENBURY, Chairman;
MR. S. M. YOUNG,
MR. B. H. GREHAN.

Mr. E. F. Delery read a most interesting and instructive paper on "Structural Features of the Additions to the New Orleans Water Plant." This paper was followed by an interesting discussion. The speaker was attended a rising vote of thanks.

A moving picture showing "Zonel and Nickel from Mines to Finished Product" was shown by the courtesy of Mr. Edward Schwartz, representing the International Nickel Company.

A rising vote of thanks was then tendered Mr. Schwartz.

The meeting then adjourned to the collation which was served at the Victor Restaurant.

F. A. MUTH, Secretary.

Special Meeting of the Board of Direction, February 9, 1925.

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

The matter of recommending to the Governor the names of members of the Louisiana Engineering Society to fill vacancies on the Board of State Engineer Examiners was brought up.

On motion, duly seconded, it was voted that the President be authorized to submit such names of members of the Society as he deemed appropriate.

The meeting then adjourned.

F. A. MUTH, Secretary.

Minutes of Board of Direction, March 9, 1925.

The meeting was called to order at 7:45 p. m. in the DuBarry Room of the Roosevelt Hotel by President Garsaud, and the following were present: Messrs. Lanphier, Moses and Muth.

Reading of minutes of previous meeting were dispensed with and bills on hand were ordered paid.

It was with deep regret that announcement was made of the death of Mr. E. W. Wheeler Carr, Resident Member. President Garsaud appointed the following committee to draft resolutions on the death of Mr. Carr. J. S. Barelli, Chairman; O. P. Adams, A. M. Scott. On motion duly seconded, it was voted that a copy of the resolutions prepared by the committee be furnished the family of the deceased and that a copy be spread upon the minutes of the Society.

The resignation of Mr. J. K. Wolf was accepted with regret.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

Minutes of Informal Dinner Meeting of the Society, March 9, 1925.

Prior to the Regular Meeting a dinner was given in honor of the speaker of the evening, Mr. Lee H. Miller, Chief Engineer, American Institute of Steel Construction. The dinner was held at 6:00 p. m. in Room E, Roosevelt Hotel. President Garsaud introduced the toastmaster, Mr. A. B. Davis, and during the course of the dinner several of those present were called upon for addresses of welcome to Mr. Miller. The dinner was much enjoyed by all. There were forty-seven in attendance. Immediately after dinner the meeting adjourned to the regular meeting of the Society, which was held in the DuBarry Room of the Roosevelt Hotel.

Minutes of Regular Meeting, March 9, 1925.

This meeting was held in the DuBarry Room of the Roosevelt Hotel. The meeting was called to order about 8:00 p. m. by President Garsaud, and 142 members and guests were present.

Reading of minutes of previous meeting was dispensed with.

President Garsaud announced that the meeting was held in conjunction with meetings of the American Institute of Steel Construction, and he introduced Mr. Robert W. Wolcott, President of the Contractors and Dealers Exchange of New Orleans, and General Manager of Lukens Steel Company. Mr. Wolcott gave an interesting summary of the work of the American Institute of Steel Construction, then introduced Mr. Lee H. Miller, Chief Engineer of that Institute.

The technical exercises of the evening consisted of a most interesting and instructive address by Mr. Lee H. Miller, on "The Design, Fabrication and Erection of Structural Steel." Following the address there was considerable discussion.

A rising vote of thanks was tendered the speaker, and the meeting then adjourned.

F. A. MUTH, Secretary.

The Proceedings of the Louisiana Engineering Society

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DOUGLAS ANDERSON, Editor.

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LOUISIANA ENGINEERING SOCIETY

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PROCEEDINGS

OF THE

LOUISIANA ENGINEERING SOCIETY

VOL. XI.

JUNE, 1925

No. 3

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EDITORIAL NOTES AND COMMENT

The New Louisville and Nashville R. R. Bridge. While the Louisville and Nashville is one of the big railroad systems of the South, that section of it between New Orleans and the Gulf Coast is of special interest to the people of this city. This interest is now heightened by the tremendous boom in property values which is attracting the attention of the country to a degree only secondary to that of similar conditions in Florida.

That particular section of the road between Chef Menteur and the Rigolets presents serious difficulties, not only of construction, but to an even greater degree of maintenance. The area consists of marshy islands intersected at many points by waterways, the two above named being both quite wide and very deep. The land itself is just about at Gulf level and the

road bed is eight feet above this. Storm tides in 1915 rose above the level of this road bed.

At ordinary times, even with the low tides which prevail in Lake Borgne, there are very strong currents moving through these passes. When a tropical storm, like the ones of 1909 and 1915, comes along, the bridges are subjected to destructive forces which are greater than the older types have been able to withstand.

The two new bridges, one of the principal structural features of which is described in Mr. Elam's paper, have been designed and constructed especially to cope with the abnormal conditions which prevail at the time of such storms.

The particular feature which is the subject of the paper is the application of the open dredging process to the sinking of the deep piers required for each of these bridges.

The paper as presented by Mr. Elam was illustrated with a large number of lantern slides, some of which are reproduced here as illustrations for the published paper.

In the discussion of the paper Col. Shaw calls attention to an interesting point in the design of these new bridges, illustrated by the use of the through open type of girder construction as opposed to the deck girder spans used upon the old bridges.

The Young Engineer and the Activities of the Society. The principal feature of this issue is a technical paper written by a young man who is a senior student in the Civil Engineering Course of the College of Engineering of Tulane University. In closing the discussion on this paper Col. Garsaud took occasion to call attention to what he considers an advantage which the young engineer has over his older colleague in the matter of preparing a technical paper, viz.: the ability to go thoroughly into details. However this may be, it is certain that the Louisiana Engineering Society presents opportunities to the young engineers of this city which they should not neglect. The Society offers the privileges of its membership to the senior engineering classes of our two universities, and its monthly meetings and social activities assist them, and other young

engineers, to become acquainted with the leaders of the profession in this city and community. While it affords them opportunities it likewise imposes upon them certain responsibilities which they should accept really in the light of opportunities. They should try to take an active part in its work, and, if possible, make some contribution to its technical program. Engineers are notoriously modest,—too much so,—but many of the younger men are working on projects, some feature of which could really be worked up into a good paper to be read before the Society.

Perhaps the Committee on Technical Papers might undertake next season to make a sort of survey of the professional activities of the younger men and suggest to them subjects upon which they might be able to contribute papers to the Society.

Discussion of Col. Townsend's Paper. It might be well here to repeat a suggestion which the Editor has already made to Mr. Muth concerning the discussions of the paper on Spillways. These discussions will, of course, be written and they should be submitted in duplicate so that the Secretary may send one copy to Col. Townsend for his information and use in connection with any further discussion he might care to submit on the subject. Such manuscripts should be submitted to Mr. Muth early in July in order to have them appear in the August issue along with the original paper.

The Norman Disaster. The sad news of this fearful accident brought to many members of this Society a feeling of personal loss, the engineers and their families who lost their lives, numbering many friends and acquaintances among our members. Sad as this was, our hearts were filled with thankfulness at the later reassuring news that our fellow member and good friend, Mr. J. Frank Coleman, had escaped almost miraculously from the fate which overtook so many of his friends.

President Garsaud appointed a committee to draft resolutions of sympathy to be extended to the Memphis Engineers' Club, and this committee offered the following resolution:

New Orleans, La.,
May 20, 1925.

RESOLVED that the Louisiana Engineering Society extends to the Memphis Engineers' Club, and through them to the bereaved family of each victim of the Norman disaster, their sincere and heartfelt sympathy in this great calamity.

RESOLVED that a copy of this resolution be spread upon the Minutes of the Society, and that a copy be forwarded to the Memphis Engineers' Club.

MARCEL GARSAUD
President

F. A. MUTH
Secretary

Committee:

CHAS. JOHNSON
Chairman

W. B. GREGORY

SAM'L YOUNG

"Put It in the Upper Left Hand Corner!" The Post Office Department through its Information Service is conducting a campaign against the large and needless waste occasioned by careless addressing of mail matter. This is one of their recent releases:

DO YOU KNOW?

THAT 21,000,000 letters went to the Dead Letter Office last year?

THAT 803,000 parcels did likewise?

THAT 100,000 letters go into the mail yearly in perfectly blank envelopes?

THAT \$55,000.00 in cash is removed annually from misdirected envelopes?

THAT \$12,000.00 in postage stamps is found in similar fashion?

THAT \$3,000,000.00 in checks, drafts and money orders never reach intended owners?

THAT Uncle Sam collects \$92,000.00 a year in postage for the return of mail sent to the Dead Letter Office?

THAT it costs Uncle Sam \$1,740,000.00 yearly to look up addresses on misdirected mail?

THAT 200,000,000 letters are given this service, and—

THAT it costs in one city alone \$500.00 daily?

AND DO YOU KNOW?

THAT this vast sum could be saved and the Dead Letter Office abolished if each piece of mail carried a return address, and if each parcel were wrapped in stout paper and tied with strong cord?

MORAL: Every man knows his own address if not that of his correspondent.

PUT IT IN THE UPPER LEFT HAND CORNER!

PAPERS AND DISCUSSIONS

THE OPEN DREDGING PROCESS AND ITS APPLICATION TO DEEP FOUNDATION SINKING IN THE NEW L. & N. RAILROAD BRIDGES AT CHEF MENTEUR AND RIGOLETS, LA.

BY E. E. ELAM,

Senior in Civil Engineering, Tulane University.

Read Before the Society, Monday, April 13, 1925.

The purpose of this paper tonight is to entertain, not bore the Society. This may be partly accomplished, for the writer appears, not as an engineer, but as a student in engineering with limited experience. However, he has had the opportunity of studying deep foundation work first hand during the summer months of last year, having been employed on the engineering staff resident on the construction of the two bridges in question. With the help of the slides which will be shown later, the writer feels that a clear conception of the open-dredging process as applied to deep bridge foundations may be had with the minimum of effort.

At the present time the City of New Orleans is vitally interested in several large bridge projects, which include the bridging of the Mississippi River, of Lake Pontchartrain and of Chef Menteur and Rigolets Passes. These bridges are still matters of debate and they are far from being built. However, there are two large bridges now under construction in Orleans Parish which are models of modern bridge engineering, being successfully built under unfavorable conditions and in defiance of tropical hurricanes. These are the two Louisville and Nashville Railroad bridges crossing Chef Menteur and Rigolets Passes, the former at a distance of twenty-two miles, and the latter thirty-three miles east of New Orleans, on the L. and N. main line. The two structures represent an investment of over five million dollars, a just tribute to the future growth of this city.

Everyone present tonight at some time or other has traveled over the L. and N. R. R. between New Orleans and the Mississippi coast, so it seems rather unnecessary to describe the land,

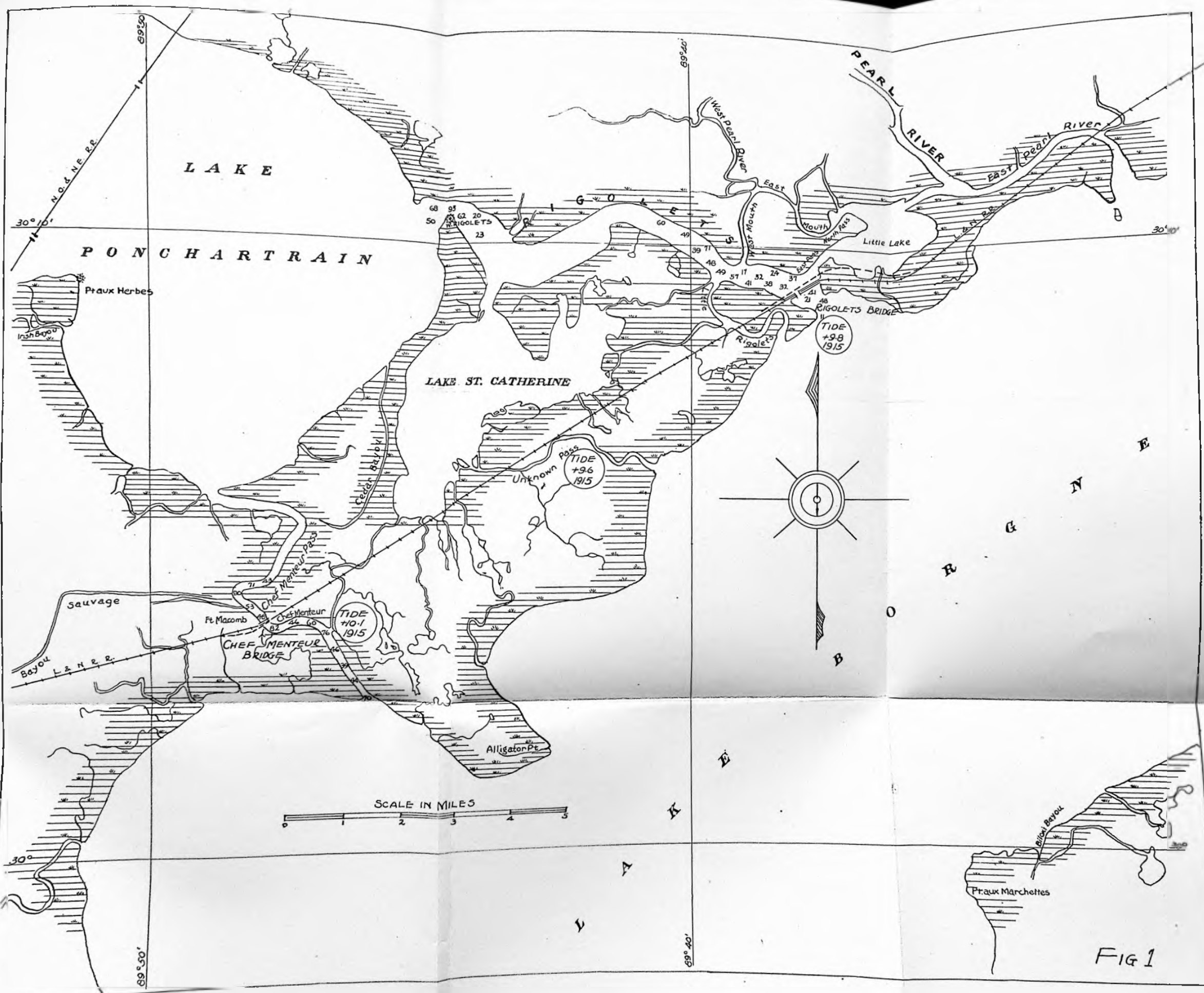


FIG 1

if we are permitted to call it such, between and on either side of these bridges. To put a railroad through such a country was indeed a feat in railway location, and to keep it there has called for a vast expenditure of money.

Figure I, a section taken from the U. S. Coast and Geodetic map of Lake Borgne and Approaches, shows clearly the section between Chef Menteur and the Rigolets, a group of marsh islands cut up by numerous waterways. It is apparent that the tide waters of Lake Pontchartrain must pass through the Chef, the Rigolets, and the several other outlets. The marsh is about at sea level and the road bed is approximately eight feet above the marsh. Tide levels during the 1915 storm show that the water reached above the present elevation of road bed.

According to the meagre sources of information available to the writer on the past history of this particular section of the road, the track at first was laid at high water level, and it was thought for a time that tidal waters from storms would pass over the right-a-way in a wide sheet and cause comparatively little damage. It is obvious, therefore, that the two passes were relieved of excess water, which was backed into Lake Pontchartrain, during times of storm. According to an old L. and N. bridge foreman who was kept busy repairing the two bridges, several of the steel plate girders used as spans between wood pipe piers were swept away during the storm of 1909, and the damaged sections were replaced with pile trestle where possible.

It is the conclusion of the writer after passing over the swamp lands daily for several months, and after seeing how several bayous were shut off during the subsequent raising of the road bed, that Chef Menteur and Rigolets Passes were called upon to carry more water than before, which resulted in the deepening and widening of these waters ways. Old inhabitants of Chef Menteur claim that that pass increased in width almost doubly in a comparatively short time. It remained, however, for the storm of 1915 to settle beyond doubt the need of new bridges at these crossings; bridges that could withstand the fury of a 140-mile hurricane, that could clear a twelve-foot

tide and be capable of withstanding current and wave action of vast amounts.

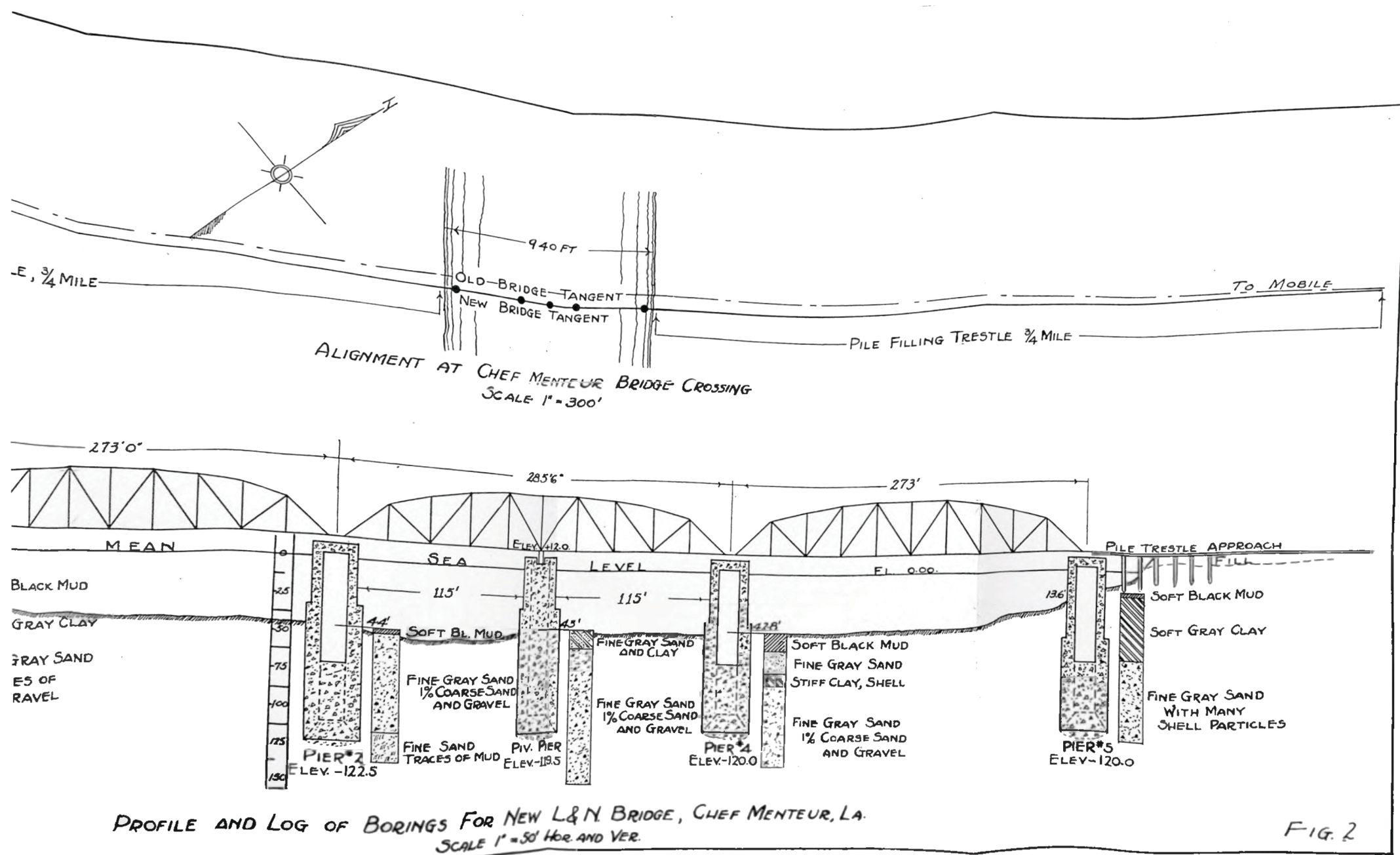
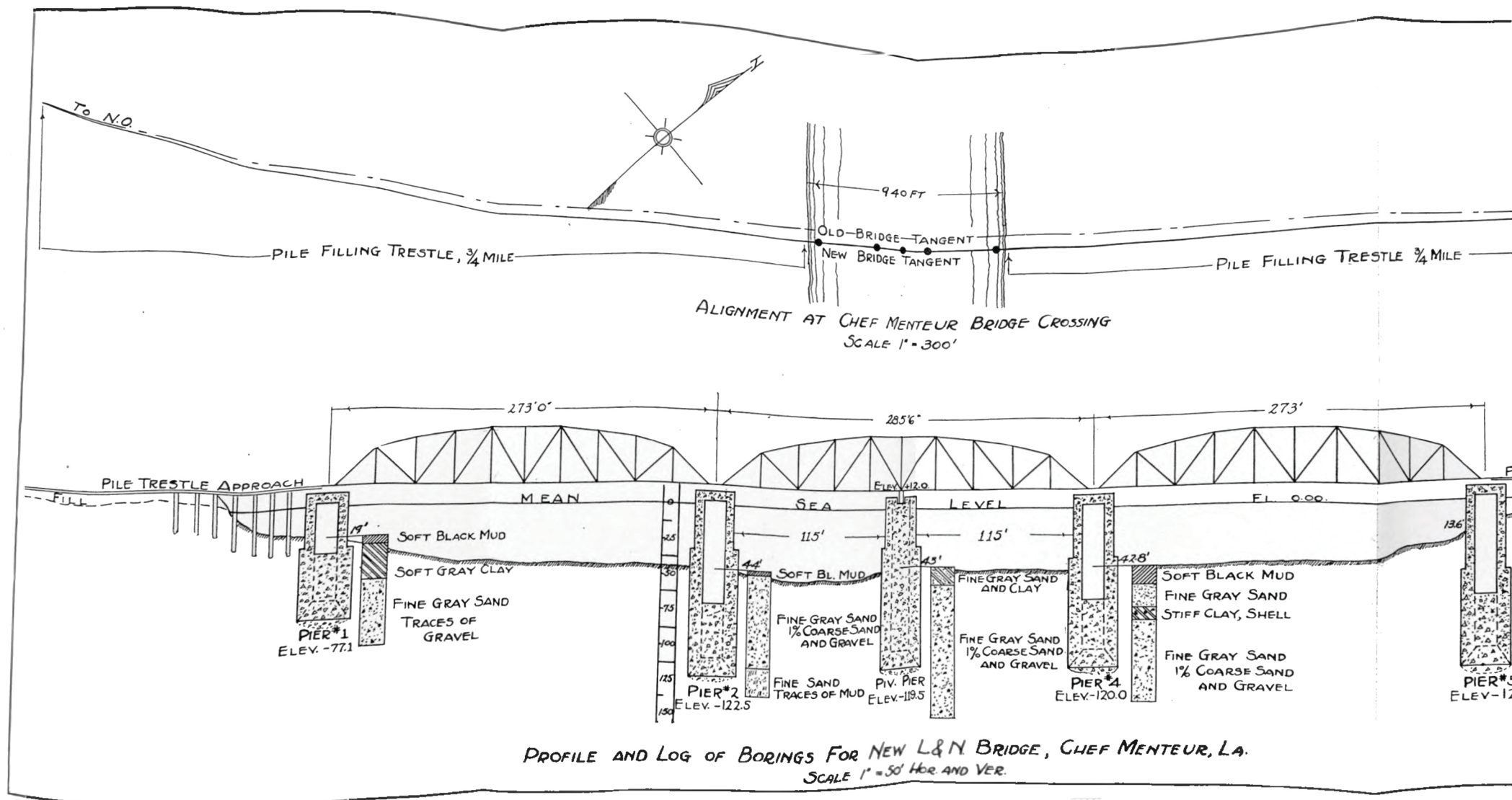
The proper design of substructure to meet the above conditions was the important part of the bridge undertaking. Test borings made in 1916 showed that proper foundation could be gotten from 90 to 120 feet below mean low water.

At this point reference to Figure II will prove interesting, in that it shows a log of the test borings made by the L. and N. R. R. in 1916, taken from the original print furnished through the courtesy of the Engineering Department. The profile of Chef Menteur was taken as the better example of the two crossings, for at this place the piers are considerably deeper than at the Rigolets.

The design of piers decided on was that of a hollow cylindrical type of heavily reinforced concrete, 34 feet in diameter at the base, 23 feet at the top, and sealed at the base and capped at the top securely with concrete. Figure III shows a rather hurried sketch of the pier details drawn especially for the making of a slide. The left hand section, Figure 3-A gives the bare outlines of the pier, showing the jet pipes and steel shells fitted together at the base by means of a cone section which forms the dredging chamber. The jet pipes were two inches, and 21 in number, distributed uniformly around the cutting edge, and were capable of being used at 200 pounds per square inch pressure in case of necessity. As sinking proceeded the plate and pipe were lengthened in 6 foot sections.

Figure 3-B shows the finished pier. In this section the jet pipes have been purposely omitted to show the reinforcing steel and cone braces. The latter consists of 4"x4"x4 $\frac{1}{4}$ " angle iron rivetted up to form a truss, which is very effective in strengthening the cutting edge. Figure IV gives a good view of the cone braces, and shows clearly the method of connecting the outside and inside steel shells.

After carefully examining such treatises as Fowler's "Sub-Aqueous Foundations" and Waddell's "Bridge Engineering," the writer was unable to find a rational method of pier design to cover the type of foundation just described. Both authors hold that the importance of skin friction on deep piers founded



on soft materials should not be underestimated, and recommend that skin friction of 400 to 600 pounds per square foot can be safely figured on. It is deemed good practice to seal the caisson at the base when it refuses to sink under its own weight, or better, under temporary loading. Doubtless the practice of pier design is a matter of wide experience and judgment, and no typical analysis can be made to cover any number of cases, as each bridge in itself represents new problems. It is claimed by the L. and N. engineers who designed the piers that skin

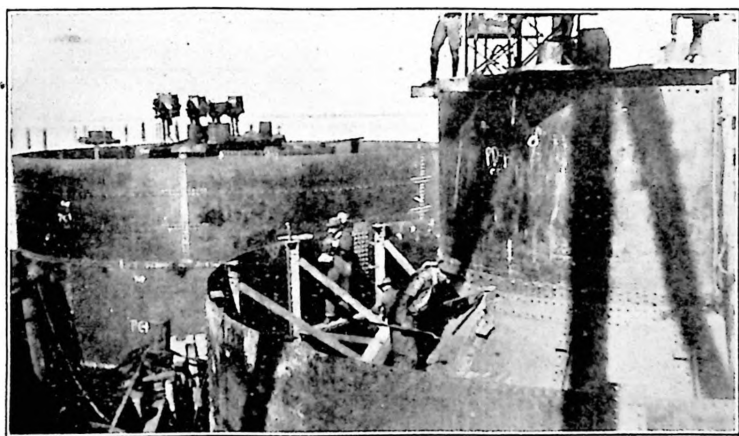


FIG. 4

friction alone is sufficient to hold up any possible load which could be encountered.

In sinking the piers for the L. and N. bridges the open dredging process was used. The distinguishing features between this method and the other known as the pneumatic process are the absence of compressed air, and workmen in the dredging chamber where excavation takes place. In modern steel caisson work the open dredging process consists merely of sinking two concentric shells of steel rivetted together at the base by means of a trusscut cone section, to form a cutting edge, which penetrates through the mud or sand as excavation proceeds. Concrete is deposited between the two concentric



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cylinders, thus giving weight sufficient to force the cutting edge through the materials loosed by the clam shell bucket during excavation. Once the caisson is started down properly and after the cutting edge is several feet below the mud line, the process consists in an alternate addition of steel in sections and the depositing of concrete between the shells as dredging proceeds in the dredging well.

Figure IV shows the steel cylinders being rivetted up before sinking is started. Care must be exercised at this point to secure water tight joints. After the work has been carefully inspected the steel shell is launched from the erection pontoon

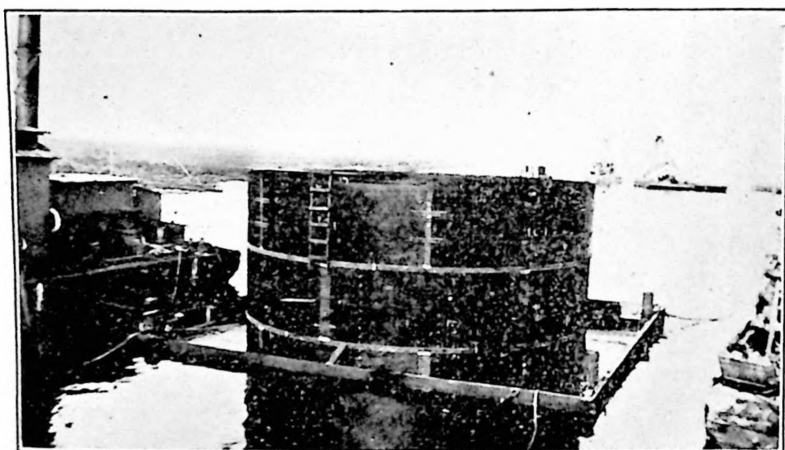
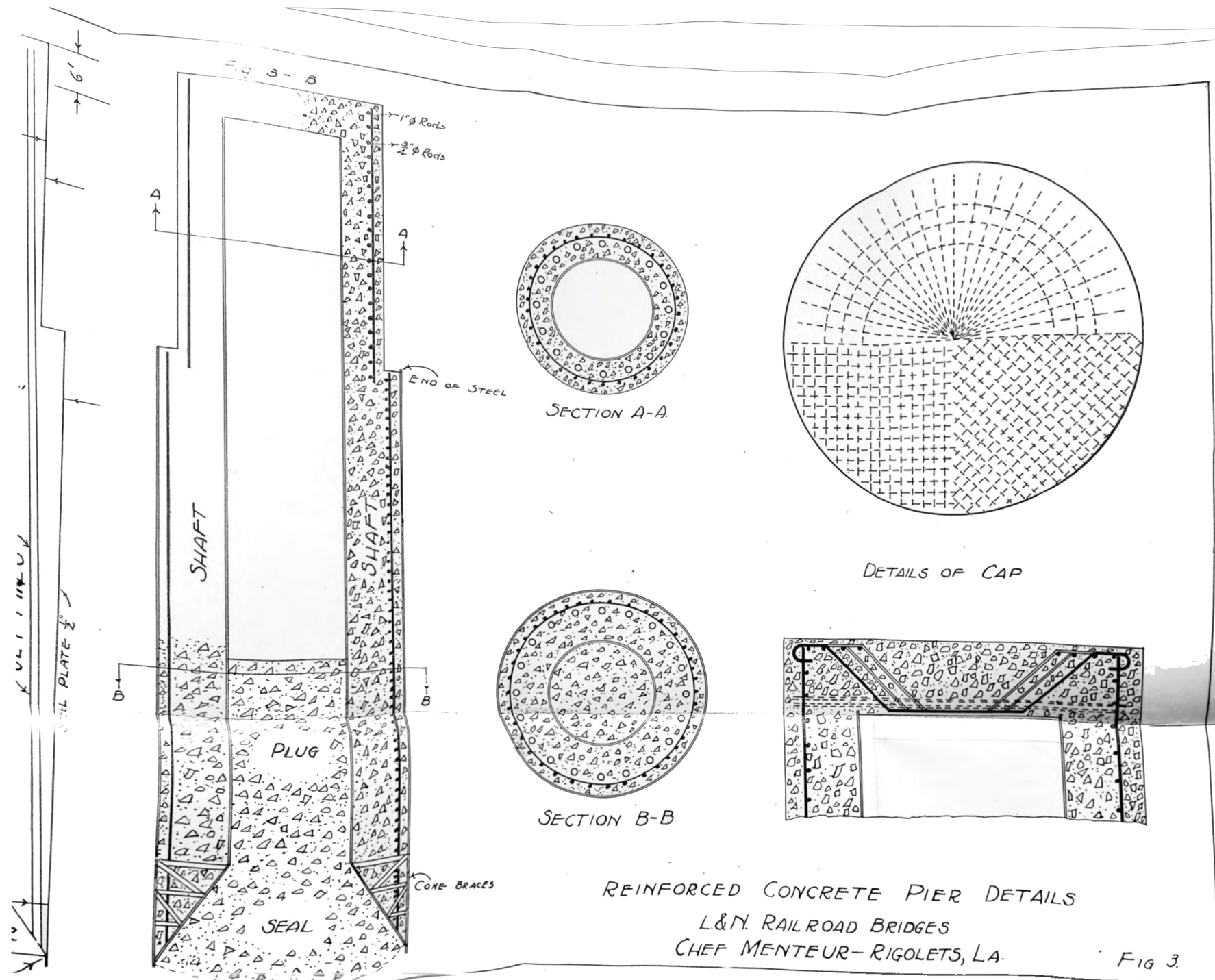
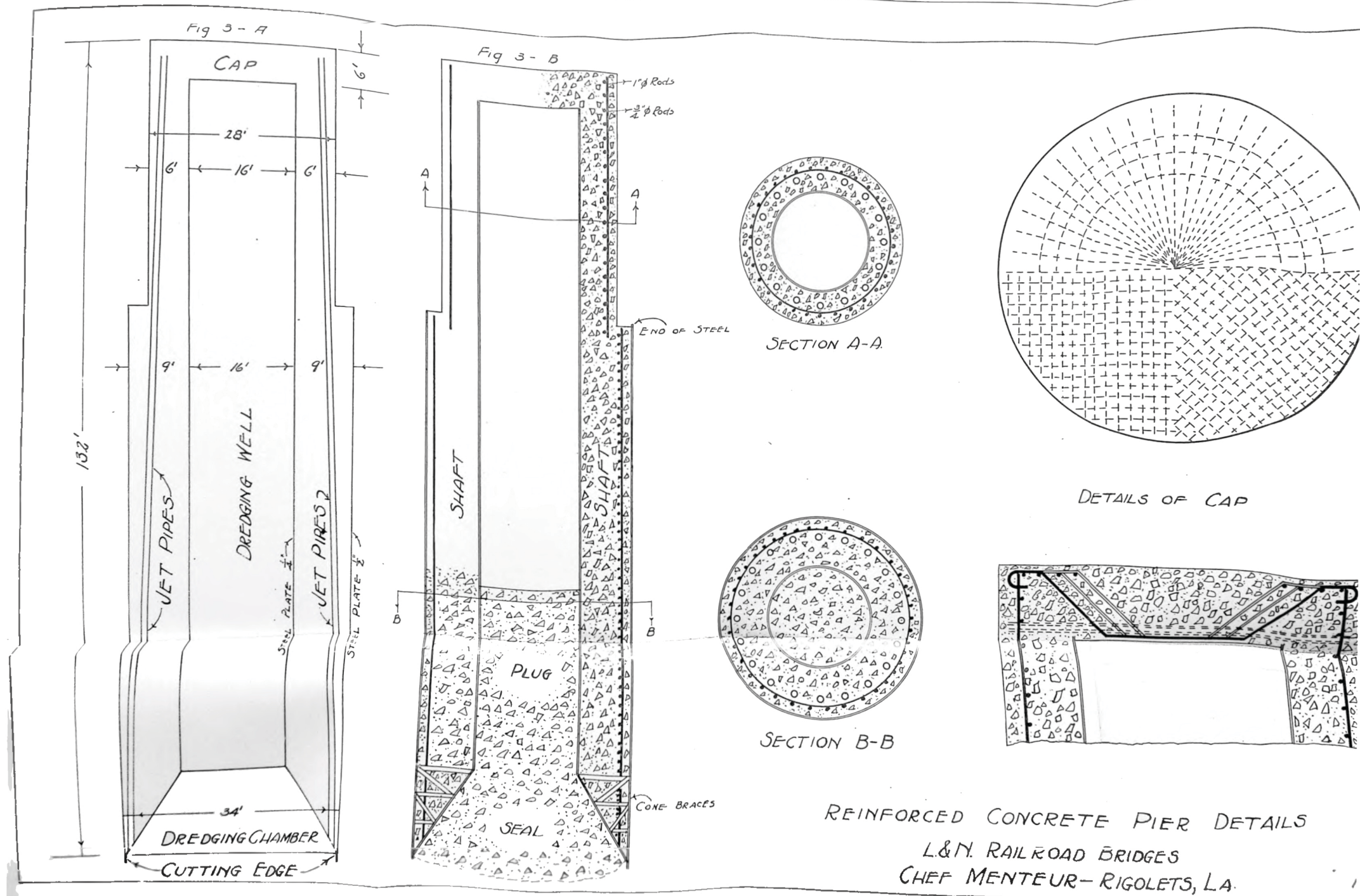


FIG. 5

by flooding, as is shown in Figure V, and towed to the location of sinking, where it is firmly held in position with guide piles, after being centered from suitable triangular stations.

In most instances sinking proceeded at a fair rate until the caisson was at a depth such as is shown in Figure VI. From this point on, the outside steel is replaced by removable forms, and sinking proceeded with until the outside steel was well below the mud line. Side friction at this point was just enough in most cases to prevent further sinking due to weight. The practice of "shooting down" with dynamite was successfully used in such instances. Figure VII gives another view of the



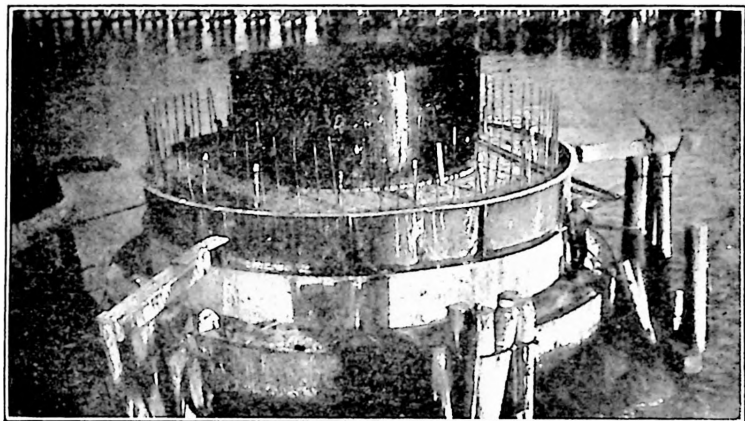


FIG. 6



FIG. 7



caisson after the last batch of concrete had been poured just before the placing of the reinforced cap, the details of which are shown in Figure III. However, before the caisson is "capped" it must be properly sealed at the base, and to accomplish this the concrete was deposited through water after being properly enriched to take care of washing.

To permit the caisson to be sunk without giving some information on the quantities and kinds of materials embodied and the methods of proportioning same, and the principals connected with the work would be altogether unfair. Each pier represents a combination of approximately 25 carloads of cement, 7 carloads, or 650,000 pounds, of steel plate, several tons of reinforcing iron, and enough sand and gravel to give the required 1:2:4 mix which was used. Jahneke Service, Inc., furnished approximately all these materials, and fabricated the steel in their New Orleans shops.

Great care was given to the mixing of the concrete used. Water was hauled for a considerable distance to prevent the use of the brackish water of Lake Borgne. Water content was kept low, a slump of about four inches was insisted on.

The work was performed by the Missouri Valley Bridge and Iron Company, of Leavenworth, Kansas, under the supervision of D. Hedrich, superintendent, and Frank Harrison, of Jacksonville, Florida, as engineer. The L. and N. Railroad was ably represented by George G. Bryson, resident engineer, who had full charge of the work.

The writer feels loath to again digress from the specific and go into the general, but it is only through the consideration of the two methods of deep foundation sinking and their comparison that a practical and working knowledge may be had and the limitations known of the open dredging process.

The other process, known as the pneumatic, may be compared to an inverted glass in a vessel of water. On forcing the glass downward the water surface will rise until the pressure or the confined air balances the head of water between the confined and free surfaces. In the actual process the glass is replaced by an air-tight steel or wooden chamber open at the bottom and accessible through the top by means of air-tight

locks to permit the passage of workmen, excavated material and compressed air. During excavation pressure must be maintained in the air chamber equal to that of the water head outside. When it is desired to sink the caisson the pressure is released and the cutting edges sink through the partly excavated and loose materials due to the weight of the air chamber. So it is apparent that beyond a certain depth it is unwise to subject workmen to the excessive pressures required, and for this reason the use of the pneumatic process is limited to depths of about 110 feet.

A departure, however, from the general practice of pier sinking by the open dredging process was effected in the foundations under discussion, in that the process was readily convertible into a pneumatic process, within the allowable depths, by simply capping the inner steel shell with a specially devised dome equipped with the necessary locks and pipe connections. This was a special precaution against sunken pile and steel of old bridges lost during former storms.

The open dredging process for deep foundations has been in use only about thirty-five years, and it was devised and perfected by American engineers to meet the ever-growing demand for deeper foundations through relatively soft materials. Some of its oldest examples are: the Poughkeepsie Bridge over the Hudson River, where a depth of 134 feet below high water was reached; the Morgan City Bridge, over the Atchafalaya River, where eight-foot cylinders of steel were sunk to a depth of 120 feet below high water; and the Hawkesbury River Bridge in Australia, where a depth of 134 feet was reached. Probably the greatest depth ever obtained was on the bridge over the Ganges River at Sara, India, where one of the piers was landed at a depth of 185 feet below high water. It is interesting to note at this point that the proposed depths of the Mississippi River Bridge at New Orleans will be about 250 feet below Gulf level, and is probably the greatest depth yet proposed by the open dredging process.

The following passage is taken from the Report of the Board of Advisory Engineers made to the Public Belt Railroad of New Orleans, La., in 1919, on the "Mississippi River Rail-

road Crossing at New Orleans and Plan of Terminal Development," and represents the conclusions of Dr. J. A. L. Waddell, bridge specialist of that board. "The greatest depth below water yet obtained by the open dredging process is 185 feet, but this is no reason why much greater depth cannot be attained. In estimating for side friction on caissons it is customary among bridge engineers to assume 400 pounds per square foot as the reliable resistance that relieves the pressure at the base and 600 pounds per square foot as the resistance which opposed the sinking. With 300 pounds per square foot required to stop the sinking it is evident that there will be no trouble involved in going down with the caissons to an elevation of minus 250 feet." The maximum of 300 pounds per square foot represents the caisson weight at the 250-foot depth divided by the surface area of the underground section.

As far as records are available the maximum depth of 122 feet below Gulf level to which several of the L. and N. caissons were landed is probably the greatest yet reached in the southern part of this country.

This paper was at first intended to cover the phases of construction of the two bridges in question only, but the writer found the practice of deep pier sinking so interesting that he has made frequent references to other bridges, and will, with your approval, continue the discussion on more general lines. The following is taken from Dr. J. A. L. Waddell's "Bridge Engineering," the author of which is probably the greatest American authority on the matter of bridge pier sinking, and will prove very interesting in comparing the two methods used in bridge pier construction:

"Open Dredging vs. the Pneumatic Process. The conditions under which the open dredging process is favorable to deep pier sinking are, (1), where the foundation is too deep to be reached by the pneumatic process, and (2) where the foundation at the depth to be attained is sand, gravel, or other hard material that is protected thoroughly against scour. However, when depths to be reached are between 30 and 100 feet the pneumatic process is best suited.

When compared in dollars and cents the cheaper of the two is the open dredging process. In the latter

there is no expensive pneumatic machinery to ship back and forth and keep in repair; there are no expensive 'sand-hogs,' as the pneumatic caisson workers are called, to be employed; there is no danger to workmen from compressed air, and there is greater daily progress in sinking. The open dredging process gives greater effective weight in sinking as the total mass of the pier can be depended upon, but in the pneumatic process the weight of the working chamber alone is realized in forcing the cutting edges through the foundation material.

While in most cases of deep foundations where there is any choice between the two methods, the open dredging process in all likelihood will prove cheaper, but it is wiser not to adopt it unless the final bearing be sand or gravel, because it is better to pay a little more for the certainty of sinking which the pneumatic process insures. Again it would not be good engineering to adopt the open dredging process for a rock foundation that is easily reached by the pneumatic process, because the cutting edge of the caisson would be almost certain to take an uneven bearing on the rock and this only could be rectified by the use of divers at a great expenditure of time and money. Moreover, if the bed rock is higher on one side of caisson than the other it is liable to cause tipping of the pier which is difficult to overcome without the aid of compressed air.

It is difficult to give the comparative costs per cubic yard for sinking caissons by the two processes, for so much depends on the location of the bridge, the magnitude of construction, the nature of the materials penetrated, the amount and character of obstructions and various other conditions. Under the most favorable conditions the cost per cubic yard for sinking by the open dredging process is one-half of that for the pneumatic, for fairly good conditions it is about the same; and in case of striking large logs it is sometimes more expensive."

Discussion.

MR. KEMPER: Did I understand you to say the Morgan City Bridge was the open dredging process?

MR. ELAM: Yes, it was, only they used an eight-foot pier, one hundred and twenty feet deep.

MR. KEMPER: Are you sure of that? The reason I ask you that, I understand they were using pneumatic process.

MR. ELAM: They can't use the pneumatic process at one hundred and twenty feet.

MR. KEMPER: I happened to be there one day, and they brought a man out and they said he had collapsed under this pneumatic process, and I heard it talked so generally. I believe the bridge to which you have reference is one on the Lafayette-Baton Rouge branch of the Southern Pacific; I understand they had trouble. The Frisco also had trouble.

MR. ELAM: They had to sink two larger piers to support the one which slid out of the original position.

MR. COLEMAN: I think you are mistaken in stating that the Morgan City was an eight-foot pier; I think you have that mixed up with the Gulf Coast Lines crossing the Atchafalaya further up.

MR. STEINMAYER: How is it they make borings, and what type of machinery do they use in making them?

MR. ELAM: I cannot tell you, but I know this: the piers in the Chef Menteur bridge were sunk very close to the calculated borings, some were sunk within three-tenths of a foot of designed depth. I do not know how the borings were made, whether they were core or wash borings.

MR. GALLAGHER: Were there any difficulties encountered in sinking the caissons?

MR. ELAM: I understand in the Rigolets job some stumps were struck.

MR. GALLAGHER: Do you know at what depth they were struck?

MR. ELAM: There were three or four layers of stumps, and some shells, the exact depths of which I do not know.

MR. DERICKSON: Mr. Elam, I would appreciate a little more information on the use of the explosive in sinking the caisson. How much was used?

MR. ELAM: They used in this operation two or three sticks of dynamite per shot, sixty per cent., and it was lowered down

under water and set off in the dredging well. The dynamite did the work well, forcing the caisson down a foot or more at each shot.

THE CHAIRMAN: Did they have any chance to examine the concrete after the dynamite went off?

MR. ELAM: At Rigolets they did, and there was no damage.

MR. O'NEILL: Did they have to use any dynamite when they struck the stumps?

MR. ELAM: In one case they sent a diver down at Rigolets to cut the stumps out. They didn't have to use any divers on the Chef bridge. I have a set of original borings here which Mr. Steinmayer gave me of the Chef Menteur bridge. Any of you gentlemen who are interested may look at them.

THE CHAIRMAN: There is one thing that impressed me in listening to this paper, that is the clearness with which the young engineer tackles the subject, and also the thoroughness with which he describes the details. I think most of us who are old in the business are prone to forget the details. Most of us can talk about things in general, but when we go to talk specifically, as Mr. Elam has done, it requires a good deal of work and thought. I believe this paper shows that Mr. Elam put a good deal of thought into the matter of details. He presented it in such a way that it did not bore us, at least I was not bored, and I think I have learned quite a few things from that paper tonight. Does the Society wish to discuss Mr. Elam's paper any further?

COL. SHAW: I would like to bring out one point that perhaps may be of interest and to go a little further into the reasons for selecting that particular type of structure. It happens that I was retained by the Public Service Commission several years ago when they ordered the L. and N. to rebuild the bridge, and it was the opinion at that time, which was thoroughly concurred in by the L. and N. officials, that the type of bridge which they were using was not fitted for those crossings on account of the extreme resistance they presented to the storm action. The L. and N. bridge, prior to the storm of 1909, was composed of deck girder spans, resting on pile trusses, and they were exposed to the force of the waves at all ordinary high tides, so that extreme pressure was brought against them. The

draw span at the Rigolets was the only part of the two structures which was never injured at any time during any of the storms. A draw span is ordinarily considered the weak portion of a bridge, but that span being of the through open type construction, stood all the storms that ever came against it, the only injury which it has suffered being from collisions of boats. That is the reason they adopted the through trusses. It is expected that these will pass storms without any material damage to the structure.

MR. DERICKSON: In moving a vote of thanks to Mr. Elam, I know he has a busy program from the time he gets up in the morning until the time most of us finish our work, and that he prepared this paper when many others were seeking recreation, in order that he, as a student, might contribute his part to the activities of the Louisiana Engineering Society, therefore I move a rising vote of thanks to Mr. Elam.

MINUTES OF MEETINGS AND BUSINESS OF THE SOCIETY.

Minutes of the Board of Direction, April 13, 1925.

The meeting was called to order with President Garsaud in the chair and Messrs. Lanphier, Elliott, Adams and Muth present.

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

The resignation of Mr. E. N. Ehrhart was accepted with regret.

The matter of holding a spring outing was discussed and on motion duly seconded it was voted that the matter be referred to the Society so that the outing committee could be informed as to the wishes of the members in the matter.

The meeting then adjourned.

F. A. MUTH, Secretary.

Minutes of the Regular Meeting of the Society, April 13, 1925.

The meeting was called to order with President Garsaud in the chair, F. A. Muth, Secretary, and present sixty-eight members and guests.

The minutes of the previous meeting were read and approved.

The President announced his intention to call for reports at each meeting from the Chairmen of all committees and interesting reports were made by the various committees of the work accomplished by them during the previous month.

Professor W. B. Gregory, Chairman of the Committee on Preparation of Legislation for Engineering Licensing, etc., submitted report and requested that his committee be discharged. On motion duly seconded, it was voted to receive the report of this committee and discharge the committee as requested; also that the President appoint a committee of seven members to be selected from and representing mechanical, civil, electrical and chemical engineers.

Professor James M. Robert submitted an interesting report of the meeting of the American Engineering Council which he attended as delegate from our Society in January.

The action of the Board of Direction in referring the matter of spring outing was taken up by the Society with view to holding such an outing in accordance with plans to be developed by the Committee on Entertainment and Outing. After discussing the matter, on motion duly seconded, it was voted that the Society hold a spring outing and that the details be turned over to the Outing Committee. This motion was unanimously carried.

The technical exercises of the evening consisted of an interesting and instructive address on "Construction of Deep Foundations of the L. and

N. Bridges over the Rigolets and Chef Menteur'' by Mr. E. E. Elam. The paper was followed by interesting discussions. A rising vote of thanks was tendered the speaker.

The meeting then adjourned to collation at the Victor Restaurant.
F. A. MUTH, Secretary.

Minutes of Board of Direction, May 11, 1925.

The meeting was called to order with President Garsaud in the chair and Messrs. Elliott, Robert, Lanphier, Moses and Muth were present. Messrs. Locket and Olsen of the Committee on Entertainment and Outing also attended the part of the meeting devoted to a discussion of the outing.

The reading of the minutes of the previous meeting was dispensed with and bills on hand were ordered paid.

The matter of an outing was discussed and Messrs. Lockett and Olsen expressed their views for the benefit of the board.

On motion duly seconded, it was voted that an outing across the lake be decided upon and that the details be arranged by the Committee on Entertainment and Outing.

President Garsaud announced the following committee appointed to draft resolutions on the Norman disaster and to furnish copies of the resolutions to the Memphis Engineers and their bereaved families, also for spreading on the minutes of the Society: C. Johnson, Chairman; Prof. W. B. Gregory, S. M. Young.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

Minutes of the Society, May 11, 1925.

The meeting was called to order with President Garsaud in the chair, F. A. Muth, Secretary, and present 147 members and guests. This meeting was held in Gibson Hall, Tulane University.

The reading of the minutes of previous meeting was dispensed with.

The technical exercises of the evening was a most interesting address on "Spillways" by Col. C. McD. Townsend, District Engineer, New Orleans. Everyone present enjoyed the splendid paper of Col. Townsend, which was followed by considerable discussion. A rising vote of thanks was tendered the speaker.

The meeting then adjourned.

F. A. MUTH, Secretary.

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DOUGLAS ANDERSON, Editor.

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PROCEEDINGS OF THE LOUISIANA ENGINEERING SOCIETY

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EDITORIAL NOTES AND COMMENT

Spillways. Much talk has been indulged in upon this subject, some of it rather loose, and some of it coming from sources in which there was more talking than thinking. It is refreshing, therefore, and enlightening to have a statement from one who is recognized as an authority by all the parties interested. This does not mean to say that one must agree with Colonel Townsend's arguments or his conclusions as set forth in his paper on "Spillways," but it does mean that the ground has been cleared and the propositions definitely laid down by one who does not fear to express his views candidly and frankly, and whose long experience with, and deep study of the problems of the Mississippi River allow him to speak with authority thereupon. At the same time it is to be remembered that the writer of the paper has, in his long association with the Government, absorbed something of that spirit of conservatism which

in certain quarters is held responsible for the policy of "Levees Only" as a protection against the flood waters of the Mississippi. Colonel Townsend's conservatism, however, is of the scientific type which refuses to accept statements of opinion as demonstrated facts.

The data upon which to base an accurate estimate of the effectiveness of the spillway are yet to be secured, tabulated and properly co-ordinated. Crevasses are accidental spillways, but the data to be obtained therefrom seem to lend themselves to interpretations and arguments leading to diametrically opposite conclusions. Colonel Townsend believes that the spillway now under construction at Pointe-a-la-Hache, and which the Safe River Committee regards as only a compromise measure for the desired spillway at Lake Borgne Canal, will accomplish as much as the latter in the matter of lowering of flood heights. He further believes that the Pointe-a-la-Hache spillway may be used for study and observation, and for the accumulation of data, which may serve to remove this whole problem from the realm of theoretical speculation into that of scientific reasoning, for which definite data from controlled conditions are necessary.

Mr. Klorer contends that, while the Pointe-a-la-Hache project is a worthy one from the standpoint of an experiment, it may by no means be considered as a substitute for the proposed spillway near Lake Borgne Canal. He hopes that the Mississippi River Commission will avail themselves of the Pointe-a-la-Hache spillway as a means of securing experimental data for the further study of many disputed points. He seems to doubt whether the Commission will do this unless they are sufficiently urged by the proper authorities.

Colonel Townsend appears to be not opposed to the spillway idea as a method of flood control, but he doubts very seriously whether any engineer or group of engineers have enough data available to enable them to design and construct an artificial spillway that would not be prohibitive in first cost, difficult of location, or dangerous in operation.

In his closure of the discussion he calls attention to the fact that the spillway, as a means of flood reduction, is an experiment which has never been attempted on any river. A dis-

charge of 250,000 second-feet equals that of the St. Lawrence River in flood, and 1,000,000 second-feet exceeds the flood discharge of the Danube. Without more data than we now possess these are enormous forces with which to experiment.

On the occasion of the presentation of Colonel Townsend's paper it was agreed that the discussions thereon would be presented in writing, after those desiring to discuss the subject had been furnished with copies of the paper, thus permitting them to study it in detail. The following gentlemen have presented such discussions: Mr. John Klorer, Colonel Marcel Garsaud, Mr. J. P. Kemper, Mr. G. W. Lawes and Colonel A. M. Shaw. Each of these sent a copy of his discussion to Colonel Townsend so that he might use them for reference in his closure. All of these statements are published in full in this issue of the Proceedings.

Note on Mr. Elam's Paper. The Editor has received from Mr. Ira W. Sylvester, of Alexandria, an interesting note and comment on one point in the original paper which gave rise to some questions and discussion at the time this paper was read.

Mr. Sylvester's statement reads:

I have just read with interest and appreciation the Paper by Elam on the foundation work of the new L. & N. bridges at the Chef and Rigolets.

As touching on the early use of open dredging the following extract from a letter of General G. M. Dodge to Mr. W. H. Abrams, of the Texas & Pacific Railway, may be of interest.

General Dodge, who was Chief Engineer of the T. & P. Railway at the time the Melville bridge over the Atchafalaya was constructed, 1882-1883, writes of the bridge as follows:

"We were greatly delayed in the construction of this bridge from the fact that in our first soundings we got a foundation, as we supposed, below water level of sixty-five feet and started our caissons for that depth, but after putting up one or two of the piers at that depth, a flood came down the Atchafalaya and washed out some forty feet below our foundation, and that put us apparently in a fix, as we could not go down that far with pneumatic process. But Mr. Anderson, who was a very ingenious man and great at overcoming difficulties, invented what is known as the Clam Dredge, and he rigged this dredge so as to give it a fall from the grade of the

road to the bottom of the pier, which set it in the sand, and by the machinery closed it up like a clam shell, and by weighting the piers we went down in this way, 125 feet according to my recollection. The clam dredge has been used for this kind of work ever since."

It will be noted that General Dodge credits Mr. Anderson with the original development of this form of foundation work.

Tuberculation in Cast Iron Pipes. Research Narratives in its July, 1925, issue carries the following interesting article on this subject:

CAST IRON PIPE

Conveyor of Water for Civilized Communities

For a century, pipes made of cast iron have been used more extensively than any other kind, in western Europe and America, for conveying and distributing water to communities. Pipes of this material, laid in trenches in the ground in 1665, still supply water to the fountains of Versailles. Philadelphia has cast iron pipes reported to have been in service for more than a hundred years. In many other communities also cast iron pipes have given good service for long periods. But like other objects of iron, pipes are the prey of corrosion.

Though cast iron pipe rusts on the surface, seldom pitting or scaling off, yet corrosion reduces the capacity of pipes for carrying water, sometimes forming rough lumps of rust, called tubercles, inside the pipe. Not only do the tubercles reduce the bore of the pipe, but they also cut down the water-carrying capacity by their roughness, acting as a friction brake on the flowing water. Tuberculation proceeds rapidly at certain stages and under certain special conditions of water. Sometimes these tubercles so nearly fill small pipes after a number of years, that but little water gets through.

Devices for scraping the rust from the insides of pipes have been mechanically successful, but it has been a common experience that some of the pipes tuberculate again in shorter time than they did originally.

It has long been known that cement, now so familiar in highway pavements, sidewalks, bridges, buildings, and water reservoirs, would inhibit tuber-

culation of iron embedded in it. Also, cement can be given a very smooth surface. Years ago, water pipes were made of thin sheet iron lined and covered with cement mortar. Pipes of this kind did good service for a period, but, owing to structural weaknesses, they have passed out of common use.

The problem resolved itself into getting a thin, smooth, strong coating of cement on to the inside of cast iron pipes of all sizes, and making the coating stick so tenaciously that it would withstand the hard bumps of transportation and of laying in the trench. The coating must cover every spot of the interior of the pipe.

Charleston, South Carolina, like many another city, due to the nature of the water, experienced for years a material reduction in the carrying capacity of its cast iron pipes. This loss was most readily observable in the 24-inch main, 12 miles long, from the pumping station to the center of the distribution system. It increased the coal bill for pumping, reduced the quantity and pressure of water in the city, and hastened the time when more money must be invested in pipes. The pumping main had been cleaned three times. Each time its capacity was restored substantially to that of a new pipe, but after each cleaning the loss increased rapidly. Following the last cleaning, 80 per cent of the benefit had disappeared in thirty days. Pipe that would not tuberculate so badly was much needed. Consequently, in 1921, J. E. Gilson, Manager and Engineer of the Charleston Water Department, worked out with the Research Department of the American Cast Iron Pipe Company the possibility of using standard cast iron pipe lined with cement mortar.

The Company built an experimental plant and undertook to make cement-lined cast iron pipe. At first, Rosendale, or "natural," cement was used, the coating being $\frac{3}{16}$ inch thick in pipes 4 to 10 inches in diameter and $\frac{1}{4}$ inch thick in 12-inch to 24-inch pipes. Natural cement was preferred in the beginning because quicker setting and less subject to shrinkage and hair-like cracks. Each pipe (12 feet long) was stood on end with an iron cone, point up, at the bottom. Cement mortar in just the right condition was poured into the pipe around the cone. The cone was then

drawn up out of the pipe, distributing the mortar into a thin, dense, smooth coating.

During 1922 and 1923, the process was much improved. Portland cement was substituted for the weaker natural cement. The pipe, open at both ends, is now placed, with its axis horizontal, on revolving rollers. A rich mixture of cement of proper consistency is distributed over the interior surface of the pipe while it is being revolved. After the cement is uniformly distributed, the pipe is rotated at a higher speed for about 25 seconds. These changes make possible a thinner, denser and more strongly adherent lining. Incidentally, it was discovered that the jarring vibration of the pipe as it was rapidly rotated drew some of the water in the mortar to its inner surface, thus making the inside of the pipe almost as smooth as porcelain.

Apparently this engineering investigation has yielded an acceptable solution of an old waterworks problem, increasing the durability and service value of cast iron pipe, and, above all, preventing loss of capacity through tuberculation.

New Members. It is a pleasure to welcome to the activities of the Society the following new members:

Resident Members.

George C. Beardslee, 7724 Benjamin Street, District Representative, Lakeside Bridge and Steel Company.

Edward S. Bres, 305 Canal-Commercial Building, Member of firm of Scott & Bres, Contracting Engineers.

Rudolph Herpich, 3904 Delgado Avenue, Supervising Engineer, Standard Fruit and S. S. Company.

Lloyd D. Knapp, 2407 Soniat Street, Terminal Engineer, T. P. Mo. P. R. R., at New Orleans.

B. S. Merrill, 7509 Jeannette Street, Structural Engineer, with Favrot and Livaudais.

Blair A. Ross, 140 Decatur Street, Assistant Engineer, Fourth Mississippi River Commission District.

Non-Resident Members.

John H. Bateman, Baton Rouge, La., Louisiana State University.

Jacob T. Bullen (reinstated), Box 772, Shreveport, La., Caddo Parish Engineer.

Will S. Guedry, Box 774, Monroe, La., Assistant Engineer of Construction, Louisiana Highway Commission.

Resident Associate Members.

Paul J. Gilbert, 2556 North Rocheblave Street, Mechanical Engineer and Marine Draftsman.

Henry M. Lichtenstein, 5917 Laurel Street, Draftsman and Estimator, with E. W. Carr, Inc.

William L. Stevens, Jr., 88 Fontainebleau Drive, Draftsman.

Resident Junior Members.

Albert E. Marks, 3320 Palmyra Street, Draftsman, with Phoenix Utility Company.

Nathaniel L. Marks, Jr., 3320 Palmyra Street, Draftsman, Orleans Levee Board.

Resident Student Member.

Tim L. McNamara, 1705 Valmont Street, Senior in Chemical Engineering, Tulane University.

PAPERS AND DISCUSSIONS

SPILLWAYS.

BY COLONEL C. MCD. TOWNSEND.
Read Before the Society, May 11, 1925.

The subject of Spillways, while at the present time acute in the City of New Orleans, is by no means a new one. It was equally acute during the floods of 1912 and 1913. It is also discussed by Humphreys and Abbot in their work on the Hydraulics of the Mississippi River, published in 1865, and they refer to reports on this subject dated many years earlier. It is the first idea which would occur to one who recognizes the fact that the increase in flood heights in the Mississippi River below Cairo since 1882 has been entirely due to the construction of levees which have confined its waters to a restricted channel, but since the flood of 1922 is the highest on record below the mouth of White River, some may assign the increase in gauge readings to other causes, and an explanation of the conditions during that flood is desirable. The floods were not excessive in any of the large tributaries. At Cincinnati, on the Ohio, the flood attained a height of 52.2 feet, 18.8 feet below that of the flood of 1884; at St. Louis, on the upper Mississippi, 33.9 feet, 7.5 feet below that of the flood of 1844; at Chattanooga, on the Tennessee, 35.8 feet, 22.8 feet below that of the flood of 1867; at Nashville, on the Cumberland, 45.1 feet, 10.2 feet below that of the flood of 1882; at Little Rock, on the Arkansas, 24.9 feet, 6.3 feet below that of the flood of 1892; and at Shreveport, on the Red River, 21.3 feet, 14.6 feet below that of the flood of 1849. Nor was the combination of the floods of the tributaries such as to produce an excessive discharge of the main river at Cairo, the maximum discharge at Columbus, Ky., being 1,500,000 second feet, as compared with about 2,000,000 second feet in 1912 and 1913. The White and Arkansas Rivers combined, however, had a maximum discharge exceeding 400,000 second feet. This maximum entered the main river between two flood crests at Cairo and increased the maximum discharge at Vicksburg to about 1,800,000 second feet.

There had, however, existed an opening in the Tensas levee line below the mouth of the White River which was closed prior to the flood of 1922, and the increase in flood heights below the mouth of White River in 1922, over those of 1912 and 1913, was

due to this cause, together with a strengthening of the levee line in the interim.

In 1882, the delta was completely inundated. It has been estimated that about 1,000,000 second feet flowed between levees at the crest of the flood in the vicinity of New Orleans, and that a similar amount escaped above the city and flowed over the surrounding country. In 1922, the discharge was confined between levees from Cairo to the Wecoma Crevasse, a distance of 693 miles, with the exception of a break 400 feet long in the levee line of Laconia Circle near the mouth of the White River, which overflowed an area of 19 square miles. Twenty-seven thousand, two hundred ninety-one (27,291) square miles of Mississippi bottom lands were protected from overflow, and 4,232 square miles flooded, of which over 3,000 square miles would have been inundated by back water at the mouth of tributaries, even if the levee line had held.

In the following table are given the flood heights in 1882, the highest flood prior to 1922; the flood height in that year at the principal gauge stations between Cairo and Fort Jackson and the maximum increase of flood heights at the different stations; also the commission grade line at the different stations and the difference between that grade line and the height obtained by the highest flood:

	Miles	1882	Highest floods prior to 1922	1922	Maximum inc. in flood heights	Comm. Grade Line	Height of flood below Grade Line
Cairo	0.	51.87	54.69-1913	53.6	2.82	58.0	3.3
Memphis	227.0	35.15	46.55-1913	42.5	11.40	51.5	5.0
Helena	307.1	47.20	55.20-1913	53.1	8.00	58.5	5.3
White River.....	391.7	48.40	56.50-1916	56.8	8.40	61.9	5.1
Arkansas City....	436.7	47.10	56.4 -1916	58.1	11.0	60.5	2.4
Lake Providence	543.0	38.3	48.8 -1916	49.6	11.3	53.7	4.1
Vicksburg	601.8	48.75	53.85-1916	54.85	6.1	58.0	3.2
Natchez	705.7	47.75	53.5 -1916	55.3	7.55	57.5	2.2
Red River Land- ing	772.6	48.50	53.2 -1912	55.3	6.8	57.5	2.2
Baton Rouge.....	841.0	35.95	43.82-1912	45.7	9.75	48.1	2.4
Carrollton	964.5	14.95	21.05-1912	21.27	6.32	25.2	3.9
Fort Jackson.....	1046.8		8.8 -1916	9.6		11.0	1.4

The Fort Jackson gauge was established in 1891 and recorded 6.9 feet in that year, the Carrollton gauge during the same flood reading 16.0 feet, and it is considered pertinent to the subject of spillways to invite attention to the fact that a rise of 2.7 feet on the Fort Jackson gauge, between 1891 and 1922, has been accompanied by a rise of 5.27 feet on the Carrollton gauge.

It is admitted that the increase of flood heights at Carrollton is due solely to the increase in the flood discharge, due to the confinement of the river between levees, the reverse proposition logically follows that a reduction of the river flood discharge at Carrollton to that which existed in 1891 will reduce the flood heights on that gauge to 16 feet, **provided the river slopes from Carrollton to the Gulf remain the same as in 1891.**

The maximum discharge of the river in 1882 as computed by the Mississippi River Commission has not been exceeded by any discharge measured since that date, nor is there any evidence that any flood prior to 1882 equalled it in volume. The constantly reiterated statement that the rise in flood heights at New Orleans results from the removal of forests and the drainage of farm lands in the northwest is, therefore, without foundation. An exhaustive analysis of the flow of the tributaries of the river for forty years has disclosed the fact that the only work of man that has increased the discharge has been the diversion of water from Lake Michigan through the Drainage Canal at Chicago into the Illinois River. This diversion is appreciable at the mouth of the Illinois River, and infinitely great as compared to the effect of deforestation and drainage. It is, however, infinitesimal in its effect on flood heights at New Orleans. In other words, the danger of increased flood heights from deforestation and drainage, of which certain citizens of New Orleans are so apprehensive, can be mathematically expressed by $1/00 \times 0$.

As the flood of 1882 has not been equalled in the forty-three years which have since elapsed, and as there is no evidence that it has been exceeded in the preceding years during which the river was traversed by the European, it affords a reasonable basis on which an engineer can base an estimate. There is a possibility that New Orleans may be shaken by an earthquake

similar to that which overwhelmed New Madrid 100 years ago, and created Reelfoot Lake, but engineering structures in New Orleans are not determined by such an assumption. There is less probability that a climatic change will cause the snow on the Rocky Mountains and in northern Minnesota to melt so much earlier in the season that the floods of the Missouri and Upper Mississippi will be superimposed on that of the Ohio River. To meet such a contingency, an increased expenditure for spillways is not considered justifiable and, notwithstanding adverse criticism, it is believed to be more in accordance with the best engineering practice to base our estimates on the flood of 1882.

Two million two hundred thousand (2,200,000) second feet will, therefore, be assumed as the maximum flood discharge that will pass the mouth of Red River in the Mississippi and the Atchafalaya Rivers. This is the computed discharge on which the Mississippi River Commission has based its 1913 estimates of the levee grades which are given in the above table. With a gauge reading of 16 feet, in 1891, the maximum discharge of the river was 1,200,000 second feet at New Orleans, and since the recent bill presented to Congress by the Baton Rouge Convention prescribed 16 feet as one of the limiting heights of floods at New Orleans to be obtained by a spillway, the problem of spillways which has first to be considered resolves itself into either a reduction of the maximum discharge from 2,200,000 second feet on the upper river to 1,200,000 second feet at New Orleans by spillways above the city while preserving the slope that existed in 1891 or the slope between New Orleans and Fort Jackson must be increased by spillways below if a larger volume is permitted to flow.

The various propositions that have been made to reduce the flood discharge by spillways above the city will first be considered. The writer happened to be President of the Mississippi River Commission when Mr. Wilson was first inaugurated as President of the United States. A wave of reform was then sweeping over the country, and numerous patriotic citizens wrote to Mr. Wilson advising him how to curb the Mississippi River, which was then overflowing its banks. These letters were sent to the writer with the request that he prepare reports

which were to be returned to the President. As a spillway was the favorite method suggested, and as the writer was compelled to spend considerable time answering these propositions during the first year of Mr. Wilson's administration, he claims to be conversant at least with the prevailing thought of the country as then expressed.

Starting from the north, the first spillway proposed was a diversion of the Missouri River by a canal 100 feet deep and 1,000 feet wide, extending from near Omaha, on the Missouri, through New Mexico to a point on the Rio Grande. The object of this spillway was not only to reduce floods on the Mississippi, but to irrigate the lands of New Mexico. This was considered by the writer as impracticable not only on account of the excessive amount of excavation required but also by reason of the necessity to pump water a height of over 4,000 feet to enable it to flow on the farm lands of New Mexico, which were to be irrigated.

Another proposition was to divert the waters of the Missouri River, near Kansas City, in a canal of similar dimensions through the Ozark Mountains, into the Red River. The excavation from this canal was to furnish sufficient rock to improve the roadways of the United States, and the writer agreed that such would be the case. A second set of advisors proposed to divert the waters of the Ohio through the Tennessee River to Florence, Alabama, thence across a ridge into various rivers in Alabama. This was objected to on the grounds that Florence, Alabama, was over 100 feet higher than the Ohio, at Paducah, and that no provision was made to prevent the diverted waters from flooding the streams of Alabama through which they must flow.

A third proposition was to erect a series of boilers in the vicinity of Cairo, pump the excess flood water into these boilers, and evaporate it. The writer had to invite attention to the fact that even disregarding the amount of coal required for such a procedure, the sudden release of water at the rate of 1,000,000 cubic feet per second into the atmosphere in the form of steam during the weather that prevails at Cairo during January and February floods might possibly produce a considerable fall of snow, and during the month of March a rainstorm which would

exceed any that has occurred on this earth since the days of Noah.

It is needless to state that these projects were not submitted by engineers, but they are no more impracticable than suggestions by scientists to reduce floods by planting forests in regions where the rainfall is so slight that it would be necessary to irrigate the land to enable the trees to grow, nor projects submitted by engineers to retain in reservoirs in the Rocky Mountains water which enters the Mississippi River in June for the purpose of reducing floods that occur three months earlier.

Below Cairo, projects have been submitted which merit more careful consideration. One of the most popular propositions, and one that is usually presented to the Mississippi River Commission after every flood, aims to create a spillway at the upper end of the St. Francis Basin, which would overflow into it. The outlet of this basin is to be closed by a dam, a canal constructed between the St. Francis and White Rivers, and a second dam constructed across its mouth. The water is then to be diverted through Bayou Bartholomew and the Tensas into the Black and Red Rivers, and thence by the Atchafalaya to the Gulf.

It is practicable to remove a sufficient length of the levee line of the St. Francis Basin to discharge at the crest of floods 1,000,000 second feet into that basin, or, if not, a sufficiently large channel could be excavated to accomplish this object, and by closing the outlets of the western tributaries into the Mississippi River and excavating sufficiently large canals between the different basins 1,000,000 second feet could be permanently diverted from the main river at the crest of the flood. The problem, as with all spillways, is how to control this 1,000,000 second feet after it has been diverted. If unrestrained, it will overflow the entire alluvial valley west of the river channel, as it did in 1882, and a levee line is therefore necessary to control the spillway.

Many spillway advocates ignore such things as hydraulic grade lines and delight in constructing spillways on railway tangents. Such a tangent from Cairo to the Gulf would have a length of about 500 miles and a uniform slope exceeding 0.6 feet per mile. As in railway construction, there are cuts and

fills, so also along the spillway tangent there would be heavy excavation at some locations and high levees at others. The hydraulic grade line at New Orleans during the flood of 1922 was 21 feet above mean Gulf level; at a distance from the Gulf on the tangent equal to the distance from New Orleans to Port Eads by water the hydraulic grade line would be over 60 feet above mean Gulf level.

The land slopes away from the river about one foot per mile at many localities in these basins, and if the spillway was located in the talweg of the basins, levees of considerable magnitude will be required to control the water even at a height corresponding to the bank full stage of the main river, which also discharges 1,000,000 second feet at Cairo at that stage. But in order to maintain the same hydraulic grade line as the river the spillway must also have similar hydraulic mean depths, i. e., have a section similar to that which exists in the main river. If the water from the spillway is prevented from dissipating its energy by being confined between levees, it will attempt to form such a section.

The area of cross-section of the main river at a bank full stage is about 180,000 square feet, and to so confine the discharge of the spillway that it would produce a similar section would involve the excavation of an immense amount of material; but even assuming that a portion of the energy was dissipated by giving an excessive width to the spillway and its force limited to that which has created the upper portion of the Atchafalaya River, it would be necessary to create an enlargement of 1,000 cubic yards per running foot, 5,000,000 cubic yards per mile, and some 3,860,000,000 cubic yards in a channel paralleling the Mississippi from Cairo to the mouth of Red River, a distance of 772 miles. The average length of haul would exceed 500 miles if the material was to be deposited in the Gulf of Mexico. A few hundred millions of cubic yards would also have to be excavated in the Atchafalaya River if its levee line were extended to the Gulf of Mexico.

This is a large job for a force represented by 1,000,000 second feet of water, even when working continuously, while the flow from a spillway is intermittent, and it is extremely improbable that a degree of stability approximating that of the

main river would be obtained in 100 years. A large scour would occur at various localities in the path of the spillway while the crest of the flood was passing, and the material excavated would be deposited at other localities as the flood subsided. The water surface in the spillway during the next flood would be depressed where there was a scour and elevated where there was a fill, producing an irregular hydraulic grade line which would change from year to year. The Mississippi River Commission constructs its levees three feet above the river's hydraulic grade line to provide for variations in the river channel arising from such causes, and a much larger factor of safety would have to be provided if the spillway was levied.

The dams which would be required to divert the White, Arkansas and Red Rivers into the spillway would also be difficult to construct, particularly if the spillway had not previously been enlarged to receive the diverted flow. Forty years ago, the Commission reported adversely on this proposition. After forty years of labor by the United States and local authorities in constructing levees there is now no question that the completion of the levee line will be a cheaper solution of the problem.

It has also been proposed to discharge the excess flood waters into the St. Francis Basin, and retain them until after the flood, when they are to be returned to the river instead of flowing to the Gulf in a separate channel. This project was elaborated in a paper presented to the Western Society of Engineers in 1896.

It has been estimated that the surplus water of the flood of 1882 could be retained in a reservoir of the size of the State of New Jersey if of a depth of 15 feet. There are about 4,000 square miles subject to overflow in the St. Francis Basin. Its levee line averages some 20 feet in height, and as the ground slopes away from the river, reservoirs of an average depth of about 30 feet could be constructed by building dams across the valley connecting the levees with the high land, with possibly some enlargement of the levee line at the lower end of the reservoirs. The construction of such a series of reservoirs would be possible, and would confine sufficient water during

flood stages to reduce floods at New Orleans to 16 feet. In fact, it is the most practicable solution of confining the flood waters of the river in reservoirs that the writer has investigated. The reservoirs are located where they will regulate the floods from the Ohio River, the Upper Mississippi and the Missouri, and obviate the necessity of establishing a system of reservoirs on each of these tributaries. The inhabitants of the St. Francis Basin in building their levee line have already supplied a large portion of the embankment necessary for the purpose. If they will consent to permit the overflow of 4,000 square miles of their land, a large part of which is under cultivation, for the purpose of reclaiming 1,000 square miles of swamp lands in Louisiana and of allaying the apprehensions of the citizens of New Orleans, the solution is practicable. As a business proposition, it is impossible to convert apprehensions into dollars and cents, but when it comes to the question of the United States buying several thousand square miles of cultivated lands to reclaim 1,000 square miles of swamp lands surrounding Grand Lake in Louisiana, the solution is evident. The cost of the embankments from this levee line to the highlands with their necessary regulating gates would also be considerable.

Spillways have also been suggested in the Yazoo Basin, but as the water from such spillways would be returned to the river at Vicksburg, they would have slight influence on flood heights at New Orleans.

The next location for a spillway is on the right bank of the river at the head of the Tensas Basin. In 1893, the writer, who was then Assistant to the Mississippi River Commission and in charge of the Third District, invited the attention of the Commission to the increase of flood heights which would result from the closure of the St. Francis Basin by the levees which were then in process of construction, and called attention to the fact that a gap between the Mississippi River levees and those along the Arkansas River, which would overflow at about a 47-foot stage on the Arkansas City gauge, was desirable so as to afford an opportunity for the lower levee districts to enlarge their levees before the increased discharge of the river, resulting from the closure of the St. Francis Basin, was transmitted to

them. He elaborated his views in a paper presented to the American Society of Engineers in 1896.

While the writer's views on the heights which floods would attain were considered radical even by certain members of the Commission, no objection was raised to the levee location proposed, and the flood of 1897 having confirmed the writer's deductions, his spillway became an accomplished fact recognized by the Mississippi River Commission as a temporary expediency which would afford the levee districts of Louisiana an opportunity to perfect their levee lines. This spillway discharged during great floods about 350,000 second feet, causing great damage to the plantations over which it flowed. After the floods of 1912 and 1913, the levee authorities of the State of Louisiana, supported by their Senators and Congressmen, appeared before the Commission urging its closure. In the public discussion which ensued, the Commission explained that this opening was left as a stern necessity, and that it was their ultimate intention to close it. It prescribed a levee grade to which levees were to be constructed to resist the increase in floods that would result therefrom, and every levee board, with the exception of that of the City of New Orleans, made strenuous efforts to enlarge their levees. After affording a period of five years for the levee authorities to strengthen their levee lines, the Commission authorized the closure, and although the increase of flood heights exceeded two feet at Natchez, wherever the levees were built to Commission grade and section they withstood the increased strain to which they were subjected. Even the Poydras Crevasse was not caused by the failure of the levee to resist the water pressure, but by the caving of the river bank, a danger which will not be eliminated by spillways, as will be explained later. Moreover, as will be seen by the table given above, at no locality did the flood discharge of 1922 attain such a height as to render dangerous levees built to the Commission grade.

By restoring this spillway and enlarging it so that it will discharge 1,000,000 cubic feet per second, flood heights can be reduced to 16 feet at New Orleans. The objections which the State of Louisiana would raise to such a procedure are so obvious that no further discussion is considered necessary.

Humphreys and Abbot in their work on the Hydraulics of the Mississippi River, published in 1865, recommend a spillway in the vicinity of Lake Providence, which would discharge 100,000 second feet, while opposing a spillway of the same dimensions discharging into either Lake Pontchartrain or Lake Borgne. They base their recommendations on the grounds that it would be cheaper to permit such a discharge at that locality than to enlarge the levees to such a height that the main channel would carry the increased discharge. The fact that flood heights have been increased over 11 feet at this locality gives weight to their contention. At the present day, a spillway sweeping through the town of Lake Providence would not receive the active support of those interested in reclaiming the alluvial valley who reside in the Tensas Basin.

The Atchafalaya Outlet, which is the next proposed location for a spillway, has been the subject of acrimonious discussion for the past sixty years. It was recommended by Humphreys and Abbot in their work on the Hydraulics of the Mississippi, and has been the subject of numerous reports by the Mississippi River Commission. The separation of the Mississippi River from the Red and Atchafalaya has been repeatedly urged by the levee authorities of the State of Louisiana, but heretofore it has failed to obtain the approval of the Commission, not because it would interfere with the navigation of the Red River, an objection which could be overcome by a lock, but on account of the increase in flood heights which would be caused by the closure in the main river. The question is complicated by the fact that while on a rising river there is a discharge from the Mississippi into the Atchafalaya, the spillway that was formerly maintained at the head of the Tensas Basin and crevasses in the Tensas Basin line have frequently poured into that Basin a delayed flow greater than the Atchafalaya could discharge, so that during falling stages the flow has been reversed and has been into the Mississippi River instead of away from it.

Some investigators have ignored the inflow through the spillway at the head of the Tensas Basin, and attributed the flow into the Mississippi River at Old River entirely to an excessive discharge of the Red and Ouachita Rivers. The only

great flood in which the spillway at the head of Tensas Basin has not affected the flow through Old River has been that of 1922, and during that flood the crevasse that occurred at Wecoma, near Natchez, created a spillway at that locality whose maximum discharge is estimated at 650,000 second feet, while the Mississippi and Red Rivers were pouring over 400,000 second feet into the Atchafalaya and had exhausted the discharge capacity of that stream. The Red River Outlet then ceased to operate and acted as a tributary instead of a spillway.

As the crest of the flood was passing Lake Providence at the time the Wecoma Crevasse occurred and could not have increased flood heights at Vicksburg more than one or two tenths of a foot, due to the reservoirs' effect of the lake which is created in the Yazoo Basin by back water, the action of this river prior to the crevasse affords the most practical illustration of the effect of this spillway on the river flow with a perfected levee line, that we have. But as was intimated in discussing the St. Francis Basin Spillway, the hydraulic grade line of the Mississippi River varies with every flood. It is affected by the rapidity with which the flood rises and its duration. During one year the lower tributaries of the river may have produced a high stage below the mouth of Red River when the crest of the flood passed Cairo, while during others the stage may be low. These variations make an enormous difference in the space in the main channel in which the additional discharge can flow, affecting what is termed the river's reservoir capacity.

Humphreys and Abbot cite a case where the maximum river discharge was reduced 400,000 second feet in passing from Cairo to Natchez from this cause, and the writer has found in the Ohio River a flood passing Cincinnati at a 50-foot stage which slightly exceeded 30 feet at Cairo, while a second flood of the same height at Cincinnati attained a height of 50 feet, and this variation was principally due to changes in the river slope. It is, therefore, rash to draw positive conclusions from a single flood, but it may afford an index of the river's tendencies.

Prior to the Wecoma Crevasse, the Red River Outlet appeared to produce a lowering of the crests of rivers at all stages

at Red River Landing and on the date of the crevasse was reading 1.5 feet below the Natchez gauge. Above a 25-foot stage, the Red River Landing gauge did not fall as rapidly as the Natchez gauge, which suggests that the land overflowed in the Red River Basin is acting as a reservoir.

The maximum discharge of the Atchafalaya River now exceeds 450,000 second feet, and by removing a sufficient length of the levee line south of Old River, it would be practicable to discharge an additional 550,000 second feet across the Atchafalaya Basin. It is evident that such a proposition would not be acceptable to the residents of Louisiana whose lands would be flooded by such a procedure. In fact, Louisiana levee authorities have been urging for many years a reduction in flow down the Atchafalaya instead of an increase.

While nature affords a substantial relief to flood heights on the lower river by the Atchafalaya Outlet, there are those who believe that they can improve on nature's methods. It has been proposed instead of allowing the Mississippi to discharge into the Atchafalaya at all stages, to build a dam across the mouth of Old River, which will restrain the waters of the Mississippi River within its channel until they attain a height of 50 feet on the gauge at Red River Landing when the water is to be discharged through a spillway. By preventing the waters of the Mississippi from entering Old River at low stages, it is estimated by some that the water in the Atchafalaya will attain a height of about 30 feet from the discharge of the Red and Ouachita Rivers when the gauge at Red River Landing reads 50 feet. Others estimate this height at 40 feet. There has resulted from these differences in views two projects; in the one the spillway is to be 600 feet wide and 40 feet deep; in the other a mile wide and 10 feet deep. By a discussion of the weir formula, it is demonstrated to the satisfaction of those presenting the projects that a discharge of from 350,000 second feet to over 1,000,000 second feet can be obtained through such openings, the discharge varying according to the assumptions made by the authors.

As these projects have received the approval of expert hydraulic engineers both in New Orleans and St. Louis, who support their arguments with a mass of mathematical compu-

tations and graphic illustrations, the writer has felt some hesitancy in questioning the conclusions, particularly as he can neither support his opinions by the differential calculus nor positive data. He submits, however, the following suggestions: For the past 100 years, the lower river has been adjusting itself to a diversion of water through Old River and, presumably, has a smaller cross section than would have existed if there had been no outlet, and there is a possibility that a closure of its mouth may cause floods which now pass Vicksburg at 48 feet to attain a height of 50 feet on the Red River Landing gauge and that certain floods which would pass Carrollton at an 18-foot stage with Old River unobstructed would attain a height of 19 feet before the spillway is in operation. As the spillway is to discharge from 350,000 to 1,000,000 second feet when the Red River gauge reads 50 feet, velocities in the lower river will be reduced by the spillway at the time they would otherwise have their greatest scouring effect and a deposit in the main river instead of a scour should result from the closure, as long as the spillway gates remain open. It is, therefore, improbable that the lower river would suddenly enlarge its section due to the construction of the spillway.

Whatever may be the effect of such a spillway on extreme flood heights, it is evident that it would not be effective in reducing heights at Carrollton to 16 feet, 17, or 18 feet, as provided for in the bill submitted to Congress.

It is, however, proposed after the river has attained a height of 50 feet at Red River Landing to open the gates of the proposed spillway and discharge from 450,000 to 1,000,000 second feet into Old River through openings having dimensions of 600' x 40' in the one case, and 5,280' x 10' in the other. In both cases, the velocity of flow is computed at 20 feet per second. The writer suggests that there is considerable kinetic energy in a mass of water 600' x 40' with a velocity of 20 feet per second flowing in a wave 20 feet high, and also in a mass of water 5,280' x 10' flowing in a wave 10 feet high at such a velocity. You have all heard of dams breaking and the escaping waters carrying away homes, bridges, and of railway locomotives being picked up like pebbles and carried 1,000 feet, as occurred in the Johnstown disaster. The writer has no

figures on which to base his assertions, but is of the opinion that the wave that swept through Johnstown, Pa., did not have one-tenth the energy that would exist in a mass of water 600' x 40', flowing in a wave 20 feet high, and starting with an initial velocity of 20 feet. Water is incompressible, and the escape through the spillway would be backed by the latent force existing for miles in the main river. To suddenly release even 100,000 second feet at such a velocity would be an experiment which would never be repeated. When such a mass of water struck the first bank in the river, it would be suddenly checked and a column of water would be created of great height, which would overwhelm the levee line.

The fundamental idea in any scheme for closing Old River is not river regulation, but the opening up for cultivation of the large area in the Tensas and Atchafalaya Basins, which is now overflowed during every flood. It is the only justification for the large expenditure required. The problem will be simplified if this fact is recognized.

Under existing conditions, an area of about 500 square miles in the Tensas Basin is flooded during every great flood, forming a large lake. If any large percentage of this area is placed under cultivation, it will be necessary to protect by levees a large part of it not only from discharges at the spillway, but even from the more moderate floods of the Red and Ouachita Rivers, and the lake area will be reduced to the space between the levee lines. If such levees are not constructed the settlers would be exposed to the destructive energy contained in a mass of water 600 feet wide and 40 feet deep, flowing as a wave 20 feet high and with an initial velocity of 20 feet per second, as above discussed.

Let us assume that the closure dam is located 50,000 feet from the mouth of the Atchafalaya River, and that the water of that river is at an elevation of 40 feet at the time the gates of the spillway are opened, which is when the river has attained a height of 50 feet on the Red River Landing gauge. If the distance between the levee lines was 1,000 feet, as is the case on some sections of the Atchafalaya River, the reservoir capacity of the space between levees would be 500,000,000 cubic feet and would be exhausted by a discharge of 1,000,000 cubic

feet per second in less than ten minutes. If the distance between levees equalled that on the lower river the space would be filled in less than an hour. Even if no levees were constructed, the capacity of the lake would be exhausted in less than two days, while the flood of 1922 exceeded a 50-foot stage at Red River Landing for fifty-three days.

If the gates of the spillway were suddenly opened the enormous discharge proposed might be maintained for a few minutes, but as soon as the water rose above the lower edge of the spillway, back water effects would reduce the flow. When the water attained a height of 50 feet at the entrance of the Atchafalaya River there would be no flow in Old River with the Red River gauge also reading 50 feet.

A flow down the Atchafalaya River, however, must also be taken into consideration, but as the gauge at Barbres Landing, at the head of the river, read 55 feet in 1922 when the river discharged 450,000 second feet, or five feet higher than the assumed height of the water at Red River Landing, it is at least questionable whether 1,000,000 second feet or even 450,000 second feet could escape for any length of time through any weir at the mouth of Old River unless the Mississippi rose to greater heights than it did in 1922.

Mathematics is only a process of reasoning and when a formula or dots and dashes on section paper leads to the absurd conclusion that a river discharges more water through a contracted opening than the unobstructed river discharges, it is deemed probable that there is some defect in the premises of the argument. If, instead of using the weir formula, Kutters formula or any of the accepted ones for the discharge of a stream was employed, and an estimate made of the reduction in discharge due to the contraction of the opening, very different results would have been obtained.

It is also proposed to construct a second spillway to this spillway by a tangent from Grand Lake to West Cote Blanche Bay. This will reduce flood heights at Morgan City, but also destroy the navigation of the Teche, which would have to be obstructed by a dam to prevent the water from flowing down that Bayou and returning to the Atchafalaya River. Its waters would sweep across the proposed intracoastal canal and neces-

sitate such expensive structures to preserve that waterway that it is evident that a levee around Morgan City would be a much cheaper solution of the problem.

The next proposed location for a spillway is at the head of the Pontchartrain levee district just below Baton Rouge, and the writer has contended for the past ten years that if the mouth of Old River is closed some spillway at this locality is necessary or else the Commission grade line must be changed. The problem is, however, somewhat modified at this locality. The question whether the Atchafalaya Outlet is to remain open or be closed has an important bearing on the amount of water which must escape. We will assume its closure. The reservoir capacity of the river itself must also be taken into consideration. The maximum discharge of the river at Cairo has been assumed as 2,000,000 second feet, and the assumption has been made that the reservoir capacity of the river between Cairo and Vicksburg will absorb the increased discharge due to the tributaries between these localities. During the flood of 1922 neither assumption was correct, the maximum discharge at Cairo being about 1,500,000 second feet and the inflow of tributaries increasing this discharge to 1,800,000 second feet at Vicksburg. No two floods have the same characteristics and any data relating to great floods in former years is affected by discharge through crevasses. It is on the side of safety, however, to assume that 2,000,000 second feet is the maximum discharge that would ever have passed Vicksburg in a confined river. The reservoir capacity below Vicksburg is also a large item. It is increased by the absence of an effective levee system on the Mississippi side of the river between Vicksburg and Natchez and by the diminished slope of the lower reaches.

The writer has heretofore assumed an average reservoir capacity of about 200,000 second feet for this portion of the river and knows of no reason for changing it. On these assumptions it will be necessary to provide for an escape of 600,000 second feet in the Pontchartrain levee district to insure a 16-foot stage at Carrollton.

By removing forty miles of the levees at the upper end of the Pontchartrain District 600,000 second feet could be permitted to escape through Lake Maurepas into Lake Pontchar-

train, at such velocities that it would not induce scour. The area of cross section of the spillway would be over 200,000 square feet for every foot of water flowing through it and at an elevation of two feet 600,000 second feet could be discharged with a velocity not exceeding $1\frac{1}{2}$ feet per second, a velocity which would induce a fill instead of a scour.

The same result could be obtained by removing forty miles of the levees of the Atchafalaya Levee District, and the question naturally arises whose ox is to be gored, to allay the apprehensions of the City of New Orleans by reducing its flood heights to 16 feet. Of the two propositions, the removal of the levees on the west bank of the river is slightly less objectionable, as it would to a large extent overflow swamp lands which are now flooded by the Atchafalaya Outlet. It is absurd, however, even to suggest to the Mississippi River Commission that it close one spillway and open another which will flood only the same swamps that the closure is designed to protect, but also a large area of the best sugar cane land in the United States with its expensive factories and buildings.

The Lake Pontchartrain Levee District will also object to the abandonment of a forty-mile front of its cultivated fields to enhance the value of waste lands in the Atchafalaya Levee District. The opposition will be so great as to render any such proposition impracticable.

Any spillway which can even be considered must be of limited dimensions, and its overflow confined between levees, and as was explained in discussing the proposed spillway from Cairo to the Gulf, such a confinement of the overflow will induce scour. A discharge of 600,000 second feet will convert the proposed spillway into one of the large rivers of the world, and will be over twice the estimated flood discharge of the Yellow River, which has been described as "China's Woe." When such a force is turned loose on the alluvial soil of Louisiana it is difficult to predict what will happen. We know from observing the action of other rivers in the State that the tendency is to create deep channels. The Mississippi River, just opposite New Orleans, has a depth of 180 feet. The Atchafalaya River, which approaches the nearest to the rived produced by the proposed spillway, has depths on its dis-

charge section exceeding 100 feet during flood stages. Pass A L'Outre and South Pass have pockets exceeding 100 feet in depth, and the maximum depth in South West Pass is 87 feet.

The tendency of the spillway will be to excavate a similar channel until it flows into Lake Pontchartrain. There is will start forming a delta similar to that which has been formed by the main river in the Gulf of Mexico. The sediment contained in the 600,000 second feet will be deposited and through it channels will be scoured.

One of these will naturally seek the Rigolets, the outlet to Lake Pontchartrain, and the flow of the spillway will be concentrated in it to a greater or lesser extent. In other words, such a spillway invites a diversion of the river from its present channel into one flowing into Mississippi Sound. It may occur during the first flood. It may require 100 years for its accomplishment, but the writer is of the opinion that the ground would be so disturbed during the first flood that it would require only a slight propaganda to induce the citizens of New Orleans to demand an immediate closure of the spillway in order to save the Port of New Orleans from destruction. Within historic times the Po River has abandoned its channel from similar causes in spite of all the efforts of Italian engineers to prevent it, and the Yellow River of China has created a new channel to the sea some 240 miles in length which resulted from a crevasse in its levee line that probably did not much exceed 100,000 second feet.

The engineer must take these facts into consideration in designing the spillway. He must place such an obstacle in the path of the overflow that there can be no question about the danger of the river seeking a new outlet. He cannot even afford to assume the risks which the ordinary coefficients of safety impose on engineer structures. The dire consequences of a mistake in judgment are so great that large expenditures would be justified to insure absolute safety. The cost of the obstacle will be large, levee lines will be required not only across the Pontchartrain Levee District, but surrounding Lake Pontchartrain. Such a spillway would place New Orleans on an island, would cross every rail and automobile road entering the city east of the river and would necessitate heavy expendi-

tures of railroad companies in elevating their tracks and enlarging their bridges, and by parish authorities in building bridges for automobiles.

The nearer to New Orleans such a spillway is located, the shorter will be the distance to the Gulf through it, and the greater the danger of a river diversion; the capacity of the soil to sustain the structure also diminishes. The treacherous nature of the soil in the vicinity of New Orleans is notorious. The difficulties experienced in the construction of the lock of the Industrial Canal demonstrates this fact and every boring for the proposed bridge across the Mississippi revealed strata or pockets of considerable depth containing sand which when saturated with water will flow long distances.

There is, however, another consideration which precludes the construction of the spillway in the immediate vicinity of New Orleans, i. e., the effect of the diversion of such a large body of water on the slopes of the main river during floods and the resultant danger to the existing levee line. Above Red River, provision has been made for caving banks in the location of levees, but below Red River caving has heretofore been so slight that they have been perched on the river bank to preserve as much of the agricultural lands as possible, and barely space enough exists in many cases between them and the river to provide the necessary earth for their construction. The replacement of levees due to bank caving is a heavy tax on all the levee districts at the present time.

The lowering of the flood surface to sixteen feet at New Orleans will make a radical change in river slopes for a long distance above the spillway, and as the same discharge must then pass through a smaller section, it must necessarily flow with a greater velocity and there will be produced a condition below Red River similar to that which now exists above it. An enormous increase in bank caving will result, and if the spillway were located immediately above the City of New Orleans, although the amount of caving will diminish the further down the river the spillway is located, nevertheless it will be created so close to the levees that within a few years nearly the entire levee line on both sides of the river below Red River Landing would have to be moved back from the river bank. As these

levees are now over 90% completed, the indirect cost of the spillway from this cause alone is so excessive that it is useless to discuss the cost of any other item. It is self-evident that the completion of the present levee line is a cheaper solution of the problem, and that the construction of the spillway would entail a heavy additional burden on the levee districts of Louisiana.

The construction of spillways above New Orleans, to reduce flood heights to 17 feet or 18 feet on the Carrollton gauge, differs in degree but not in principle from what has been previously discussed. A larger discharge will pass down the river and less through the spillway. The dangers of the spillway will be diminished but not eradicated.

In discussing the question of a spillway below New Orleans, it is advisable to have a clear conception of the problem before us, and to treat it dispassionately. There has been considerable oratory and printers' ink wasted over irrelevant matters.

First as to flood heights. The Mississippi River Commission in 1913 estimated that with a confined river flood heights would attain 22 feet on the Carrollton gauge and recommended that levees be constructed to an elevation of 25 feet. The flood of 1922 actually attained an elevation of 21.27 feet at that locality. The Wecoma and Poydras crevasses occurred at the crest of the flood and an acrimonious discussion has arisen as to what height the flood would have attained if there has been no break in the levee line.

The writer is of the opinion that as the crest of the flood had arrived at Vicksburg of the date of the crevasses and would have arrived at New Orleans a few days later in a confined river, the only increase in flood heights would be due solely to the transmission of that crest and could not have exceeded the Commission estimates. The Committee of Safety has submitted a set of gauge relations between Red River Landing and Carrollton and claim that these show that there would have been an increase in flood heights of some 2½ feet about 20 days later. The whole discussion revolves about the Wecoma crevasse, not the one at Poydras. If the former had not been in operation there would not have been a return flow at Red River Landing on May 16th to raise the gauge to the height estimated by the Safe River Committee. But assuming

that the Poydras levee had held and the Wecoma crevasse produced the return flow at Red River Landing, the estimated increase of $2\frac{1}{2}$ feet would have produced a flood height at Carrollton of 23.8 feet and could have been safely carried by New Orleans if its levees were of proper section and built to the Commission grade of 25 feet.

The Commission did not recommend a levee line three feet above the estimated flood height for the purpose of decorating the landscape, but to provide for just such a variation in the hydraulic grade line which is liable to occur at any locality from numerous causes.

As has been stated earlier in this paper, the hydraulic grade line varies with every flood and any computation of levee heights has to be based on average conditions with a coefficient of safety to cover exceptional variations. Three feet is a reasonable allowance, and an increase of one foot in heights in levees on a river 1,000 miles long would increase the cost enormously.

A large city, however, is entitled to greater protection than a sparsely settled farming community, and it is a rather serious reflection on municipal government that for the past ten years while the planters of Louisiana have been taxing themselves to the limit to obtain a levee line three feet above anticipated flood heights, the authorities of New Orleans have remained satisfied with a levee line which was dangerous in 1912 and 1913. The enormous property values alone, without taking into consideration the danger to human life, should have impelled the construction of a levee line by local authorities at least five feet above the threatened rise in the river.

Not only the levees but the wharves and the lock of the Industrial Canal, in spite of the repeated protests of the Louisiana State Board of Engineers, have been built to grades which every one now admits are inadequate. The city has to face a certainty that flood heights will occur which the writer predicted thirty years ago and the Mississippi River Commission announced as probable in 1913, and if the Atchafalaya Outlet is closed, in the opinion of the writer, at least one foot additional height should be provided for. While these structures could have been built originally to secure grades at little

extra cost, today it will require millions of dollars to raise them. It is a condition, not a theory, which now confronts us, and the question is not who is responsible for such a state of affairs, but what is the best means to correct the conditions.

It is considered unnecessary to discuss a lowering of flood heights to 16 feet at New Orleans by spillways located below the city. The increased velocities produced by such a radical change in the river's regimen would threaten the destruction of every wharf along the city front. With the completion of the work now proposed by the Orleans Levee Board, a flood of 21.27 feet can be passed by the city without danger, nor will the wharves and locks need to be raised. In fact, under existing conditions, the ordinary citizen rarely knows that floods up to 19 feet exist, and to discuss bringing the river back to conditions which existed in 1862 for the purpose of allaying apprehensions is not considered justifiable or necessary. The problem is what to do with reference to a further increase in flood heights, and it is a difficult and serious problem which is of vital interest only to the City of New Orleans, as the parishes of the State cannot be expected to increase their taxes to provide for the security of the city.

Heretofore, the writer has accepted the popular idea of a spillway, as an opening through which water escapes from the river, but in the further discussion it is desirable to make a distinction between an opening which discharges at all stages of the river and which is termed an outlet, an opening which limits the discharge to a certain river stage and gradually increases its discharge as the river rises above that stage which will be called a spillway, and an opening which is suddenly enlarged and which when it naturally occurs is termed a crevasse, and which when regulated by gates will be called hereafter in this paper an artificial crevasse. The distinction is important.

An outlet affects a river's discharge at all stages and reduces its flow during low water with a resultant injury to its low water channel; the spillway prevents any escape of water below a pre-determined stage, thus protecting the navigable channel during low water from an injurious reduction in flow; it also gradually increases its discharge as the river rises, and

does not cause any violent changes in velocity even at high stages; a crevasse on the contrary suddenly permits a large volume of water to escape from the river at a high stage, and suddenly increases river velocities above it by the rush of water to the crevasse while it checks velocities below it by diminishing the effective head which is forcing the water toward the sea.

The writer has been opposed to the Lake Borgne artificial crevasse recommended by the Committee of Safety not only because he considers the structure dangerous as designed, and liable to fail unless such precautions are taken as would increase the cost far beyond that of raising the structures at New Orleans which it is intended to protect, but also because it intensifies the action of river currents in front of the city, inviting a dangerous scour, and by reducing the velocity in the river below the structure, induces a large deposit.

When the river falls, it is true that there will be a tendency to remove these deposits, but a large part of the material thus moved will not be again in suspension, but will pass down the river in sand waves, adding to the difficulties which are now experienced from that source in South West Pass.

The spillway below Pointe-a-la-Hache which the writer has suggested as a solution of the problem, and which the Orleans Levee Board is preparing to construct, reduces these objections to a minimum. If twenty miles of the levee line is removed as suggested, the area of cross section of the spillway will be over 100,000 square feet for every foot the river rises above a bank full stage, and could discharge 300,000 second feet at a two-foot elevation of the water surface with a velocity of $11\frac{1}{2}$ feet per second. There will be no danger of erosion under such conditions, and the chief expenditure would be for purchasing land which has settled to such an extent that it has been generally abandoned and for leveling off a weak levee line. When the spillway began to function there would be no sudden change in river currents as would occur at Lake Borgne, but the river would gradually adjust itself to the change in slopes. The scour and fill in the main river would, therefore, be much less.

Some apprehend that the fill will be excessive and that the flow through the spillway will rapidly become so small that it

will soon have no appreciable effect on flood heights at New Orleans, and the Orleans Levee Board proposes to reduce the opening to a width of eleven miles.

It is impossible to so adjust the variable flow through a spillway which results from change in flood heights from year to year as to prevent both a scour and a fill. A width of twenty miles reduces what is occurring in the natural spillways which exist between the heads of the passes and the ends of the levee lines and where the annual fill has practically equalled the annual settlement of the delta. Three outlets have formed in this region, at Baptiste Collet, The Jump and Cubbits Gap, but the causes of their formation are known and can be avoided in the proposed spillway. A width of eleven miles only slightly increases the risk of scour during great floods, and since the width can readily be increased, if a tendency to scour develops, and since the whole project is at best only experimental, the reduction proposed by the Orleans Levee Board is not considered objectionable.

It can, however, be added that if the apprehensions of a rapid fill should prove to be correct, the Orleans Levee Board will have acquired some very valuable real estate at a very moderate price; over twenty square miles of country which is now abandoned to the muskrat would become a most fertile farming section, as the general slope of these deposits from the river bank to the marshes would probably not exceed one foot to the mile, if it conformed to the results obtained from outlets in South Pass.

The difficult problem in discussing any spillway is to determine what effect a given discharge through it will have on flood heights above it, and it is a problem which does not permit of a definite solution by either mathematical formulae or discharge diagrams. Too many unknown quantities enter into the equation.

The most important item in the problem is the river slope at the time of the discharge. If the water surface is level, as in a lake, a lowering of the surface one foot at its outlet is accompanied by a similar lowering over the entire lake area. If the slope is vertical, as on a waterfall, no excavation at the foot of the fall will affect the flow over it; similarly, when the slope is

one-tenth of a foot to the mile, the reduction in height, by an outlet, will largely exceed that which will occur when the slope is one foot to the mile, and any conclusion deduced from crevasses occurring where the slope exceeds four-tenths of a foot to the mile will be in error when applied to spillways where slopes are less than two-tenths of a foot. Moreover, the reduction in the height of the water surface at the spillway diminishes the area of cross section in the main river and necessitates an increase in velocity; and to maintain these relations the river slope itself cannot follow the straight line which is usually assumed in spillway discussion. It must be a curve which is tangent to the original flood height at a point where the river's frictional resistance overcomes the effect of the spillway and must increase its curvature as it approaches it. The surface along the spillway will also be curved with the greatest slope at its upper extremity. The form of these curves will vary the river's original slope and will be further modified by the tendency of the river to enlarge its section as its velocity increases. Not even the locus of the beginning of the curve can be determined from any data that are now available. The forces acting are so vast that no laboratory experiments could give an adequate conception of their effects.

The proposed spillway at Pointe-a-la-Hache is located in the section of the river where its slopes are gentle, and its effects on flood heights should, therefore, be a maximum. The river's depth and area also increase toward the mouth, so that for a given reduction in flood height the resultant increase in river velocity should be a minimum. If the Fort Jackson gauge is reduced by the spillway to the same height as existed in 1891, it is reasonable to assume that a discharge of 1,200,000 second feet will pass New Orleans at a height not exceeding that which it attained that year, but if the discharge is increased, there is no data available for determining how much of the increase will be expended in raising flood heights and how much in developing greater velocities.

The Atchafalaya River Outlet affords the nearest approximation to the proposed spillway, but the data in reference to this outlet are so obscured by crevasses and the discharge around the head of the Tensas Basin that they are unsatisfac-

tory. The natural spillways below the ends of the levee lines are so affected by the discharges through the outlets that there exist that their flow also gives unreliable data.

The writer estimates that the proposed spillway will practically compensate for the increase of flood heights that will be produced by a confined river with the Atchafalaya Outlet in operation and that it will produce an effect equal to that of the artificial crevasse proposed as Lake Borgne. He could present a voluminous array of diagrams to justify his opinions, but when analyzed they would be found to be based on assumptions, not facts.

The only way of accurately determining what such a spillway will do is to build it and see what happens. It is a relatively inexpensive experiment and justifiable when the great cost of adjusting the structures in New Orleans to increased flood heights is taken into consideration.

The Orleans Levee Board is enlarging the levee line to Commission grade and section, and the proposed spillway is only an additional precaution to an otherwise reasonably safe condition of affairs as far as the safety of the citizens of New Orleans from floods is concerned. Where property is the only consideration, an attempt at economy of construction is justifiable, which should not be undertaken when it is a question of human life.

In conclusion, it can be stated that if an investigation of the subject of spillways is desired which will be more than a general discussion of principles, and will lead to a determination of the heights floods will attain at specific localities, the construction of the proposed spillway is necessary to supply the data for the investigation.

Discussion.

JOHN KLOER: Colonel Townsend's paper holds out little hope for meeting the flood situation below the mouth of Red River in any way other than by increasing the height of the levees. If we accept his views, we are plunged still deeper in despair by reflecting on his statement that the 1922 high water was not an exceptionally great flood, "the maximum discharge at Columbus, Ky. (twenty-one miles below Cairo), being 1,500,000 second feet as compared with about 2,000,000 second feet

in 1912 and 1913." Colonel Townsend states that the White and Arkansas Rivers combined had in 1922 a maximum discharge exceeding 400,000 second feet, and that this maximum entered the main river between two flood crests and increased the maximum discharge at Vicksburg to about 1,800,000 second feet. The very high stages reached below Arkansas City are furthermore attributed by Colonel Townsend to the fact that "there had, however, existed an opening in the Tensas levee line below the mouth of White River which was closed prior to the flood of 1922 and the increase in flood heights below the White River in 1922, over those of 1912 and 1916, was due to this cause together with a strengthening of the levee line in the interior."

The Vicksburg discharge above referred to, viz., 1,800,000 cubic feet per second, is what we observers of the lower river have been accustomed to think of as a discharge quantity that might reasonably be expected at Vicksburg during a great flood, for the reason that such a discharge was passed in 1912 and 1916 with a reading of about 52 or 53 on the gauge at that point, and before the closure of the opening that Colonel Townsend says is responsible for the 1922 high stages on the lower river. However, do not fail to make a mental note of the fact that in this lesser flood of 1922 the Vicksburg gauge went to 54.6 before a discharge of 1,825,550 cubic feet was reached.

It is of record that as much as 2,225,000 second feet passed the latitude of Arkansas City in 1916, when the "gap" was open, and it should be a matter of concern to those riparian dwellers of the Upper Tensas and Lower Tensas Districts to consider what gauge heights are likely to prevail along their front with the "gap" closed should there be a repetition of the 1912 and 1916 flood volumes, rather than a repetition of the lesser 1922 flood volume. They should not be deluded into the belief that 1922 was the worst flood that ever came down the lower end of the valley for the reason that previous flood-height records were broken that year.

It is also of record that in 1912 as much as 2,167,000 cubic feet per second passed the latitude of Red River Landing, distributed as follows:

1,500,000 second feet down the Mississippi River,
407,000 second feet down the Atchafalaya River, and
260,000 second feet through the Torras Crevasse.

With the Atchafalaya River limited by the sill dams to the discharge of about 450,000 second feet, the lower river from Red River Landing down, if the levees hold, must take care of the difference, viz., 1,700,000 cubic feet per second, less a reasonable deduction for reservoir capacity. Colonel Townsend assumes this reservoir capacity to be "about 200,000 second feet for this portion of the river and knows of no reason for changing it." At most this is a guess, but in the absence of any specific data on this phase of the problem, Colonel Townsend's estimate may be accepted with the reservation that in a flood of long duration this reservoir capacity will be considerably curtailed. However, we should be prepared to pass at least 1,500,000 second feet at New Orleans.

By reflecting for a moment that during the 1922 high water the maximum discharge at Carrollton was only 1,260,000 cubic feet per second at a stage of 21.3 on the Carrollton gauge and that the discharge curve plots an increase of 60,000 second feet for each foot additional in gauge height, it is apparent that four feet additional flood height must be anticipated in order to pass 1,500,000 cubic feet per second, unless something be done to increase the discharge capacity of the river.

The fundamental fact in our flood problem can be briefly stated and it should be seared into our minds. It is this: Lesser flood volumes are producing greater flood heights with decreasing discharge capacities at New Orleans. There is no getting away from it, and it is regrettable that Colonel Townsend, with the fund of information and experience at his command to draw from, did not venture some explanation of the disappointing flood-discharging performance of the river at this end of the valley, the portion most ideally adapted to prove the correctness of the confinement theory. Some of us who are advocating spillways would perhaps be reconciled to increasing the levee heights if it were demonstrated that by so doing the river was correspondingly increasing its discharges, but no such evidence can be supplied.

We wonder why the spillway idea has not made greater progress in some quarters, when we find so decidedly an anti-spillway advocate as Colonel Townsend making this statement: "If the Fort Jackson gauge is reduced by the spillway to the same height as existed in 1891 (*viz.*, 6.9, or 2.7 feet below 1922), it is reasonable to assume that a discharge of 1,200,000 second feet will pass New Orleans at a height not exceeding that which it attained that year (*viz.*, 16 feet on Carrollton gauge)." By all means then let us do that something that will bring the Fort Jackson gauge down to 6.9 feet or as near to 6.9 feet as possible, when ordinarily it would be reading 9.6 feet. What more practical way can anyone suggest to accomplish this than by letting some of the water out of the river through a spillway or spillways located between New Orleans and Fort Jackson? By doing so would we not be duplicating in effect the condition that existed on the lower river in 1891 when the levee line was breached by crevasses and when there was practically no levee below Bohemia on the east bank, nor below Fort Jackson on the west bank?

But Colonel Townsend believes that this relief in flood height would be dearly bought. He states: "The lowering of the flood surface to sixteen feet at New Orleans (Carrollton) will make a radical change in river slopes for a long distance above the spillway and as the same discharge must then pass through a smaller section, it must necessarily flow with greater velocity and there will be produced a condition below Red River similar to that which now exists above it. An enormous increase in caving will result....that within a few years nearly the entire levee line on both sides of the river below Red River Landing would have to be moved back from the river bank." Does not Colonel Townsend himself partly furnish the refutation of this argument? Manifestly if a lowering of five or six feet will make a radical change in the river slope for a long distance above the spillway (and the intimation is that this change will extend as far as Red River Landing, 192 miles above Carrollton), the change in slope per mile will not be very great. There will, of course, be an increase in the velocity due to the same discharge passing through a smaller section, but a lowering of the flood surface five (5) feet at New Orleans involves a reduction

of only 6% in the cross-sectional area of the river, and since the discharge is the product of the sectional area by the velocity, the increase in the velocity can be only 6%. The potent factor in causing caving banks on the lower river would not be such a comparatively slight increase in velocity as is above indicated. Caving banks are more apt to be numerous as to location and serious as to extent when a flood stage quickly recedes and leaves a saturated upper bank in a condition favorable to slipping off; and this is true whether the flood stage was a very high one with high velocities or only an ordinary flood stage with ordinary velocities. There would not be "an enormous increase in caving" nor would the entire line of levees on both sides of the river have to be moved back in a few years as is claimed. There would perhaps be a *tendency* toward increased caving in the bends that are now caving bends, but that tendency would be no greater than the tendency that might be attributed to the increase in flood slope when compared with the flood slope that formerly existed, let us say, between Baton Rouge and Carrollton.

In 1903 the mean Gulf Level elevation of the high water mark at Baton Rouge exceeded that at Carrollton by 20.34 feet; in 1912, by 33.48 feet; in 1922, by 22.84 feet, the day before the Poydras Crevasse, and by 25.71 feet on May 16th, the date that the flood crest reached Baton Rouge. Notwithstanding this increase in slope I do not believe that any more mileage of new levee is being built now due to caving banks than was built in 1903 or thereabouts. If memory serves me right, the percentage of levee yardage, the construction of which is made necessary by caving banks is about $2\frac{1}{2}$ per cent per annum of the total yardage in the levee system of the respective districts below Red River Landing, and this percentage has not varied much in the last thirty (30) years.

The present high water slopes that exist on various lengths below Red River Landing are as follows:

		Av. H.
	Diff. in	W. Slope
Distance	H. W. Elev.	per mile
miles	(1922)	ft.
Red River Landing to Bayou Sara.....	34	5.6 ft. 0.17
Bayou Sara to Baton Rouge.....	34	7.11 0.21
Baton Rouge to Plaquemine.....	20	4.74 0.24
Plaquemines to Donaldsonville.....	32	6.73 0.21
Donaldsonville to College Point.....	18	4.04 0.23
College Point to Carrollton.....	54	9.44 0.18
Carrollton to Fort Jackson.....	82	13.25 0.16

If these average slopes prevailed uniformly, mile for mile, there probably would be little or no caving. The caving banks are in those bends where local slopes exceed these average slopes to a pronounced degree. Nor is this statement entirely correct. The relation of high water slope to rate of caving is not always the direct relation that one would suppose. For example, Poydras Bend might be described as extending from a point about one mile below the Lake Borgne Canal to the Kenilworth residence. It is the most actively caving bend on the river below New Orleans. In the bight of the bend, caving banks necessitated a new levee in 1899; additional caving necessitated the abandonment of this levee and the construction of a new levee in 1914; and still further caving has occasioned another retirement and a new levee is now in process of construction. The average rate of bank recession in this bend is 25 feet per year, an unusually high rate for that part of the river below New Orleans, yet the high water slope per mile is only $1\frac{1}{2}$ tenths of a foot. Further down stream, between Phoenix Postoffice and Harlem Plantation, a distance of three miles, the high water slope is four-tenths of a foot per mile for the first mile, one-tenth of a foot for the next mile, and four-tenths of a foot for the third mile. At this locality there has been only one new levee built in the past twenty-five years, and that was occasioned by the memorable hurricane in 1915. The bank erosion or rate of caving is less than five feet per year. So that while high water slope has a tendency towards increasing caving, by increasing velocity, it is not the only and exclusive factor responsible therefor.

In this connection it is interesting to compare high water slopes on the Atchafalaya River, on which stream comparatively few levees have to be rebuilt on account of caving banks. I have taken the 1916 high water elevation for the reason that I have no readily available figures for subsequent high waters.

	Distance	H. W. Elev.	H. W. Slope per mile
	miles	1916	ft.
Barbers Landing to Simmsport.....	5	1.59	0.32
Simmsport to Melville.....	26	10.85	0.43
Melville to Krotz Springs.....	10.5	8.40	0.77
Krotz Spring to End of Levee (1916).....	6	6.40	1.06
End of Levee to S. P. Bridge.....	14	11.60	0.80

With particular reference to the proposed spillway into Lake Borgne which was recommended by the Safe River Committee of One Hundred, Colonel Townsend fears, in addition to destructive caving that will result from the change in slope caused by the diversion of so much water from the main river, the danger of the river making a short cut to the sea.

It is the writer's opinion that the fear of excessive caving is not well founded. The lesson learned from Poydras Crevasse is that the change in slope was quickly adjusted as far up the river as Plaquemines, 114 miles distant.

With regard to the second fear, viz., that the river may cut out a new channel to the sea, this might occur if the structure failed to meet the conditions it is designed to withstand. But knowing in advance these conditions, and exercising due diligence and caution in providing against failure, even to the extent of using an excess of caution, there should be no reason why such a structure could not be designed and guaranteed against all possible failure and at a cost commensurate with the benefit received. If it is Colonel Townsend's judgment that the plan submitted by the Safe River Committee is deficient in that respect, the Safe River Committee will be pleased to consider any modifications or additions that Colonel Townsend deems necessary.

The erosion that would take place in the spillway channel to the Gulf would not continue indefinitely to such depths as mentioned in the paper if the amount of water going over the spillway is throttled by the concrete crest of the structure. Erosion might be prevented by matting the spillway bed, but this is unnecessary. The erosion that will occur will be self-curing, and a point will be reached when the spillway channel will become capacious enough to take all the water delivered to it without further erosion. The destructive velocities at the throat of the spillway can be controlled by "stilling basins" and other devices successfully used by the Miami Conservancy Commission, in dissipating the energy caused by much greater heads of water than that contemplated at the suggested spillway.

Colonel Townsend states, with reference to the Pointe-a-la-Hache levee removal spillway, that "the only way of accurately determining what such a spillway will do is to build it and see what happens. It is a relatively inexpensive experiment and justifiable when the great cost of adjusting the structures in New Orleans to increased flood heights is taken into consideration." It is to be hoped that the Mississippi River Commission will make every effort to avail itself of the opportunity provided at the expense of the citizens of New Orleans to obtain definite Mississippi River hydraulic data on many disputed points. It is doubtful if the Commission will do so unless sufficiently urged, and the proper authorities should do this necessary urging, offering to pay the expenses of the observation parties should it happen that the necessary United States Government funds are not available.

But while the Pointe-a-la-Hache project referred to is a worthy one, insofar as being an experiment is concerned, the Safe River Committee has clearly put itself on record that this kind of spillway, at the location selected, can by no means be considered as a substitute in results to be obtained for the one recommended by it and proposed to be located near the Lake Borgne Canal.

MARCEL GARSAUD: Colonel Townsend's paper has been very instructive and the conclusions drawn by him relative to the Plaquemines, or Pointe-a-la-Hache spillway, have been most

gratifying to the writer. Colonel Townsend agrees with the Orleans Levee Board as to the discharge of the spillway and confirms our own hope that flood heights at New Orleans will be materially reduced. His statement that the project will supply data for an investigation of the subject of spillways bears out our contention before the Mississippi River Commission.

As the writer was responsible for the insertion of the 16-foot gauge study in the Wilson Spillway Survey Bill, it may not be amiss to explain our insistence on this matter. It was felt that if the bill were to include a study to restrict gauge at New Orleans to 18 feet, the bill might as well, at little extra cost, provide for an examination including a 16-foot gauge. We want the investigation thorough and complete and we would leave no room for the criticism that the study made did not go far enough. We are not quite as sure as Colonel Townsend that a prevention of the gauge exceeding 16 feet at New Orleans presents insurmountable obstacles. It is not expected that one spillway will divert a sufficient volume, but, on the contrary, it is believed that at least two diversions are necessary besides the Pointe-a-la-Hache spillway.

We agree with Colonel Townsend that a flow of 1,000,000 cubic feet per second above Red River through a subsidiary channel is chimerical. We believe the solution will be found through the Atchafalaya, a supplementary spillway nearer New Orleans, and the Plaquemines relief outlet.

The levees will have to be maintained to Mississippi River Commission grade, and we have the feeling that Colonel Townsend's fears as to scouring are a little exaggerated. We advocate precaution, however, and we make the guess that those familiar with soil conditions in Lower Louisiana will be able to cope successfully with this phase of the problem at no prohibitive cost.

Finally, we cannot refrain from conjecture when Colonel Townsend advises us that we cannot hope for a 16-foot stage at New Orleans, because from a possible flood of 2,200,000 cubic feet per second we would have to divert 1,000,000 second feet from the main channel. If it is admitted that the Atchafalaya as at present functioning can carry only 400,000 second feet, and no other diversion is possible or feasible, we wonder how high the

floods would rise in New Orleans with the remaining flow of 1,800,000 second feet, when, in 1922, with a discharge of slightly over 1,300,000 second feet, the gauge at Carrollton read 21.27. From curves plotted by the engineers of the Safe River Committee, the river at Carrollton seems to rise one foot for every increment of slightly less than 70,000 second feet at the flood stage, the reservoir capacity of the channel having already been exhausted. It might be interesting to check up the natural conclusion that the surplus of 500,000 second feet would cause an increased flood height of 7 feet or a gauge reading of 28. The Mississippi River Commission levee grade is 25.

Colonel Townsend impresses us as favoring spillways, or a diversion of a sufficient volume of water, provided a solution can be found which will combine a suitable location, the prevention of serious scouring, and a warranted cost.

The problem is not solved, but it behooves us to apply ourselves to the task with all the energy and determination that we can command.

J. P. KEMPER: Colonel Townsend enjoys the enviable distinction of being the outstanding authority on rivers in the entire Engineer Corps of the United States Army. His experience with the Mississippi River covers many years in various capacities, culminating in the highest positions obtainable. He was for many years President of the Mississippi River Commission and many of its present methods of operating were inaugurated by him. Having been, a few years ago, retired from active service, because of having reached the age limit, it became necessary to reinstate him on the active list, in order that he might devote his talent to the very important and difficult work of maintaining a channel at the mouth of the Mississippi River, which problem has been so baffling to so many engineers and has proved so expensive to the Government. Recent reports indicate that the problem has been finally brought to a successful solution. Colonel Lansing H. Beach, U. S. A., now retired, told the writer that Colonel Townsend knew more about rivers than any man in the world, and General Beach is himself a most eminent river

(NOTE: Where Mr. Kemper uses italics in quoting from the paper, they are his own and not Colonel Townsend's.—*Editor*.)

engineer. It was during the incumbency of General Beach as Chief of Engineers, U. S. A., that Colonel Townsend was reinstated on the active list. Colonel Townsend's career is thus outlined in order that the importance of his address on "Spillways" might be fully appreciated. Arriving at this critical time, when the question of some modification of the present "Levees Only" system is being actively discussed, this address has an official importance which is construed by many as being an ultimatum to the proponents of all means of flood control other than levees. A slight concession is made in withdrawing opposition to the removal of the levees about fifty miles below New Orleans, in the vicinity of Pointe-a-la-Hache, but, with that exception, the time-honored opposition to any supplement to levees, by reservoirs, outlets, spillways or whatsoever means, remains obdurate.

The writer of this discussion thinks that nothing more timely could have happened than Colonel Townsend's paper. It sets forth the case of the Mississippi River Commission and the War Department and furnishes the basis of their stand in the controversy. It is now up to the opposition to show the necessity of a change. If this can be shown, it is up to Congress to bring about the change. The writer of this discussion will comment, paragraph by paragraph, upon the paper, giving credit where credit is due, (and much credit is due in spots) but not failing to endeavor, to his utmost, to break down certain assumptions which have almost become traditional (Folklore as they were once designated by an eminent New Orleans engineer, at a meeting of the American Society of Civil Engineers), but which have not stood the test of modern experience.

Paragraph 1 recognizes the fact "that the increase in flood heights in the Mississippi River below Cairo since 1882 has been *entirely due to the construction of levees* which have confined its waters to a restricted channel." The writer of this discussion concurs in this conclusion absolutely, but the Colonel thinks that "since the flood of 1922 is the *highest on record below the mouth of White River*, some may assign the increase in gauge readings to other causes, and an explanation of the conditions during that flood is desirable." He then cites gauge readings to show that not one flood record was made in 1922, on any tributary of the

lower river. "Nor was the combination of the floods of the tributaries such as to produce an excessive discharge of the main river at Cairo, *the maximum discharge at Columbus, Ky. (21.6 miles below Cairo), being 1,500,000 second feet, as compared with about 2,000,000 second feet in 1912 and 1913.* The White and Arkansas Rivers, combined, however, had a maximum discharge exceeding 400,000 second feet. This maximum entered the main river between two flood crests at Cairo and increased the maximum discharge at Vicksburg to about 1,800,000 second feet."

In Paragraph 2, the Colonel attributes the increase of flood heights below the mouth of White River to the closure of an opening which had, prior to the flood of 1922, existed in the Tensas levee line.

The writer concurs entirely in Paragraphs 1 and 2.

Paragraph 3, draws a contrast between the floods of 1882 and 1922. Attention is called to the fact that during the former about 1,100,000 second feet passed New Orleans in the river and a like amount escaped over land, while, in the flood of 1922, 27,291 square miles of bottom lands were protected and only 4,232 square miles flooded, of which 3,000 square miles would have been inundated by back water at the mouth of the tributaries, even if the levee line had held. The writer will admit that the two principal crevasses of the flood of 1922 were ideally located to give the greatest measure of flood relief with the least possible damage. The Wecoma crevasse was located just about the limit of the back water in the Tensas Basin, hence the greatest measure of storage was made available in that basin without the damaging effect of head water which would have been incurred had the crevasse been further up the river. The Poydras Crevasse was at the nearest point to the Gulf and where there was the least possible cultivated land in its path. This coincidence, however, was purely accidental. It must be realized that the flood of 1882 was probably the greatest volume of water ever concentrated in the lower Mississippi Valley since the coming of the white man. There is not sufficient data to definitely prove this, but the preponderance of evidence points that way.

The flood of 1922 was unusual *only because the levees, being stronger and better than heretofore, held longer than usual and*

caused greater flood heights before they broke. The excessive flood heights, as Colonel Townsend has shown, were caused solely by the closure of the Cypress Creek opening which had, in all previous floods, permitted a large volume of water to flow down through the Tensas Basin, availing itself of the immense storage capacity of the basin. This flow sometimes exceeded 300,000 second feet. Its closure was responsible for an immense congestion of water in the basin at the mouths of the White and Arkansas, raising the stage there probably six feet higher than would have been the case had the closure not been made. The effect of this was to diminish the slope from up stream, thereby reducing the flow, for a given stage. The increased flood height increased the flow down the river, but before a sufficient height could be reached to compensate for the former flow through the opening, the levee broke at Wecoma and restored, in part, the storage lost by the closure.

The writer can remember the following floods since 1882 whose volume in the lower river exceeded that of 1922, which fact can be proved by a study of gauge readings and discharge observations, viz., 1883, 1884, 1890, 1891, 1892, 1893, 1897, 1903, 1908, 1912, 1913 and 1916, twelve in forty years. Under the present existing conditions, any of these floods would have overtopped the levees, not only as they exist today but as they will be when all the levees are brought up to the present Commission standard grade. This is a broad statement and needs proof.

This proof is furnished insofar as the floods of 1912, 1913 and 1916 are concerned by the report of the Mississippi River Commission for 1922. This report shows the maximum discharge into the latitude of the mouth of the Arkansas River was in 1912, 2,427,000 second feet; in 1913, 2,160,000, in 1916, 2,484,000, and in 1922, 2,041,000. It further shows the flow on down the river past Arkansas City was in 1912 2,007,000 second feet at a maximum stage on the Arkansas City gauge of 55.33 feet; in 1913, 1,782,000 at a maximum gauge reading of 55.15 feet; in 1916, 1,839,000 at a maximum gauge reading of 56.40 feet, and in 1922, 1,768,000 at a maximum gauge reading of 58.0 feet. The report further shows that in 1912 an unknown quantity of water escaped into the Tensas Basin through the Cypress Creek open-

ing. (It was not measured.) In 1913, the amount which escaped was 138,000 second feet; in 1916 it was 336,000 second feet. In 1922 this opening had been closed, hence none could escape. The report of the Mississippi River Commission for 1922 shows this by a table, and then says: "The table above shows that the amount of water per second entering the basin at and above the mouth of the Arkansas River *was less at the crest of the 1922 flood than at the crests of the 1912, 1913 and 1916 floods.*"

If we compare the flood of 1922 with that of 1916 we find that 441,000 second feet less water entered the basin in 1922 than in 1916, but as none of it could escape into the Tensas Basin, it all had to pass down the river or be stored until the crest of the flood had passed. It can be stored only by increasing flood heights and, likewise, its flow down the river can be increased only by increasing flood heights. Pursuing this course, the river rose until it reached 58 feet at Arkansas City, when the levee gave way at Wecoma, about 260 miles below Arkansas City, and by permitting a large volume of water, more than 600,000 second feet, to escape into the Tensas Basin, afforded enough relief to the river to prevent further crevasses above Red River. The relief was not soon enough, however, to prevent the Poydras Crevasse, about twelve miles below New Orleans on the east bank, which occurred the next day. A small crevasse at Myrtle Grove, on the west bank of the river, about thirty-five miles below New Orleans, had occurred several days before, but was of insufficient volume to afford much relief.

There is much difference of opinion as to what would have been a maximum flood had the levees held. Two crests culminated at Cairo, one at 53.6 feet on March 25, which receded to 49.9 feet on April 9 and 10, and rose to 53.5 feet on April 25, the day before the Weecoma Crevasse. The second crest was within one-tenth of a foot of the first. The fact cannot be questioned that the crest left Cairo the day of the Weecoma Crevasse and was not due at New Orleans for three weeks. Any contention that it was further down the river is based solely upon the influence of the crevasse. The records are there to speak for themselves. The amount of additional flood height that would have been attained had the levees held is hard to calculate be-

cause the river was full from end to end, the slopes were a minimum, hence the velocity low, the submerged areas at the mouths of the tributaries were great, hence the storage surface was great. It is reasonable to suppose that the rise would have been slow and the duration long. It is my opinion that a rise of one-tenth of a foot a day at New Orleans, for twenty days, would have been a reasonable expectation. This would mean a flood of at least 23 feet on the Carrollton gauge. I think that a rise of another foot at Arkansas City would have been a reasonable expectation, bringing the gauge to 59 feet. Since the provisional grade is 60.5 feet at Arkansas City, a margin of 1.5 feet would still have been left. Further down the river, however, the provisional grade would not have fared so well. There would surely have been an additional rise of from 2 to 3 feet between Natchez and Red River Landing, and both of their gauges were within 2.2 feet of the provisional grade line. There is no doubt that the flood of 1922 had in the river, at the time of the Weecoma and Poydras Crevasses, enough water to overtop the levees all the way from Natchez to Baton Rouge, had they been up to the *last standard grade and cross section* which was adopted by the Mississippi River Commission in 1914.

But the Mississippi River Commission assures us that 443,000 second feet more water entered the basin at the mouth of the Arkansas River in 1916 than in 1922. Such being the case, if the provisional grade cannot take care of the 1922 flood, how can it take care of 443,000 second feet more than the 1922 flood? Even if we admit that without crevasses the river would have gone no higher in 1922 than it did go, the provisional grade would be utterly inadequate to take care of the flood of 1916 or 1912 below Arkansas City.

Paragraphs 4, 5 and 6 refer to tables showing flood stages from Cairo to the Gulf in the floods of 1882, 1912, 1913, 1916 and 1922. They are interesting in so much as they show progressively higher flood stages since 1882, accompanied by progressively less volumes of water discharged, I mean that the floods of 1882, 1912, 1913, 1916 and 1922 diminish consecutively in volume of water discharged, while, with the exception of a few gauge readings, they increase consecutively in flood heights. This is ef-

fectively shown by Colonel Townsend's table in Paragraph 5.

Attention is called here to the fact that the grade line for the tops of the levees was established *three feet above the maximum flood expectation* as calculated after the flood of 1913, and *this additional three feet was placed there as a margin of safety*. The table in Paragraph 5 shows that at Arkansas City and Baton Rouge six-tenths of a foot of the margin had been consumed when relief came through the crevasses; at Natchez and Red River Landing eight-tenths of a foot and at Fort Jackson one and six-tenths foot. This makes it apparent that, if flood control is to be accomplished by levees alone a very pronounced revision upward of the grade line is inevitable. The flood of 1922 showed that the entire grade line below White River except Carrollton is now obsolete. For some reason which does not seem clear the provisional grade of 25.2 feet at Carrollton is out of proportion to the points above. For example, water during flood rises twice as fast at Red River Landing as it does at Carrollton; hence, in order for water to reach 25.2 feet at Carrollton it would be necessary for it to reach 63.1 feet at Red River Landing. This is 5.6 feet above the provisional grade at that point. This is not a conjecture on the part of the writer; an examination of the gauge readings of various floods will show that, after bank full stage is reached, the river at Red River Landing rises almost exactly twice as fast as it does at Carrollton.

The writer concurs in Paragraph 7 that the increased flood heights at Carrollton are due solely to the increase in the flood discharge, due to the confinement of the river between levees, and that the reverse proposition logically follows.

The writer in the main concurs in Paragraph 8.

The writer concurs in Paragraph 9, except the statement "*an increased expenditure for spillways is not considered justifiable.*"

In Paragraph 10, the maximum discharge expected to come down the Mississippi and Atchafalaya is fixed at 2,200,000 second feet, and it is stated that 1,200,000 would pass New Orleans to the Gulf at a maximum stage of 16 feet. The writer concedes it would be necessary to provide for a maximum of a million second feet by outlets or spillways, including the Atchafalaya, aided, of

course, by storage basins, if the flood of 1882 were to be taken care of.

The writer assumes that Paragraphs 11, 12, 13, 14 and 15 were thrown in for the amusement of the audience. He is reluctant to believe that the purpose was to expose to ridicule all who believe some modification of the levee system is necessary to successful flood control.

The writer is not familiar with the plan proposed in Paragraphs 16 to 22, inclusive. It is needless to say that a plan which would involve diverting a million second feet of water from the river and letting it flow unrestrained over the entire alluvial valley west of the river, flooding everything as was the case in 1882, had not been carefully thought out. One would seem to have fairly just grounds for questioning the reputability of so reckless an engineer. If, as Paragraph 18 seems to intimate, hydraulic grade lines were ignored and cuts and fills were not considered, the writer thinks the Colonel would be amply justified in ignoring the proposition as being unworthy of consideration by the best available engineering talent.

Paragraphs 19 and 20 more than bear out the writer's suggestion. Transporting many billions of yards of excavated earth an average haul of 500 miles to the Gulf. Think of it! As we read on through Paragraphs 21 and 22 we are gratified to find that the Commission rejected this plan, although we cannot agree that the completion of the levee line to the present established grade line will solve the problem.

The writer thinks that the plan suggested in Paragraph 23 contains merit, and regrets that he has never seen the paper which was presented to the Western Society of Engineers in 1896.

The writer concurs that if it is necessary, as is set forth in Paragraph 24, to overflow 4,000 square miles of the St. Francis Basin, a large part of which is under cultivation, for the purpose of reclaiming 1,000 square miles of swamp land in Louisiana and of allaying the apprehensions of the citizens of New Orleans (provided these apprehensions are unfounded) the game is not worth the candle. If an effort were made to induce the United States to buy several thousand square miles of cultivated land

to reclaim 1,000 square miles of swamp lands surrounding Grand Lake, in Louisiana, it would be a dastardly deed. Paragraph 24 reveals a most important fact that it is well for the residents of the flood plain of Louisiana to appreciate. It is a fact which the writer suspected some time ago and became convinced of later. That fact is that the Mississippi River Commission, for which Colonel Townsend has long been spokesman, is so hostile to the lower end of the river that it cannot accord it any measure whatever of justice. Colonel Townsend's charge that the effort of the people of Louisiana to obtain a solution of the flood problem is prompted by a desire to reclaim 1,000 square miles of swamp land on Grand Lake is so palpably false as to be ridiculous. The facts are exactly the reverse. The result of the levee system to date has been to raise flood stages at the mouth of Red River from a probable maximum of 42 feet a hundred years ago to 55.5 feet in 1922. This means that land in the vicinity of the mouth of Red River which was then 13.5 feet above high water now goes under water. This condition was brought about by the levees which reclaimed lands in the upper reaches of the St. Francis, Arkansas, Yazoo and Tensas Basins at the expense of those in the vicinities of the mouths of the tributaries. As progress is made down the river, this condition becomes progressively worse. Levees are required to be higher and higher. The increased head at Red River Landing has brought about an increased flow down the Atchafalaya into the Atchafalaya Basin. This has backed water up on to cultivated lands east of Bayou Teche and west of Bayou Lafourche and made them worthless. Whole sugar plantations have been destroyed. Owners began building private levees, but the increased heights of the floods overtopped them. They built higher, and again they were overtopped. The levee board is undertaking to build protection levees, but the effect is always to concentrate an ever-increasing flood height on the remaining unprotected areas. But the worst is that the levees cannot be made to hold and they give way at every great flood. So, instead of the residents of the Atchafalaya Basin being prompted by a sinister motive to reclaim their swamp lands at the expense of the upper district, they are fighting with their backs to the wall to prevent their entire extermin-

nation under a most inequitable policy, which, it is all too apparent, cannot succeed.

But to return to the question of reservoirs on the St. Francis. The writer is not familiar with the St. Francis Basin, but from the plans and profiles it would seem feasible to impound water during floods and let it out to aid low water navigation in the Fall. Whenever the question of reservoirs is broached by army engineers, some proposition is suggested which has no application to the case in hand. Thus Paragraph 24 begins with the statement: "It has been estimated that the surplus water of the flood of 1882 could be retained in a reservoir of the size of the State of New Jersey if of a depth of 15 feet." There is no necessity of impounding all the surplus waters of the flood of 1882. Miles upon miles of levees were down in 1882. Practically the entire flood plain of 30,000 square miles was under water. No purpose would be served by removing this water from one reservoir and placing it in another, the size of New Jersey. No levee system can prevent the accumulation of water at the mouths of the tributaries, since these mouths must be left open. It is possible, however, as well as practical, to construct reservoirs at the mouths of the tributaries, hold the water out of them, on a rising river, until an extreme height is reached, when the water can be permitted to flow into them, thereby, in a measure, diminishing the intensity of the flood, and at the same time storing water to be released later to aid low-water navigation. Perhaps no more foolish engineering feat is performed in the United States than dredging the crossings of the channel of the Mississippi, at low water, to improve navigation. *The river has become shallow because the water has run out.* To dredge the high places of the channel permits the water to run out faster and the bottom is reached quicker. The only way to maintain a channel for navigation is to impound water at flood and release it at low stages. Reservoirs at the mouths of the various tributaries would be suitable for this purpose and, at the same time, hold down flood stages.

In a paper, published in the Engineering News Record recently, Colonel Charles L. Potter, U. S. A., present President of the Mississippi River Commission, took the writer to task for,

as he said, criticising the Mississippi River Commission for closing the Cypress Creek gap, below the mouth of the Arkansas River, which closure raised the water in the river almost six feet. He intimated selfishness and a lack of altruism in not wishing the residents of the upper Tensas Basin to have the relief which this closure afforded. The criticism to which he referred was before the Flood Committee of the House of Representatives. Somehow Colonel Potter missed the point of the writer's criticism. He did not criticise the closing of Cypress Creek gap; he merely stated the fact. His criticism was of the policy of "*Levees Only*" whereby, through the closure of the natural storage reservoirs, flood heights are raised above the carrying capacity of the levees. In other words, *if they insist on forcing that water into the river, they should take care of it after it gets there*, and that without flooding lands that were formerly free from overflow, unless these lands are purchased and converted into reservoirs.

The land of a resident of Avoyelles Parish, near the mouth of Red River, looks as good to him as the land of a resident of East Carroll Parish in the Upper Tensas Basin looks to him, and it will be hard to convince the Avoyelles man that it is selfish and unethical for him to kick when his land is deliberately submerged,—good high land when purchased,—in order that land in East Carroll Parish, swamp land, worthless except for timber when purchased, may be converted into tillable high land. That is what the levee system culminating in the closure of Cypress Creek gap has done. The writer's condemnation was of the Mississippi River Commission for its failure to foresee this condition, for its failure to acknowledge it when it became evident, and, worst of all, for its determined fight against any plan which might correct it.

The writer concurs in Paragraph 25 relative to spillways on the Yazoo. No spillway nor outlet is of benefit which does not permanently remove the water from the river. For that reason, any spillway or outlet on the west side of the river which does not lead into the Atchafalaya has no value. The only hope for the lower Yazoo Basin is to lower flood levels. This can be accomplished by reservoirs and outlets or spillways. Wherever they

can be shown to be practicable and feasible, the residents of the Yazoo Basin should be backing the plan.

Paragraphs 26, 27 and 28 refer to the Cypress Creek Gap which constituted a spillway into the Tensas Basin. Although part of this water returned to the Mississippi at Red River Landing through Old River, still the storage capacity in the Tensas Basin was so beneficial that the closure of the Cypress Creek Gap in 1921 caused the flood of 1922 to be six feet higher at the mouth of the Arkansas than would have been the case had the gap been left open. The writer's position on this question has already been made clear in this discussion; he wishes, however, to comment on the following statement: "*Wherever the levees were built to Commission grade and section they stood the increased strain to which they were subjected.*" Be it understood that only part of the levees are built to the *present Commission grade and section*, which was adopted in 1914. The remainder of the levees are built to a previous Commission grade and cross sections, now obsolete. Before all the levees can be brought to the latest adopted Commission grade and cross section, a new flood shows that grade and cross section to be inadequate and it becomes necessary for the Commission to call a meeting and adopt a higher grade and thicker cross section. This has been going on since the beginning of levee construction on the Mississippi River. At present, standard levees and less than standard levees are sandwiched between each other indiscriminately. Suppose a chain were made up of links some of which could withstand a strain of 3,000 pounds and others only 2,000. It is admitted to be a foolish kind of chain. Now, suppose a gradually increasing strain be applied to this chain until it breaks. Would it give way in a link that could withstand 3,000 pounds or one that could withstand only 2,000 pounds? Foolish question, isn't it? Here is another question. Why do the Mississippi River Commission and the United States Army Engineers try to get by with this kind of argument?

In comment on Paragraph 29 the writer thinks that had Humphreys and Abbott's suggestion been taken at the time and a spillway installed at Lake Providence, the principle of spillways for holding down flood levels would have been proved and

the flood problem probably solved at a far less cost than the levees have cost to date.

Paragraphs 30, 31, 32, 33, 34 and 35 are mostly descriptive of conditions in the Tensas Basin and the Atchafalaya. The writer sees only one assertion to which he seriously excepts. It is contained in the following statement in Paragraph 32: "As the crest of the flood was passing Lake Providence at the time the Weecoma Crevasse occurred and could not have increased flood heights at Vicksburg more than one or two tenths of a foot * * *." The writer has already shown that the crest was at Cairo on April 25. It was not due at Vicksburg for two weeks when the Weecoma Crevasse occurred and the river was due to rise there surely more than a foot. The crest did not reach Helena, 236 miles above Lake Providence, until May 3. That crest was due to pass Vicksburg about May 9 or 10, had there been no Weecoma Crevasse.

Paragraphs 36, 37 and 38 refer to projects to close Old River with a dam and controlled gates. The writer recognizes in the one described as being 600 feet wide and 40 feet deep a close similarity to a plan suggested by him. The plan as proposed by him never contemplated permitting so great a volume as 1,000,000 second feet, nor even near that much, to flow through the opening. Its idea was to combine the storage capacities of the lower Tensas and Atchafalaya Basins with the carrying capacity of the Atchafalaya River, and so co-ordinate them with the Mississippi River as to have the river carry all of a flood which it safely can and have a place to deposit that portion of its load which it cannot safely carry.

Colonel Townsend's suggestion that the lower river has been adjusting itself to a diversion of water through Old River and presumably has a smaller cross section than would have existed had there been no outlet, is hardly tenable. First, all "Levees Only" proponents contend that leveeing causes the river to scour its bed. That is the fundamental basis of their theory of flood control. Well, the lower river has been continuously leveed from Red River down for 100 years. It should have scoured much in that time. But they contend that the Old River outlet causes local impairment of the channel below the outlet. Well, the

Commission's surveys of 1895 and 1910 of numerous cross sections opposite, above and below the Old River outlet *showed a flood stage improvement rather than the expected impairment.* Colonel Townsend's fears along these lines are unwarranted. It is true that alluvial streams are invariably of less cross section and slope near their mouths than further up stream. This is not due at all to the old Guglielmini theory that an alluvial stream always adapts itself to the amount of sediment it carries, enlarging its cross section by scouring, when the load is light, in order to increase its burden and depositing part of its load when it is excessive, thereby diminishing the cross section until the velocity becomes great enough to just carry the load. A very pretty theory, but it is not a fact. If it were, all streams would be of uniform slope and cross section adapted to the amount of solid matter being carried. From Red River Landing to the Gulf, the Mississippi would be of uniform cross section and of uniform velocity throughout, because no water enters nor leaves it below Red River.

The writer cannot understand why the old theory is clung to; Humphreys and Abbot exploded it sixty years ago. A most casual study of the Mississippi shows that it simply is not a fact. The sediment which a stream carries is purely incidental. The big job is to carry water. Water has erosive power, hence the sediment, which must be carried. Let us assume that the world was once a molten mass surrounded by a vapor which condensed into water as the earth cooled. Internal gases caused eruptions which threw up mountains. Necessarily, depressions were created between the mountains and the water settled therein. Then began the process of weathering. The sun pumped up the moisture; variable temperatures produced rain; the force of the water striking the rocks in falling and its motion over them, prompted by gravity, caused erosion. Streams were formed and in them parts of the rocks disintegrated both by physical and chemical action were borne to what had become the sea. It is easy to see that, as this sediment reached the sea and filled it up at the edges, the slopes became less. All the land in the world was once mountains. It has been weathered down and shoved into the sea. As the distance from the mountains becomes greater the slopes be-

come less. They are least where the streams enter the sea. To compensate for the lost force due to reduced slopes, streams have a trick of setting aside storage basins to hold the surplus water until it has time to carry it to the sea. The lower Mississippi set aside 30,000 square miles for that purpose. When the white man arrived, the capacity of the river at New Orleans was far less than at Cairo. The difference was made up in the storage. There was no particular hurry, nobody wanted the lands. Indians would not work. History shows that a white man never passes up anything he wants without a try. He wanted those rich lands and he went after them. The same energy expended in the hills would probably have paid him better, but he didn't see it that way. In the Mississippi River, he went up against a tough proposition. Legislatures and Congress have been fooled into making appropriations to accomplish purposes based upon human desires rather than sound hydraulic principles. Legislatures and Congress can be fooled, but not rivers. They follow a perfectly fair and universal law and cannot be swerved therefrom. The man has fought foul, the river fair. The river was the better fighter, submitting to its guidance from On High. The river has won. Moral: *In dealing with forces of nature one must not transgress natural laws.* We will never solve the flood problem until those laws are recognized and followed.

With reference to Paragraph 38 the stage at Carrollton can be definitely fixed by regulation of the stage at Red River Landing. A stage of 50 feet at Red River Landing will produce a stage of 19 feet at Carrollton. If there are to be no spillways below Red River Landing and the Carrollton gauge is to be held to 16 feet the Red River Landing gauge must be held to 44 feet. The writer's plan did not contemplate this because he knows that the Red River Landing gauge cannot be held to 44 feet unless the capacity of the Atchafalaya is increased beyond what he considers practical limits.

In Paragraph 39 I am afraid Colonel Townsend let his imagination get the better of his judgment. It may be possible to suddenly open gates and permit a precipitate discharge of from 450,000 to 1,000,000 second feet of water through a fall of 20 feet or more. It could not, however, be considered intelligent prac-

tice. The writer's concept of how to do it was so very different from this that it is hard for him to realize that anyone could conceive of it as Colonel Townsend did. The writer's idea of operating the gates was about as follows: We will assume that the Red River Landing gauge is just reaching 50 feet and that the water on the opposite side of the gates is 20 feet below. We will further suppose that the river is rising say three-tenths of a foot a day, which is equivalent to an increase in the discharge of about 20,000 second feet, daily. The idea is to divert this increased discharge, through Old River, into the lower Tensas Basin, permitting the Atchafalaya to carry it off as rapidly as possible. The first day it will amount to only 20,000 second feet, average. A very small opening or series of openings in the gate system can accomplish this almost without a ripple. Practically no more than that required to fill a lock. The diversion of this water, on a rising river, will, by preventing a further rise at the gates, increase the slope from above and consequently increase the flow. This increase must be taken care of by opening more gates. This must be done so gradually that the water below the gates will have time to attain its natural slope. Of course it will rise rapidly at the gates. In fact, it must attain a gradual slope through the gates, the steepness of which will depend upon the rapidity with which the Atchafalaya can carry the water off and the Red, backing up stream, can store it in the lower Tensas Basin. If the joint carrying capacity of the Atchafalaya and the storage capacity of the lower Tensas Basin are sufficient to prevent the river from exceeding fifty feet until the end of the flood has been reached, the desired end will have been accomplished. If it fails, the result will be that the Tensas Basin will fill up and the river will continue to rise until the crest is finally reached, the water flowing into the Tensas Basin, just as it does now. This might happen at long intervals. Now, it does it nearly every year. The writer is working now to collaborate some definite data on a great flood so he can determine what percentage of great floods can be handled this way, and what supplemental devices are necessary to handle the greatest expected flood.

Paragraph 40 is a *clear-cut misstatement of the case*. The fundamental idea in controlling the flow through Old River is to stabilize floods, *holding them to a fixed maximum stage*, instead

of causing them to rise to levee-breaking heights at each great flood, as is being done under the present system. This fundamental idea contemplates utilizing intelligently the storage capacity of the Tensas and Atchafalaya Basins so as to prevent the ever-increasing encroachment by floods upon lands which were above flood level before the Mississippi River Commission started upon its mad escapade to *reduce flood levels by forcing more water into the river*, as it declared it would do, upon its organization, in 1879.

In answer to Paragraphs 41 to 44 there was in 1922 a storage reservoir of 2,000 square miles in the lower Tensas Basin, instead of 500, as stated by Colonel Townsend. There is no thought, under the plan suggested by the writer, to reclaim land in this basin. The idea is to hold this basin in abeyance for storage of excess floods. It is hoped and believed that it will not be necessary to flood the whole 2,000 square miles by a stage of about 56 feet at Barbres Landing and then break the des Glaises levee and flood a vast area west of the Atchafalaya, as was done in 1922, but there is no thought of leveeing the area at the mouth of Red River. The writer, and in fact anyone with a modicum of common sense, knows that the plan which the Mississippi River Commission outlines of leveeing the north side of Red River and the west side of the Black is beyond being ridiculous. Such a procedure would necessitate pumping the rainfall from a vast watershed, the cost of which would exceed a hundred fold the value of the lands reclaimed.

The Atchafalaya will carry a certain percentage of the surplus flood water and the balance will be stored in the lower Tensas Basin until a height is reached at which the Atchafalaya can carry it. It is a question of careful design. It can take care of what it can, and no more. *If this is not enough, more must be provided for by other means.* The thing to do is to measure a great flood and then provide means to take care of it. In this undertaking, we are not going to be sidetracked by wild pictures of absurd propositions.

In Paragraph 45 Colonel Townsend intimates that the use of the weir formula instead of Kutter's formula has led the advocates of a control outlet at Old River to the "absurd conclusion

that a river discharges more water through a contracted opening than the unobstructed river discharges." Such is not the case with the writer. Rising rivers have the habit of gradually consuming the storage capacity of their natural reservoirs. It is to avoid this that it is desired to retain the storage capacities of the lower Tensas and Atchafalaya Basins until they are needed. The longer the Mississippi can be made to carry the entire flood, the greater percentage of that flood it will carry. It is only the last few feet, at the top of a flood, that break the levees. Infinitely more water is carried by the river below the danger line than above it. When it gets above it, we must be prepared to meet the emergency. This we believe can be done by combining the storage capacity of the two basins with the carrying capacity of the Atchafalaya.

In Paragraph 46 the Colonel condemns the writer's plan to lower the Atchafalaya Basin by a relief outlet from Grand Lake into West Cote Blanche Bay. The writer does not believe that navigation on the Teche would be impaired thereby, and he has given the subject much close study. No dam would be needed in the Teche because an exceedingly small percentage of the water would flow down the bayou and return to the Atchafalaya River. The great preponderance of slope would be the other way. Nor does the writer believe the Intra-Coastal Canal would be materially affected by such an outlet. There would be some cross current, but it will be so near the discharge of the outlet that the slopes would be very slight in the Intra-Coastal Canal. The only real inconvenience would be from deposit, but as the Atchafalaya is depositing its sediment within the basin, the water which flows to the Gulf is almost entirely free of heavy matter. It is muddy, but that is fine silt which goes on out to sea. To dig such an outlet as would be sufficiently effective would be expensive, and Colonel Townsend may be right in suggesting it would be cheaper to levee Morgan City, although, of course, both sides of the Atchafalaya Basin must be leveed and drainage provided for, leaving the center of the basin for storage and sediment. The writer is working on this proposition now, with a view to determining which plan would be the more feasible.

In Paragraphs 47, 48 and 49 Colonel Townsend discusses a spillway below Baton Rouge into Lake Maurepas. Since he dis-

cusses it only from the viewpoint of removing forty miles of levees in order that the velocities may be held down to $1\frac{1}{2}$ foot per second, "a velocity which would induce a fill instead of a scour," he puts it beyond practical limits. To wipe out half of the land between Baton Rouge and New Orleans, as good as any agricultural land in the State, to say nothing of flooding for forty miles, the Illinois Central, Yazoo and Mississippi Valley and Louisiana Railway and Navigation Companies railroads, the Jefferson Highway and the Orleans-Hammond Road, would indeed be an affair of some consequence. And, after that was done, we would still have Pat Harrison to contend with.

A spillway need be only so wide as to permit the passage of the desired volume of water at the fixed height. All talk of not being able to make it safe is absurd. It is only a dam a few feet high with water flowing over it a few feet thick. There are in successful operation dams many times higher with very many times the kinetic energy per unit of length. Call for bids on a spillway to discharge even 600,000 second feet in a length of two miles, with a suitable bond to guard against any emergency, and the bids will be forthcoming at once. While the writer believes the best location on the east side of the river to get the maximum of relief is this site below Baton Rouge, he is afraid it would encounter too many obstacles in the way of railroads, highways and owners along Lakes Maurepas and Pontchartrain and the Mississippi Coast to permit of its installation. Colonel Townsend's idea that the river may be diverted has no value. In the first place, the spillway will be controlled so its flow may be entirely stopped at will. It can surely be made as safe as the present mud levees. In the second place, the tendency will be to fill rather than scour. Witness the Bonnet Carre Crevasse which ran for nine years. A few small channels were formed through an ever-rising ground. This question is too long to discuss in this review, but the terrors of spillways do not exist, which fact can be made clear to any open mind.

Paragraph 50 to 56 continue along the same lines. Paragraphs 57, 58 and 59 predict the damaging effect a spillway in the vicinity of New Orleans will have upon the levee line. It seems to anticipate a greatly increased velocity and expects the levees to be all swept into the river in a short space of time. In Para-

graph 60, preparatory to discussing the question of spillways below New Orleans, the Colonel proposes to give "a clear conception of the problem before us, and to treat it dispassionately." He deplores the waste of oratory and printers' ink over irrelevant matters. So, by the way, does the writer.

Paragraph 61 recites that the Commission in 1913 estimated that the flood heights would reach 22 feet at Carrollton and recommended a grade line of 25 feet. In Paragraph 62 the Colonel discusses his difference of opinion with the Safe River Committee on what height the flood of 1922 would have attained at Carrollton and concludes that had the New Orleans levees been up to 25 feet they could have held the confined flood. The writer concurs in this opinion because due to the fact that the provisional grade line at New Orleans is relatively much higher than at any point above New Orleans, if the entire levee line were up to grade, water would be running over practically all the levees above New Orleans before the Carrollton gauge reached 25 feet. The writer understands that the three feet added to the calculated maximum flood heights was a factor of safety to meet all contingencies. All calculations, however, should be based on a confined river, and advantage should not be taken of crevasses to prove the adequacy of the provisional grade line. The Colonel is correct in the statement that the hydraulic grade line varies with every flood. This is due to the varying quantities of water contributed by the tributaries, and to the length of the flood which determines the effect of the natural storage reservoirs.

In Paragraphs 65 and 66 Colonel Townsend takes the City of New Orleans to task for not bringing its levees up to standard grade and cross section. The writer concurs entirely in his condemnation. The Mississippi River Commission, in fixing the grade line at New Orleans, saw to it that this grade line would not be overtopped. If New Orleans will bring her levees up to grade and can be assured that the levees will not be undermined, she can rest assured that water will be running over many hundred miles of levee above New Orleans before it can run over hers.

In Paragraph 67 Colonel Townsend dismisses the idea of lowering flood heights to 16 feet at New Orleans by spillways located below the city. He predicts such an increase of velocity as to

threaten the destruction of all the wharves along the city front. He states that a flood of 21.27 feet can now be passed by the city without danger and that the dangers of higher floods concern only New Orleans and "*the parishes of the State cannot be expected to increase their taxes to provide for the security of the city.*" What a sop is this to throw to the country folk. It is well for them to understand that the high provisional grade line at New Orleans will make certain the breaking of the levees in the country. Colonel Townsend cannot help but know that before a flood at New Orleans can reach the grade which the Commission, of which he was President, fixed, the entire flood plane of the State, outside of New Orleans, will be under water. And there could have been no other purpose than that in fixing a grade line that high at New Orleans.

The writer has never advocated a spillway below New Orleans to be charged with the entire burden of reducing flood stages at New Orleans to 16 feet. He has always contemplated it working in conjunction with a similar device at Old River. Let us, however, see what the effect would be of a spillway, say, at Poydras, through which enough water would flow to hold the Carrollton gauge to 16 feet. Poydras is twenty-three miles below Carrollton. When the Carrollton gauge read 21 feet in 1922, the water at Poydras was about 4 feet lower or 17 feet above Gulf. To lower the water to 16 feet at Carrollton would increase the slope from Red River Landing about $12\frac{1}{2}\%$. This increased slope carried on to Poydras would mean that the water must be lowered to 11.3 feet at Poydras. This assumes the slope to be a straight line, which it is not, but is a parabola with the apex at the surface of the water at the spillway. In the equation $Y=\sqrt{2PX}$, Y measures the cross section, X the slope and $2P$ the constant controlled by the resistance. It is, therefore, probable that it would be necessary to hold the water surface at 11 feet at Poydras in order that it may not exceed 16 feet at Carrollton. The natural ground level at Poydras is about 6 feet, after you get away from the ridge a little way. Suppose we set the weir to begin discharging at 12 feet on the Carrollton gauge; this would be about 8 feet at Poydras. At this stage there will be flowing past Carrollton about 900,000 second feet and the same amount would be flowing past Poydras. The problem is to in-

crease the flow to, say, 1,350,000 feet at a maximum stage of 16 feet at Carrollton and 11 feet at Poydras. The amount which would proceed down the river below the spillway would be directly proportional to the stage at the spillway. If it discharges 900,000 second feet at 8 feet, at 11 feet it would discharge about 1,100,000. This would leave 250,000 second feet to flow through the spillway. Using the weir formula, this would require a spillway at Poydras between fourteen and fifteen thousand feet long. But to hold a flood to 16 feet which in 1922 passed Carrollton at 21 feet would increase the slope from Red River Landing about 12 per cent, and as the velocity increases as the square root of the slope the velocity from Red River to Carrollton would be increased about 6 per cent. The reaction from this would be to hasten the flood, which would mean lower stages. But we have by this spillway increased velocities in front of New Orleans by passing the same volume of water at a less height. We have lowered the flood stage at Carrollton five feet. The river there is 2,500 feet wide, so we have diminished the cross section 12,500 square feet. At 21 feet, the cross section is about 193,000 square feet. To pass 1,350,000 second feet at 21 feet at Carrollton requires a velocity of 7.00 feet per second. This actually occurred May 8, 1912, and is the greatest velocity ever acquired at New Orleans. To pass the same volume of water with 12,500 square feet less cross section would require a velocity of 7.47 feet per second. Now, if the docks can stand a velocity of 7.00 feet per second, is it reasonable to suppose that they would be torn to pieces by increasing that velocity to 7.47 feet per second?

The Missouri exceeds 8 feet per second at Omaha and 9 feet per second at St. Charles, Missouri, 25 miles above its mouth. The Ohio once reached 9.60 feet per second at Cairo. The Arkansas sometimes exceeds 10.5 feet per second at Little Rock. You cannot eat your pie and have it, too. If you want to get rid of the water you must permit it to step along. But, they exclaim, "Think of the increased scour of the banks due to the increased velocity." The friction varies as the square of the velocity, hence a velocity of 7.47 increases the friction over a velocity of 7.00 by 14 per cent. To that may be replied that the friction also diminishes as the diminished depth. All of the friction will be removed from the levee between 16 and 21 feet because that

will be brought out of water. The point where the scour does the greatest damage is where the slope is the greatest. As the slope becomes more gentle, the scour becomes beneficial. It is destructive only where it undermines the levee. This is in the sandy loam above the blue clay and seldom is deeper than 35 or 40 feet. Let us suppose it to be 30 feet deep. If we lower the stage of the water from 21 to 16 feet we diminish the pressure from 30 feet to 25 feet, or $16\frac{2}{3}$ per cent, and thereby reduce the scour, through diminishing the weight, more than we increased it by increasing the velocity. Exception may be taken to the statement that friction increases in proportion to the depth. Some authorities, practically all of the old ones, contend that the scour is independent of the pressure. Trautwine says: "The friction of liquids moving in contact with solid bodies is *independent of the pressure* because the lifting of the particles of the fluid over the projections of the surface of the solid body is aided by the pressure of those lifted." This is clearly an erroneous conception of the characteristic that pressure of liquids is equal in all directions. The horizontal components of the pressure upon a particle of water on the bottom of the stream balance each other, but the vertical component, represented by the weight of all the water above it, must be held in equilibrium by the upward pressure of the bottom. The law of flowing water is the law of the inclined plane. Were there no friction, a particle of water, starting from rest, would have a uniformly accelerated motion, which, like a falling body, would be 32.2 feet per second when the slope had become 16.1 feet.

In the case of the Mississippi River at New Orleans, it would have to travel eighty-odd miles before it attained this velocity. But the friction of the sides and bed as well as the atmospheric resistance on the surface must be reckoned with. If the stream were uniform and these resistances constant, the velocity would be uniform. It is impossible to produce such a stream in practice, and Kutter's formula ($V=C\sqrt{R \times S}$) is as nearly perfect as a formula can be which must take into consideration an ever-varying stream, varying as to cross section, slope and hydraulic radius.

In the law of the inclined plane the friction varies as the square of the velocity down the plane and also as the weight.

There is no reason why this same law should not apply to liquids down an inclined plane, and the weight is proportional to the depth. There is no tendency to scour horizontally, and were the bottom smooth it would scour but little. But when the bottom is rough, the flowing water strikes the obstructions and the force with which it strikes is based upon its momentum, which is the product of its weight by its velocity. The weight is in direct proportion to the depth, hence the deeper the water the greater the friction. The scour depends not only upon weight and velocity but also, and in a greater measure, on the sediment being conveyed. Perfectly clear water scours almost none. The greatest scour is attained where the combined effect of the velocity weight and sediment are the greatest. This is not on the bottom, because there the velocity is reduced to a minimum. The force is about all consumed in carrying the solid matter that is rolled along the bottom. The greatest scour is on the sides, where the combined velocity weight and sediment carried in suspension are the greatest. The policy of levee construction has greatly increased this scour by raising flood heights and increasing the exposed surface. The idea that greater velocities, at lower stages, is conducive to more destructive scour is fallacious. The point of maximum scour will be lowered, and as it goes down, the slope carries it away from the bank to where the scour will prove beneficial rather than detrimental. The present policy is just one more fallacious interpretation of hydrodynamics.

In Paragraph 68 Colonel Townsend differentiates between Outlets, Spillways, Crevasses and spillways controlled by gates, which, for some reason not obvious to the writer, he sees fit to misname an "artificial crevasse." In Paragraph 69 he explains the difference between outlets, spillways and crevasses, charging outlets with impairing the low-water channel, being rather lenient on spillways and giving crevasses "Up the Creek." The writer has no *penchant* for crevasses himself. He thinks the Colonel unduly hard on outlets when he charges them with impairing low water channels. The channel gets bad because the water *has* run out and not because it *couldn't* run out. The case at Old River is unique in so much as it is a connecting link between the Mississippi and the Red and is not a simple outlet. If it were, it would probably not fill up for a long while (until it

became a deteriorating outlet, but under present conditions its velocity and sometimes its direction of flow depends upon the relative heights of the Mississippi and the Red. For a large part of the year its velocity is far below that required to carry the sediment being brought down by either the Red or the Mississippi. Old River must be considered a typical outlet in that respect.

In Paragraph 70 Colonel Townsend expresses opposition to the Lake Borgne "*Artificial Crevasse*" because it is dangerous and will produce too much current above and too little below, inducing a large deposit. The people of the lower valley are not responsible for Colonel Townsend being timid. If everybody said "it can't be done" we would never have gotten anywhere. Engineering feats in flood control already accomplished show Colonel Townsend's fears to be entirely unfounded. The writer has already shown that the increased velocities above will do no harm. As to reducing the velocity below the structure and inducing a large deposit, *such has never been the case and never can be*. The writer realizes that he is flatly contradicting statements of many engineers, including members of the Mississippi River Commission and the Louisiana State Board of Engineers. He has contradicted them before with the sole idea of forcing them to produce surveys to prove their contention. They have never produced them, and he charges that there are no surveys which can prove it, notwithstanding the Commission has been preaching his theory and acting upon it since its organization in 1879. The writer here gives them a magnificent opening to show that he does not know what he is talking about. Let them lay their surveys on the table to be examined by a disinterested board of engineers and see whether or not they can stand the test. A velocity of two feet per second can carry all the sediment contained at any time in the lower Mississippi. The Carrollton gauge has to get down to near two feet for the velocity to get as low as two feet per second. With a spillway beginning to discharge when the Carrollton gauge reaches twelve feet the velocity below the spillway could never be less than five feet per second, and it rarely exceeds five feet during the flood at Red River Landing.

In Paragraph 71 the Colonel admits the deposit will be removed but will pass down the river in sand waves, adding to the difficulties which are now experienced from that source in South West Pass. There will be no such deposit, hence no sand waves.

In Paragraphs 72 to 83, the end of his paper, Colonel Townsend discusses the spillway below Pointe-a-la-Hache, which consists in removing eleven miles of the levee and permitting the water to escape into Breton Sound. The Colonel claims authorship of the suggestion. Land values down there are slight, the cultivable lands are shallow, taxation for levees heavy. The difficulties of the land owners are greatly enhanced by storm damage from the rear. The lands must be protected from storms on the Gulf by back protection levees. These are sometimes overtopped or broken. In 1915, not only were some of the back levees broken but the writer has been informed that the levee on the bank of the Mississippi was itself broken and water from the Gulf poured into the river. This, of course, was an extreme case. Howbeit, farming down there is of doubtful profitability, and this opportunity to dispose of their properties comes as a life saver to the inhabitants. All told, the writer is glad it has been undertaken. The difficulties at the mouth of the river will be lessened thereby. All the sediment that goes into Breton Sound will not have to pass out the mouth of the river, where sediment gives much trouble. There will be benefits at New Orleans because any lowering of flood stages will be beneficial. The amount of benefit will be in direct proportion to the lowering of flood stages. As the present flood stage at Pointe-a-la-Hache can hardly be ten feet above Gulf, or, say, six feet above the surrounding land, it is probable that it will be lowered at Pointe-a-la-Hache between three and four feet. This may lower it at New Orleans, more than fifty miles above, by a foot. The actual volume which will flow past New Orleans ought to be increased a little for a given stage. The slope from Red River Landing will be increased about 6 per cent, which should increase the velocity about 3 per cent and the flow about 40,000 second feet. This is decidedly worth while. If we can get 40,000 second feet more flow at a stage one foot lower than formerly we will have made progress. Every little is a help.

It is to be hoped that surveys will be made of the river bed in the vicinity of the spillway and all possible data obtained to honestly ascertain the effects and that data honestly used in the future in the interest of genuine flood control. Colonel Townsend's discourse has shown the inadequacy of the "Levees Only" system as the *sole* means of flood control and a determination to adhere to it. Let us hope that forces can and will be concentrated by all available means to broadcast the truth and create a public sentiment which will break down this oligarchy which has the lower valley by the throat and is determined not to turn loose.

G. W. LAWES: The impression forced upon me by the remarks of Colonel Townsend was that "Spillways" were an experiment of doubtful value, but that least harm could accrue from the experiment if put into execution at the locality below Pointe-a-la-Hache. To my mind, spillways or lateral outlets of any kind along the course of a sedimentary stream are wrong in principle and wherever occurring are bound to have a harmful effect in aggravating the very conditions which the spillway advocates are desirous of remedying.

Having had about forty years of intimate experience with the Mississippi River through my association with the Eads Jetty Company, the United States Corps of Engineers and the Board of State Engineers of Louisiana, and having devoted a great deal of careful study to the problems of the river, sincere in my desire to reach right conclusions with regard to the best methods of preventing menacing increase of flood heights in the river and particularly at New Orleans, I have been unable to reach any conclusion other than that spillways will not remedy the conditions and at best would only be a temporary expedient.

There can be no question that the volume discharged by the Mississippi River has been constant throughout all time, since it became the present stream. Before levees were resorted to for reclaiming the fertile lands and making them habitable and profitable this volume was discharged, from season to season, through the main channel of the river, through various other and devious outlets, over the banks and across the low lands, sinuously winding its way, tortuously, to its final destination, the

Gulf of Mexico. How much time was consumed in this process is undeterminable, but it must of necessity have been considerable each season. With the advent of levees the floods became more and more confined to the main channel, and, as predicted by Humphreys and Abbott in the report of their investigations of the river, the flood heights have been raised to their present proportions, agreeing very closely with the heights advanced in the conclusions of the investigators of what would occur when the levee system would be complete.

The channels of the lower river, extending from the lower terminus of the levees today, at Fort St. Philip, to the Gulf, are totally inadequate in discharge capacity, taking into account the element of time, to accommodate the volume passing New Orleans during flood periods. This results in congestion and retardation of flow and the consequent backing up of the flood for a considerable distance up the river. In order to obtain the necessary discharge capacity through this stretch, the channels must be corrected and controlled so that a greater velocity will ensue, thereby insuring the discharge of a greater volume in a given time.

With a flood at its maximum, temporary relief can be obtained by an outlet, such as a crevasse, spillway or other opening, but this relief can never be permanent and will only result, in the end, in disastrous effects to the regimen of the river in the vicinity and through a considerable distance above and below. The opening, if allowed to remain, will finally become inoperative, through the natural sedimentation which takes place in unconfined sedimentary streams, and the conditions which obtained at the time the opening occurred will recur.

I hold, and the more I study the question the more convinced I am, that the only and final solution of the problem of relieving the flood situation in the lower river is through the correct and proper treatment of the mouth of the river, by confining and narrowing the channel to the normal width which obtains, say, from Fort St. Philip to New Orleans, and by this method accelerating the velocity of the current, causing a scouring in the main channel, thus increasing the volume of discharge so it may be maintained at that of New Orleans.

What are the conditions of the channel of the river from Fort St. Philip, where the levees end, to the Gulf? At Fort St. Philip the width of the river is practically the same as that from New Orleans down to the Fort, and the channel depth is in the neighborhood of 120 feet. From Fort St. Philip down to the Head of the Passes there occurs a gradual increase in width, with consequent shoaling of the channel, until at the Head of the Passes the width is nearly three times greater than at Fort St. Philip and the depth of channel is about thirty feet, or ninety feet less than at the Fort. The discharge capacity through this stretch is greatly diminished and the flood height at New Orleans is proportionately augmented, resulting in a height that would not obtain if the discharge capacity at New Orleans could be maintained to the Gulf.

The requisite confining methods are practicable and feasible and, considering the immense benefit, economical.

I am convinced that if, prior to, or even coincident with, the closing of the great basins in the upper river, the necessary corrective measures had been applied to the mouth of the river, the flood heights we experience during years of excessive high water would not have obtained and our present levees would be amply sufficient in height and section to safely protect us from the river. I am also convinced that if, even now, the corrective measure are applied, New Orleans would secure the desired relief from flood menace.

The result of the proposed removal of the levees throughout a stretch of eleven miles below Pointe-a-la-Hache will only serve to aggravate the conditions existing at the mouth of the river. The congestion of channel now existing is due to non-confinement, and this proposed remedy(?) will increase the unconfined area and create additional shoaling in the channels of the river below New Orleans and decrease the discharge capacity proportionately.

After all the years devoted to improving the conditions of the river, through the confinement methods, proposed and adopted by the Mississippi River Commission in 1881, it is now proposed to abandon this method, revert back to non-confinement, below New Orleans, and re-establish conditions which previously pre-

vailed. All of which, instead of accomplishing the ends sought, will be of no avail and flood heights will continue to increase at New Orleans.

ARTHUR M. SHAW: Whether justified or not, there long has been a feeling among the residents of the lower Mississippi Valley, and especially of New Orleans, that those in charge of the regulation and control of the river have not given due regard to our special and local conditions. We have realized that restricted localities may not receive aid and consideration from the Federal Government out of proportion to their interests, nor to the detriment or neglect of other and more important interests, but we have felt that a great port and city, with its miles of rich agricultural lands tributary, should receive more than an occasional perfunctory visit and a curt dismissal of plans which we have proposed for relief; and this feeling has been especially marked at times of high water when valuable properties have been destroyed, other great areas threatened and the rising river even has caused concern for the safety of the city itself. During times of flood and threatened flood much has been spoken and written which is pure slush and sentiment, and it doubtless is well that a balance wheel be provided to serve as a safeguard against ill-considered action, but those of us who live in this section believe that after we have made a careful, sober and conscientious study of the situation and presented what appeared to us to be a workable plan, this should have received even special consideration. We do not ask for charity, but we do ask for a free, open and fairminded consideration of such of our vital interests as are involved in the river problem, this consideration to be followed by action which will remove the river menace, so far as this may be practicable.

In marked contrast to what we have felt has been the attitude toward our local problems, Colonel Townsend has discussed the various phases in a manner which shows a thorough knowledge of conditions, a sympathetic understanding of our needs and a readiness to consider and discuss methods which may violate traditions which many appear to have held sacred.

While we may differ from the author in some of his conclusions, especially those dealing with the proposed spillway below

the city, we must be grateful to him for his clear and frank statement of his method of reasoning and deductions. These can be discussed by engineers, as an engineering problem, dispensing with campaign oratory and other types of smoke screens. The author has been almost brutally frank in his criticism of some of our local actions, especially in the matter of city levee grades, but the criticisms appear to be well founded and should be received in the spirit in which they obviously are made.

As an eminent authority on river hydraulics, who has spent a lifetime in this special study, we either must accept the author's conclusions or present logical, convincing proof of the correctness of our own. This has been done so well by others, who are better equipped for the purpose than the writer, that no effort will be made at this time to discuss the technical questions involved.

In my opinion, this paper by Colonel Townsend marks an epoch in the consideration of the river problem from the New Orleans viewpoint. He "speaks our language" and he knows our needs. He has furnished us with an opening and the groundwork for a rational study of practical problems, the solution of which will do more toward the advance of this section than any other of the various projects which are claiming the interest and attention of the people.

In spite of the differing opinions still held by the engineers of this section, a survey of the condition as it existed three years ago and that suggested by a reading of this paper will convince any fairminded person that we have gone a long way toward the desired solution.

COLONEL TOWNSEND: The question of spillways in India raised by Mr. Gravely merits a fuller statement than was given in the verbal discussion. This work is not applicable to conditions found in the lower Mississippi as the improvement of rivers without levees is applied to the minor tributaries of large rivers where tropical rains wash a large amount of sediment from the hills onto the low lands of the valley and spread it over a large area. It is desirable to utilize these streams for floating logs to market during floods, and for this purpose their flow, instead of being permitted to spread over a large portion of the river basin,

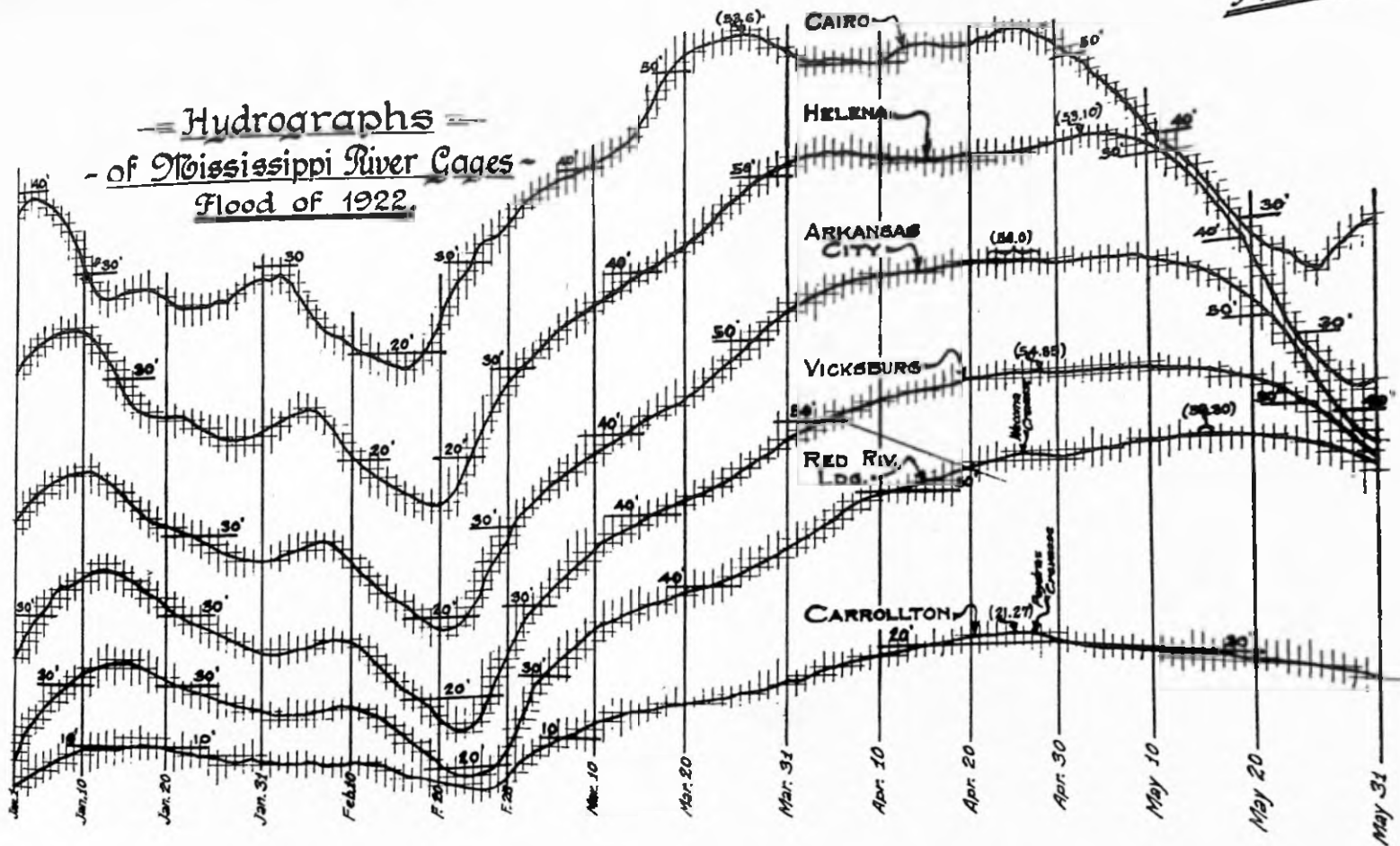
To reopen the discussion is not considered profitable. It is sufficient to state that, notwithstanding their claims of an underlying strata of blue clay, they opposed spillways either at Lake Borgne or Lake Pontchartrain. The revetments of the banks of the river at New Orleans clearly demonstrate that the material of which they are composed is subject to scour through at a slower rate than the more sandy banks found above the mouth of Old River. There is a certain stable slope for the various classes of material and when the bank is scoured until that slope is exceeded it caves into the river whether it is composed of blue clay or sand.

That clear water will take up sediment is demonstrated by every drop of rain that falls on a plowed field; that the amount of sediment carried in suspension varies with the velocity of the discharge is shown by the scour of every hillside as well as by observations made by the Missouri River Commission at St. Charles, Missouri, and by observations on the Danube taken in 1919, 1920 and 1921, and reported in the "*Annales des Ponts et Chaussees*," January, 1923.

A river's carrying capacity is also a function of the character of the soil through which it flows, and although the water discharged by the Ohio River during floods largely exceeds that of the Missouri River, the amount of material in suspension transported by the latter is much greater than that moved by the former, as is clearly exhibited in the sedimentary observations of the New Orleans Water Works and as has been frequently explained. If, however, the flood discharge from either the Ohio River or the Mississippi River is checked, a deposit occurs as is shown by the shoaling behind the permeable dikes which have been constructed to improve the mouth of the river. The velocity of 8 feet per second in the Missouri River at Omaha and of 10.5 feet in the Arkansas at Little Rock produce a most dangerous bank caving in both these rivers.

Mr. Kemper's deductions as to the height that the flood of 1922 would have attained if confined by levees can readily be shown to be so exaggerated that they would be amusing if it were not for the effect that their constant reiteration has had on the minds of citizens of New Orleans who are not familiar with the subject of river hydraulics.

Hydrographs of Mississippi River Gages Flood of 1922.



There is appended (Plate 1) hydrographs of the river during the flood of 1922 at Cairo, Helena, Arkansas City, Vicksburg, the mouth of Red River and Carrollton. It will be noted that while there are two crests to the flood at Cairo of 53.6 feet on March 26th and of 53.5 feet on April 25th, each lasting one day, at Arkansas City the flood attains its maximum of 58 feet on April 22nd and remains at that height for six days. It then falls to 57.7 feet on May 3rd and again remains stationary for three days. The change in the form of the hydrograph between Cairo and Arkansas City is clearly traceable to a flood in the Arkansas River which attained its maximum at Little Rock, 178 miles from its mouth, on April 24th, and one in the White River which culminated at Clarendon, 100 miles from its mouth, on April 18th. The floods of these tributaries are so superposed on one another and on the main river that they cause at Arkansas City a uniform stage of 58 feet for six days, but as they recede the main river is unable to maintain its elevation and the gauge falls to 57.7 feet on May 5th, the date that the crest of May 3rd at Helena, 129 miles above Arkansas City, is transmitted to that locality. The height at the mouth of White River on that date conforms within a tenth of a foot to that given by the writer's published formula for determining flood heights at that locality. After May 5th the river's decline accompanied the fall of both the main river and the tributaries.

Mr. Kemper attributes the fall of the Arkansas River gauge, not to a reduction in the flow of the upper rivers, but to an increased draft on the lower river through the Wecoma Crevasse which occurred on May 26th. He has called attention in his review to the reservoir capacity of the portion of the Tensas Basin overflowed during the flood of 1922, which is stated by the Mississippi River Commission as having an area of 470 square miles (Report for 1922), although in 1912 it exceeded 1,000 miles due to the overflow from the spillway at the end of the basin. He fails, however, to take into consideration in his discussion an area of 1,227 square miles in the Yazoo Basin that was also overflowed during the same flood and through which any reduction in river heights by the Wecoma Crevasse must be transmitted. The same methods of computation applied to both basins will show that the quantity of water which will raise a reservoir 470 square miles

two feet will lower a reservoir of 1,227 square miles about nine inches. The Wecoma Crevasse raised flood heights at Red River Landing in the Mississippi 1.5 feet and at Barbers Landing, on the Atchafalaya, 2.6 feet, and assuming that the entire flooded area was raised to the mean of these figures, the reservoir at Vicksburg would have been lowered not over nine inches by the flow through the Wecoma Crevasse into the Tensas Basin. His parabolic formula for heights above spillways which he applies to a curve of double curvature would also insure a large reduction of this nine inches in the 165 miles of river between Vicksburg and Arkansas City. But even this insignificant lowering of the Arkansas City gauge is not justified by the record, as the Vicksburg gauge shows the influence of the Helena crest of May 3rd as late as May 7th, on which date the second rise from Cairo was still able to maintain its heights at Vicksburg against the increased discharge of the Wecoma Crevasse. In other words, it required several days for the Wecoma Crevasse to enlarge to such an extent that it abstracted from the river between Vicksburg and Wecoma sufficient water to cause an appreciable draft on that of the Yazoo reservoir. During that period the Arkansas River gauge could not be affected by it.

These hydrographs visually demonstrate that the crevasses occurred after the crest of the rise had reached Vicksburg and could have had little if any effect in reducing flood heights. They merely shortened the period during which the river would have remained at its maximum stage.

Mr. Kemper's spillway at the mouth of Old River is but one of several that have been proposed at that locality. In fact, the writer himself suggested to the Mississippi River Commission over ten years ago that the solution of the Red River problem consisted in converting the outlet into a spillway by stopping the dredging in Old River during low water and permitting the stream to fill to a bank full stage. It was believed that such a course would have a beneficial effect on the bar in the Mississippi River which forms at that locality as it would increase the low water discharge.

An artificial crevasse a mile long with its crest at an elevation of 50 feet, which it was estimated would discharge 1,000,000 cubic feet per second, has also been suggested by another member

of the oligarchy who has the valley by the throat. This project avoids some of the mechanical difficulties of that of Mr. Kemper as it substitutes syphons for gates 40' x 40' which would be difficult to construct and operate.

The spillway proposed by the writer costs nothing and saves the Government the annual expense of dredging the channel in Old River and it utilizes the reservoir capacity of the Tensas Basin and the flow down the Atchafalaya River for reducing heights in the Mississippi as soon as the river overflows its banks, thus increasing the reservoir capacity during floods.

The various artificial crevasses that have been proposed will cost millions of dollars to construct, will prevent the flow of the Atchafalaya River from being utilized until the gauge at the mouth of Red River rises to 50 feet and will exhaust the reservoir capacity of the main river at the time it is most needed. As the Atchafalaya River at a 30-foot stage is discharging slightly over 100,000 second feet and at a 50-foot stage slightly less than 350,000 second feet, with the writer's spillway the main river will be discharging over 225,000 second feet through the Atchafalaya plus an increment dependent on the rate of rise which is filling the Tensas Basin at the time the gates of the artificial crevasse are to be opened. During the flood of 1922 over a month would have been employed in filling this basin by increasing increments under the project proposed by the writer before the height of 50 feet was attained. Mr. Kemper's proposal to fill this reservoir by similar successive increments would obviate the objections raised by the writer. But the crest of an ordinary flood would then have passed before the Atchafalaya was discharging the amount that it now does at a 50-foot stage, and the daily differences in the successive increments and 250,000 second feet would have had to be borne by the main river. It is noted that in his original project Mr. Kemper recommends gates larger than any that have heretofore been constructed. Smaller gates would not only be cheaper but also better adapted for slowly regulating the flow of water as he now proposes.

If those who for the past twenty years have been urging the closure of Old River and the land owners of cut-over lands in the Tensas and Atchafalaya Basins could be persuaded to adopt Mr. Kemper's idea of reserving these areas as reservoirs and could be

prevented from attempting to have them utilized for cultivation, there would be more merit to these projects. But the writer is of the opinion that any structure in the mouth of Old River, if accompanied by five years of low water, would induce a large cultivation of the low lands in the basins, and any opening of outlets either gradually or rapidly during floods would then invite such a disaster that it would never be attempted no matter how much the citizens of New Orleans demanded it. There is, however, one ray of sunshine that penetrates the gloom of Mr. Kemper's lamentations, if his conclusions are accepted. When the Orleans Levee Board completes the work which it plans the levees in the rest of the valley will be so weak that New Orleans will be safe from the dire disasters predicted, as breaks in the levee line will occur above the city.

The reservoir capacity of the river which Mr. Klorer justly describes as guesswork since it varies with every flood so affects the discharge at a given gauge height as to vitiate deductions derived from discharge observations. By selecting the proper discharge observations and ignoring the river's reservoir capacity, it has even been demonstrated that levees reduce flood heights. This was the prevailing process of reasoning of the advocates of low levees in the early days of the Mississippi River Commission, and was based on the floods of 1882, 1884 and 1886, when the reservoir capacity of the river was exhausted in 1882 and only slightly affected in 1886. In 1912, 1916 and 1922, conditions were reversed, the reservoir capacity of the river being exhausted in 1922.

The paper prepared by the writer in 1896 for the American Society of Engineers was a protest against this process of reasoning and a suggestion that the relation between the established gauges afforded a much more accurate method of determining the ultimate heights which floods would attain in a confined river. Assuming Cairo as an origin, the heights which the crest of rises below a bank full stage attained at the different gauges was tabulated. The means of these observations were obtained and using the Cairo reading as an abscissa and the other gauge readings as ordinates, lines were drawn which gave the mean gauge relation below a bank full stage between Cairo and a given locality. It was then assumed that a perfect levee system would

create the same relation between gauges above the overflow stage as existed below them, and that the extension of the lines thus obtained to the maximum heights of the Cairo gauge would determine the ultimate height the confined river would attain at a gauge. In the paper the predictions were based on a record of ten years. In Plate 2 is shown the application of the same theory to forty years' records from 1883 to 1892 at Helena, the mouth of White River, Lake Providence, Natchez, the mouth of Red River, Baton Rouge and Carrollton. There are shown by crosses the ultimate heights which result from this theory and by circles, on the same plate, the heights that the flood of 1922 attained prior to the Wecoma Crevasse, and by dots the heights attained after the Wecoma Crevasse at Red River Landing, Baton Rouge. There is also shown by a dot marked K the height Mr. Kemper assumes that the flood of 1922 would have obtained at the mouth of White River.

The forty years' records when compared to the ten years' records have materially modified the lines of gauge relations only at the mouth of White River and at Vicksburg, and in both cases reduced the heights. However, neither of these gauge relations are considered reliable, as they are curved instead of straight lines and too dependent on the judgment of the investigator in extending them above the bank full stage.

This method of determining flood heights avoids all pitfalls which beset the method by discharge measurements, not only with uncertain estimates of the reservoir capacity of the river and of the inflow from tributaries, but also a possibility of an error of about 10 per cent in the discharge measurements themselves.

These gauge relations were originally submitted merely as a means of approximately determining flood heights, and it is considered remarkable that the added experience of the last thirty years has not led to material changes. They indicate that during the past thirty years no adverse conditions have occurred that justify apprehensions of an increase in flood heights over those predicted in 1896.

That the discharge diminishes for a given gauge height above the bank full stage as the levee system is perfected is a general law and independent of a fill or scour in the river channel. In

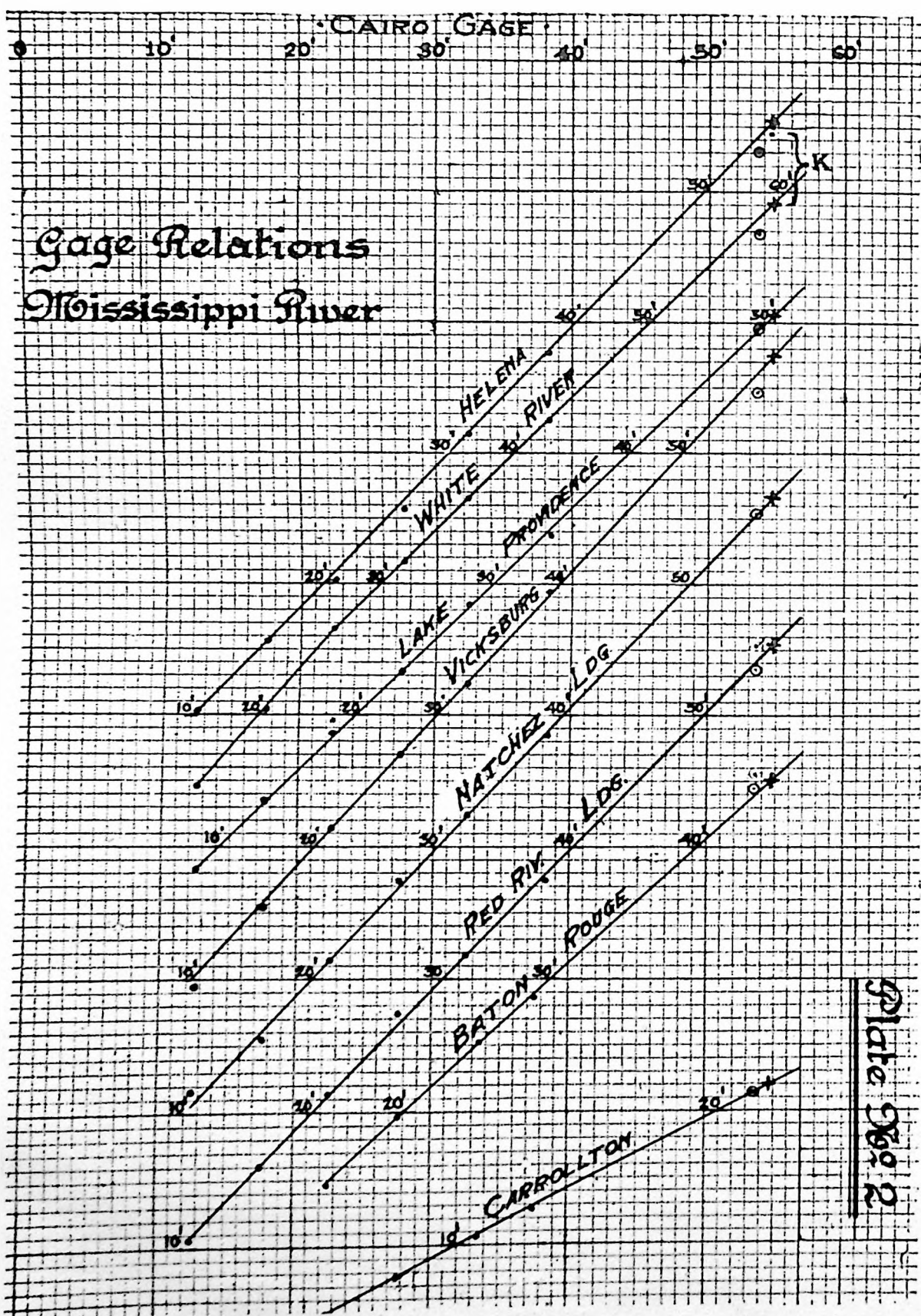


Plate 2692

fact, it would require a large enlargement of the river section to compensate for the reduction in flow caused by the levees themselves, as is forcibly illustrated by conditions in the Atchafalaya River where an enlargement of the river section is occurring as explained by Mr. Ockerson in a paper on the Atchafalaya River, published in the Transactions of the American Society of Engineers some years ago. In 1892, a measured discharge of 450,000 second feet occurred at a stage of 46.6 feet on the Simmsport gauge. In 1912 the discharge was about 400,000 second feet at a 50.0 feet stage, and in 1922 about 350,000 second feet at the same stage. In 1892 the levees below Simmsport were very generally destroyed, while they have been gradually strengthened and extended since that date.

It is generally recognized that if a pipe or sewer of a given diameter is extended to fifty times its original length it requires a greater head to force the same amount of water through it. The same principle applies to a river restrained by levees. If the levees hold, it requires a greater force to drive the same amount of water between them than when they fail.

A lowering of the water surface of six feet at any locality is a change in a river's regimen that has rarely been attempted. The only location on the Mississippi River where such a change has occurred is at Vicksburg, where the Waterproof and Centennial Cut-offs shortened the river about twenty miles and lowered the river bed at this locality about five feet. This change was accompanied by a bank caving which destroyed long sections of the levee line and continued until the river regained its original length and slope. On the Missouri River cut-offs have also occurred which caused a local lowering of about two feet on the gauges and affected bank revetments thirty miles above them. The efforts the writer made from 1890 to 1896 to hold the levee lines in the vicinity of Vicksburg aided by the Louisiana Board of State Engineers and the Tensas Levee District and not theoretical considerations, are the reasons why he opposes repeating the experiment in the vicinity of New Orleans.

When a river's average slope is increased, its scouring force is also increased, but Mr. Klorer is correct in his statement that the steepest local slopes are not accompanied by the greatest scour. As explained in discussing Mr. Kemper's remarks, ero-

sion occurs on a rising river in the bends and a fill on the crossing between them, while after a river has fallen to a certain stage the greater scour occurs on the crossing, sometimes in the river channel, when it does not cause caving, but frequently near one bank or the other. On the upper river where the average slope exceeds 0.4 feet per mile, the greatest high water caving usually occurs in bends where the local slope does not exceed 0.1 foot per mile.

That the Atchafalaya River has been less destructive of its levee system is due to the fact that the levees have been located so as to leave ample space for the river to cave its banks without attaining the levee line. Rapid caving is occurring between Melville and Krotz Springs, and the table submitted by Mr. Klorer is indicative of an enlargement of section in that region and a fill above. This river is not, however, developing the bends which exist in the Mississippi. A similar condition also exists in South Pass, where an enlargement of section has also occurred.

The writer admits that he is perhaps ultra-conservative on the question of dams in the alluvial soil of Louisiana. This conservatism has arisen from the fact that during his official career in the valley he has had to investigate the failure of six locks and dams in the Mississippi and its tributaries from foundation troubles, whose designs were apparently in accordance with the accepted views of dam construction. He also recalls the difficulties which were experienced in the construction of the lock in the Industrial Canal and of the one at Plaquemine.

In conclusion, attention is invited to the fact that the reduction of floods by spillways is an experiment which has never been attempted on any river, and that a discharge of 250,000 second feet equals that of the St. Lawrence River in time of flood, and 1,000,000 second feet exceeds the flood discharge of the Danube. These are enormous forces with which to experiment without any guide. On the other hand, levee construction has been tested for over a hundred years on such European rivers as the Po, the Rhone, the Loire and the Danube. It has been proven on all these rivers that it is an effective means of controlling floods. The levee engineer has, therefore, to consider with Hamlet whether it is better to bear those ills we have or fly to others which we know not of.

MINUTES OF MEETINGS AND BUSINESSS OF THE SOCIETY.

Minutes of Board of Direction, June 5, 1925.

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

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

Communications were read and the Secretary was instructed as to reply to be made to each.

Request from the Secretary of the State Board of Engineering Examiners to have 500 reprints made of Professor Derickson's article on "Fifteen Years of the Engineering License Law in Louisiana" was approved. (Vol. IX, No. 1, Proceedings.)

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

Resident Members.

George C. Beardslee,
Rudolph Herpich,
Edward S. Bres,

Lloyd D. Knapp,
B. S. Merrill,
Blair A. Ross.

Non-Resident Members.

John H. Batesman,

Will S. Guedry.

For Reinstatement, Non-Resident Member.

Jacob T. Bullen.

Resident Associate Members.

Paul J. Gilbert,

Henry M. Lichtenstein,
William H. Stevens, Jr.

Resident Junior Members.

Albert E. Marks,

Nahtniel L. Marks, Jr.

Resident Student Member.

Tim L. McNamara.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

Minutes of Special Meeting of the Society, June 5, 1925.

This was a special meeting of the Society, which was called to order by President Garsaud; F. A. Muth, Secretary, and present forty-five members and guests.

The minutes of previous meeting were read and approved.

Letter from the National Bureau of Economic Research, Inc., was read relative to securing of information on a forthcoming report on

"Income in Various States." Upon motion duly seconded the letter was ordered filed.

Announcement was made to the effect that it has been customary in previous years to hold no regular meetings of the Society during the months of July and August. It was also explained that upon call of the President the meeting was held tonight instead of the second Monday owing to the fact that the speaker could not be present on Monday.

On motion duly seconded it was voted to have a recess for the remainder of June, also the months of July and August.

The technical exercises of the evening consisted of a most interesting paper presented by Mr. Stanley W. Ray, former Commissioner of Public Safety, on "Traffic Theories and Regulations Especially as They Apply to Road and Street Construction." The paper was followed by considerable discussion. A rising vote of thanks was tendered the speaker.

The meeting then adjourned to the collation in the Victor Restaurant.

F. A. MUTH, Secretary.

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LOUISIANA ENGINEERING SOCIETY

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Secretary, FRANK A. MUTH, 7705 Willow Street.
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7705 Willow Street, New Orleans, La.

PROCEEDINGS OF THE LOUISIANA ENGINEERING SOCIETY

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EDITORIAL NOTES AND COMMENT

Camouflage. The English language is indebted to the French for many of its most expressive words and phrases. The World War gave us many more such, but of them none are so expressive and none so widely adopted as the word *camouflage*.

Major Bennion's paper, published in this issue, traces in a very interesting way the origin of this new aid to modern scientific warfare. It opened up a special field of activity for the artists in much the same way that other professions found themselves called upon to contribute the fruits of their learning and experience toward the great task of winning the war.

Major Bennion credits the word "camouflage" to General de Castelnau, of the French Army, but the original conception of painting guns and caissons in color to match their surround-

ings appears to have come from two French artists who were enlisted as privates in the army of France. The more distinguished of these and the more aggressive was Guirand de Scevola, a well known portrait painter. He made such a forceful presentation of his ideas and plans that he was given a captain's commission with authority and liberal funds to organize a "Section de Camouflage."

Major Bennion's comment on the artist in camouflage service was that his conception of camouflage operations was usually too limited in extent. He would give the same attention to details as would be the case were he designing a stage setting, failing often to realize that there were miles of front with moving troops, thousands of vehicles, camp fires, etc., all of which had to be concealed as far as possible.

The British also established a camouflage service, but placed it under the direct control of three officers of the Royal Engineers.

The Germans did not have a separate and distinct camouflage service, but their engineer corps developed a camouflage material of paper burlap of which they made very extensive use.

Major Bennion was ordered to take charge of the camouflage service of the American Army in October, 1917, and the remainder of his paper is devoted to a very interesting description of its organization and activities.

In conclusion Major Bennion expresses the opinion that the importance of camouflage service in future wars will be in about exact proportion to the increased development and effectiveness of the airplane and other methods of military intelligence.

It is to be regretted that it was not practicable to reproduce as a part of this paper the lantern slides with Major Bennion's comment thereupon.

Co-operation Among Local Engineering Societies. It has been the custom for some years for the Louisiana Engineering Society to hold at intervals joint meetings with the local chapters of the A. S. M. E., the A. S. C. E., the A. A. E., and others.

Some of the most interesting papers have been received this way. It is a pleasure, therefore, to welcome to this plan of co-operation the American Society of Military Engineers, under whose auspices the recent meeting was held and the paper of Major Bennion was presented, Colonel W. B. Gregory being the presiding officer.

The American Society of Military Engineers. At the meeting to which reference was made in the preceding paragraph, Major Bennion, just before the presentation of his paper, made a brief statement as to the organization and purposes of the Society of Military Engineers, as follows:

Before I discuss the paper I want to say a word or two on the subject of Military Engineers. At the time of the outbreak of the world war there were approximately 250 officers in the Corps of Engineers, and when the war reached its height, there were approximately 12,000 engineer officers, which meant that 98% of the engineer officers had not had military service prior to the outbreak of the war, or in other words there were only 2% of the officers who were in service before the war, and made that their business or profession.

The American Society of Military Engineers is an organization designed to better prepare men for similar situations in future wars. There are now a tremendous number of the engineers of America who hold commissions in the Engineer Reserve Corps.

The primary object of the post activities of the society is to maintain personal contact between the regular officers and reserve officers and also among the reserve officers themselves. The average individual has an idea that an army is a machine with works like a clock,—unfeeling and unthinking; that orders are orders; that regardless of whether a man is called John Jones or Bill Smith, he does what he is told.

As a matter of fact, principally in times of active combat, the matter of personal acquaintance, of personal friendship, plays perhaps more part in the smooth running of war machinery than is the case in business operations, and you in your professional careers know how much personal association means to you.

You get your business to quite an extent through personal contact. You cannot do business with a man very well unless you know him. The same thing holds true in the conduct of active military operations, and it is the strong desire of the powers that be in the army that this matter of personal contact shall be followed up so that as a commanding officer, I may know something of the characteristics, the individualities of my subordinates and associates, and vice versa that I may know what manner of man my commanding officer is. Only in this way can one member of the organization know what to expect of and from the other fellow and therefore act intelligently and with confidence.

Last Spring I got a letter from the Chief of the Engineers asking that I take up with the members of the local society of Military Engineers the matter of renewed activity. I appreciate that men who work in one organization are usually the wheelhorse of another society. I spoke of my mission to Colonel Gregory and Colonel Garsaud. Colonel Gregory very kindly suggested a joint meeting with the Society of Engineers of Louisiana and spoke to your secretary, Mr. Muth, who put the idea into effect.

I have felt that there is no use trying to start a post activity that we cannot maintain indefinitely. I believe, however, from what I have seen of the men who live here, that they have an active interest in military affairs and that a local post can function to a reasonable degree and I am proposing such a move. I have talked to Colonel Shaw, the president, and he agrees with me that perhaps we can hold occasional joint meetings with this Society which would be beneficial to us both. My district has work going on in this immediate vicinity and means of transportation to get there. Colonel Garsaud is doing things of interest to people around here, and there are other things going on with which you members are personally identified which I know can serve as a basis for the activities of this society.

I have in mind the possibility of a trip this fall if the members react favorably. Right now my district is sinking mattresses in Orleans harbor and will be engaged in that work until December. We are building a levee on unstable ground at Caernarvon, and Colonel Garsaud is preparing to tear down the levee

below Pointe-a-la-Hache. This should make an interesting trip, and if the members here like the idea, we might get together and visit those works.

I believe we have the basis upon which to maintain a post, and certainly if organized reserves have any real value it will depend upon the personal relationships established as the result of that organization.

Design and Control of Concrete Mixtures. For a number of years the Portland Cement Association has been disseminating valuable information upon the field control of concrete by means of bulletins, lectures, etc. Engineers and students in this community recall with pleasure the very interesting and instructive lectures given here on several occasions by Colonel H. C. Boyden when he was associated with that organization.

Of late this work, under the direction of Mr. Kelley, has taken the form of a series of demonstration lectures with definite problems of mixture design. Such courses have been given in a number of cities, and when the question was raised of giving the course in New Orleans, Professor Derickson suggested that the logical place to hold the lectures would be at the College of Engineering of Tulane University. The offer of the facilities of the College was promptly made to Mr. W. D. Steward, District Engineer of the Portland Cement Association, and arrangements were made to hold the lectures in the amphitheatre of the Chemistry Building.

The circular letter addressed to the engineers and contractors of the city met with such a favorable response that the seating capacity of the room was taxed to the limit at the first meeting, which was held Monday, October 5th, at 8:00 P. M.

The course was taken also by Senior students in Civil Engineering and Mechanical-Electrical Engineering of Tulane University.

The lectures were given by Mr. Kelley, who was assisted in the demonstrations by Mr. Wine.

It speaks well for Mr. Kelley's personality and his method of presentation, as well as for the interest and enthusiasm of our local engineers, when it is noted that these lectures ran continuously for nearly two weeks from 8:00 to 10:30 each evening. This was during a period of extreme heat coupled

with one of the worst visitations of mosquitoes we have had in many years. This made conditions under which the men had to work often far from comfortable.

The course was finished on October 16th. The average attendance was 146, while as many as 260 men, representing 88 firms, attended one or more lectures.

In addition to having given this very excellent course of lectures, the Portland Cement Association, through its local office, stands ready to answer any questions regarding concrete which may have arisen, and further extends to all those who attended the lectures its co-operation in the solution of any problems which may arise in connection with their special lines of activity in which concrete is used.

Those who have requested the service will receive regularly the bulletins and special literature issued by the association.

This is a striking instance of the sense of responsibility which great corporations and business enterprises in these modern days feel for the efficiency and integrity of the service which they sell along with their product. As one of the Tulane students remarked: "It is interesting to see a company whose business it is to sell cement teaching people how to economize in the use of it."

The cordial thanks and appreciation of the engineers, contractors and students of this city are due the Portland Cement Association for having inaugurated and carried to such a successful conclusion this very helpful and instructive course of lectures.

Delegate to the Annual Meeting of the American Engineering Council. At the September meeting of the Board of Direction it was voted that the President of the Society be the delegate to the meeting in January, 1926, and that the Vice-President be the alternate. It was further voted that this be made the regular procedure, so that in the future the President of the Society will be *ex-officio* the delegate to the annual meeting of the American Engineering Council. This action followed upon the resignation of Professor James M. Robert, who, according to the former system, was the official delegate elected for two years.

OBITUARY

ALLARD D'HEUR,

MARCH 14, 1859—JUNE 17, 1925.

Charter Member of the Louisiana Engineering Society.

Mr. D'Heur was born in Liege, Belgium, on March 14th, 1859; was educated at Liege and graduated at the University of Liege, subsequently taking a post-graduate course at Cologne. He came to the United States about 1881, shortly after his graduation, and was engaged in the operation of a ranch near Weatherford, Texas, and later in the disposal of a large landed estate in that neighborhood for his uncle. Later he was for a time connected with the Santa Fe Railroad on construction work in Texas, from which work he went to the Southern Pacific Company, in 1888, being located at Houston. He was very shortly thereafter transferred to New Orleans, and was associated with the Southern Pacific Company in New Orleans, and neighborhood, from 1888 to 1898. It was during this period that he joined with a number of other engineers in the organization of the Louisiana Engineering Society. During his service with the Southern Pacific in New Orleans he had charge of the construction of the Iberia and Vermilion Railway and was later Division Engineer. Mr. D'Heur was transferred to San Francisco in 1899 and occupied a number of positions with the Southern Pacific interests until in 1911 he was made Vice-President and General Manager of the Kern Trading and Oil Company, and acted as Manager of the Southern Pacific Fuel Oil Department. He remained connected with these interests until the time of his death, at which time he was President of the Associated Pipe Line Company and Vice-President and General Manager of the Pacific Oil Company. His connection with the Engineering Department of the Southern Pacific lasted throughout practically all of his active business life—a period of thirty-seven years.

Mr. D'Heur was a man of broad education and was remarkably well informed on all subjects having to do with science, philosophy and art. He was particularly a student of Mediaeval History and of Archaeology.

It was a sad coincidence that Mr. D'Heur passed away within a few days of the death of Mr. Kruttschnitt, Chairman of the Board of the Southern Pacific Company, with whom he had been close'y associated throughout life. Both men were looking forward to some years of leisure after retirement which they expected in a very short time.

Mr. D'Heur never married and left no immediate family—his nearest relations being Mr. Allard D'Heur, of New Orleans, a son of one of his brothers who resided in Shelbyville, Indiana, and Mr. Allard D'Heur, Jr., of Taft, California, also associated with the Pacific Oil Company, a son of another brother who resided in Germany.

The above biographical sketch was prepared for the Proceedings by Mr. A. L. Black, himself a charter member of the Society, and now a resident of San Francisco, where he is Vice-President of the Market Street Railway Company.

There are still living seven of the original small group of men who organized the Louisiana Engineering Society in December, 1897.

PAPERS AND DISCUSSIONS

CAMOUFLAGE.

By H. S. BENNION,

Major, Corps of Engineers, U. S. A.

Read Before the Society, September 14, 1925.

Camouflage is a war activity which came into being largely as a result of the airplane, its primary purpose being to defeat or limit the power of the airplane to obtain information. It, however, extends its scope to include defense against terrestrial observers and those on captive balloons.

The airplane is used for direct observation, delivering its message upon its return home or signaling back while observing. This latter method will no doubt be more efficacious in the future due to the recent development of radio. The airplane also is used for taking photographs, which in turn are studied by experts, interpreted, information of immediate value transmitted to interested parties, and finally the photographs are catalogued for comparison with subsequent pictures of the same locality. This new source of military intelligence created the necessity for counteracting measures. These measures were called camouflage, though they might have been called counter intelligence measures.

In former times when an army had to consider terrestrial observers only, patrols, advance or rear guards and outposts were used to screen the main body of troops, and small ground elevations, trees, brush or rank vegetation served to conceal troops and their equipment. Nowadays, friendly aircraft and antiaircraft artillery serve to drive away or hold up in the air hostile airplanes, but wonderfully clear photographs can be taken from heights of two miles or more, and in spite of the most adequate defense, the enemy air service will get over the line to observe and photograph, which makes necessary camouflage to deceive and to conceal.

Camouflage was probably the best advertised innovation of the World War, partly because of the fact that it was started

by French artists who are excellent advertisers, partly due to the wonderful imagination of modern newspaper reporters and partly because of the fact that the subject itself appealed to the fancy of the public. This publicity was a benefit in some ways and in others it was a curse because everyone, military and civil, was led to believe that the camouflage service was a vaudeville troupe which went around the front doing stunts of magic. The performance of the French camouflage service was such as to give some credence to this notion, and our own service started with enough artists, actors, stage hands, moving picture functionaries and miscellaneous geniuses to give a comic opera flavor to our most serious operations. You will be interested to hear a brief history of the origin of camouflage.

At the outbreak of the war in 1914, when German airplanes came flying over the French troops concentrated in the vicinity of Toul and Nancy, most of the artillery commanders resorted to the natural method of hiding their guns by the use of trees and brush, but two or more French artists who were privates in some of these artillery organizations and who had, no doubt, read Abbott Thayer's book on the protective coloring of birds and animals, conceived more or less simultaneously the idea of deceiving the enemy observers by painting the guns and their caissons in colors to match their surroundings. One of the artists was Guirand de Scevola, a nationally known portrait painter; a very dramatic, assertive and impressive man, who promptly got his idea before the colonel of his regiment and several generals, including General de Castelnau. He profoundly impressed them, and they gave him every facility to put the idea into general operation. General de Castelnau, as I recall, is the man who coined the word "camouflage." Mr. De Scevola's wife was one of the leading actresses of the Comédie-Française and very influential with the Government. Seizing his opportunity, De Scevola was ordered to Paris, had himself made a captain, and obtained authority and liberal funds to organize a "Section de Camouflage." He congregated scores of French artists in the military service, built nine factories with a personnel including women laborers and German prisoners of about 10,000.

In the beginning the services rendered by his section were a great benefit to the French troops. The factories turned out large quantities of very well made material with which to conceal the guns at the front. The viewpoint of De Seevola and his assistants, however, was that of the artist. They were prone to focus their attention on detailed subjects, spending a tremendous amount of time and material on the camouflage of one gun when several thousand others might be left to shift for themselves. He had many impractical ideas, and his entire organization gradually drifted to the rear, where they got out of touch with the front and failed to progress in their ideas. In 1918, they were using methods which were successful in 1915, but the enemy had long since become thoroughly familiar with them.

I found that the artist always conceived of camouflage operations at the front as a stage setting of about the same size as a stage and having to be exposed to observation and subjected to use about as long as the ordinary scene on the stage. He looked at the subject in detail, unable to grasp the fact that there were hundreds of miles of front where troops had to be concealed; that the movements of the troops, their regular daily activities, the smoke from their kitchens, the thousands of vehicles moving on the roads and so on presented the real problems of camouflage. Except in the rare case, the direct observer was at such a distance that the perfection of the artist in duplicating colors and carrying out details was entirely useless and out of place. Our poor artists who enlisted with heroic ideas of how they were going to hazard their lives painting fake trees or sculpting dead horses in No Man's Land to conceal works of tremendous military importance received perhaps the rudest shock that was administered to any patriots of the World War. These men soon found themselves attached to the pick or the shovel. At the factory they dug drainage ditches, cesspools, built the roads and acted as laborers. Those who eagerly professed to be painters were, in the days before we had machinery for the purpose, put on the end of a 2x4 to mix cold water paint by the barrel full. It was indeed a misconception that headed them toward the camouflage organization.

The British, under the tutelage of the French, established a camouflage service, but placed at its head three officers of the Royal Engineers, who tackled the problem without much imagination but with a considerable degree of common sense, employing practical factory methods and fairly practical methods at the front. The English Army, however, was much more frugal with its funds and personnel than was the French, so that their camouflage operations were somewhat limited.

The Germans followed the lead of the allies to a certain extent. They did not organize a camouflage service, but the German Engineers manufactured a camouflage material made out of a paper burlap, the paper being rolled like the fuse of a firecracker and woven. Most of the German officers developed a good understanding of camouflage and they practiced excellent discipline, which served to more than make up for their deficiencies in material and organization.

The Italians and Belgians installed camouflage sections patterned after the French.

When we went to war, immediately after the arrival of General Pershing and his staff in France, the famous equestrian sculptor, Herbert Hazeltine, an American living in Paris, agitated the creation of a camouflage section. He was commissioned a Captain of Engineers and placed in charge of the new service. At the same time a New York architect of prominence, Evarts Tracy, organized some camouflage troops in this country. When I was ordered to take charge of the camouflage service in October, 1917, I found Hazeltine with four other artist officers,—one Engineer Lieutenant, four artist privates who had been promised commissions, an office, a limousine and a factory established in the Moulin de La Galette, a dance hall on the tip top of Montmartre. The engineer, as factory manager, was driving about 100 Parisian women to cup up burlap to make helmet covers, wheel covers for artillery carriages and similar articles which we never used. Lieutenant Richard S. Meryman, now instructor at the Corcoran Art Gallery, was painting silhouettes of Yankee soldiers to be sprung on the enemy in the early dawn in such a way as to scare him into believing that an attack was to be made and thereby cause him

to open up and disclose the location of his machine guns. These were never used.

The French sculptor generally recognized as the successor to Rodin, M. Landowski, was moulding snipers' heads to be stuck above the trench crest to draw and locate the enemy fire. These also were never used. Private F. Earl Christy, who illustrates the front page of the *Cosmopolitan* and other magazines, was bookkeeper for Lieutenant Keene. Private John J. Murphy, now one of the leading wood etchers of this country, was standing guard night and day lest the German spies should make away with our treasured secrets. Captain Hazeltine and his adjutant were engaged in interviewing candidates for commissions. I was overawed by the atmosphere of the whole thing, and keenly feeling my own ignorance of camouflage, I concluded to do exactly as I was advised by those who were presumed to know what they were doing.

One of my first acts was, in accordance with the advice of Captain Hazeltine, to request the British to furnish us with 200 steel tree observation posts, immediate delivery, to supply the American troops who would be entering the front lines before we could build up our factory output of this commodity. A few days later I saw Colonel Wyatt, of the British Camouflage Service, who advised me quietly and tactfully that to date the British forces had used four trees, all of which were unnecessary, but had been installed at great hazard to satisfy the whim of some general. This, and a few other experiences, happening at the same time, decided me that artist or no artist I would run the show according to my own lights. Necessarily my ideas and the ideas of my assistants with regard to our work lagged considerably behind our practical experience, and we made many mistakes. During the course of a few months we got far away from the French ideas, both as to the manufacture of camouflage and as to the practice of camouflage at the front. The French made their camouflage generally to order. In many cases an artist visited the site at the front where a military work was to be installed, made colored sketches correct in detail as to scenery and colors which he carried back to the factory and there he supervised the manufacture of the material for the job. This insured beautiful work but limited out-

put. We adopted five standard colors, six standard patterns, three standard sizes of fish nets and one standard roll of wire netting, which could be manufactured in quantity, stored and ordered by code. At the front also we gradually learned what our job was, and how to handle it.

We found that an object merely covered up could still be seen and identified by its particular characteristics; that the bizarre painting of guns and trucks was no longer of any value; that the most important camouflage measures were the selection of positions in scattered woods, in broken terrain and along roads where air photographs would not tell the same story that they would out in an unbroken field, where the single track of a man could plainly be identified. Of major importance were the maintenance of discipline, the scattering of guns, dumps, tents, buildings, etc., in irregular fashion so as to hide them and also to provide poor targets. We found that the exact color or shade of camouflage was of relatively minor importance as compared to its texture and the shape given its upper surface. We also found that merely to camouflage guns and other objects was not enough; that if we wished to keep our operations secret from the enemy we had to use our wits in other respects. I can best illustrate the point I have in mind by describing how the enemy discovered where, when and in what strength we were going to attack his position north and west of Verdun prior to the Meuse-Argonne offensive.

We hid our artillery with great care, our staff required marches to be made during certain hours of the night, prohibited reconnoitering by officers along the front and practically suspended all activities in the sector to be attacked. The Germans were not expecting us to attack in this direction, but were expecting us to attack toward the east of Verdun. There were heavy train movements in that region of France, heavy artillery could be seen passing toward the front and was, no doubt, so reported by spies. Because our hospital service was non-combatant, our staff allowed them to erect hospitals on roads close up front in full view of the enemy. We built barbed wire cages for prisoners back in the rear but in the wide open. The cessation of normal activity at the front created an air of expectancy; some of the regiments, after marching all night,

pitched their pup tents in the open so that they could be seen by the Germans. Most of the organizations made no attempt to conceal the smoke from their kitchen fires and everything combined to tell the Germans exactly when and where we were going to attack, so that four days before we did attack they fell back from their first to their line of defense, leaving a few machine guns to impede our advance and exact heavy toll from us at little expense to them.

In conclusion I wish to state that in my opinion in future wars the camouflage service is going to have an increased and important role in proportion to the increased effectiveness of the airplane and of the military intelligence service of armies. Big advances in both of these services have been made since the World War and more can be expected as time goes on.

MINUTES OF MEETINGS AND BUSINESS OF THE SOCIETY.

Minutes of Meeting of Board of Direction, July 15, 1925.

The meeting was called to order by Mr. F. P. Hamilton, Vice-President, during the absence of President Garsaud, and the following members were present, Messrs, Moses, Lanphier and Muth.

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

Ballots for new members were canvassed, there being eighty-four formal ballots with three informal ballots cast.

The following members on motion duly seconded were declared elected:

Resident Members.

George C. Beardslee,	Lloyd D. Knapp,
Rudolph Herpieh,	B. S. Merrill,
Edward S. Bres,	Blair A. Ross.

Non-Resident Members.

John H. Bateman,	Will S. Guedry.
------------------	-----------------

For Reinstatement—Non-Resident Member.

Jacob T. Bullen.

Resident Associate Members.

Paul J. Gilbert,	Henry M. Lichtenstein,
William L. Stevens, Jr.	

Resident Junior Members.

Albert E. Marks,	N. L. Marks, Jr.
------------------	------------------

Resident Student Member.

Tim L. McNamara.

It is regretted that the following were dropped from membership of the Society with the understanding that upon payment of delinquent dues they may be reinstated:

Edwin A. Arpin,	A. W. Jackman,
Cecil A. Eby,	A. A. Keither,
Fred E. Smith.	

The name of Mr. Clifford H. Stem was transferred from Resident Junior Member to Resident Member in accordance with the requirements of the Constitution.

Resignations of Mr. Xavier Kraemer and Mr. E. L. Powell were accepted with regret.

Announcement was made with regret of the deaths of Messrs. Allard D'Heur and George Selman.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

Minutes of Regular Meeting of Board of Direction, September 14, 1925.

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

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

On motion duly seconded it was voted the President of the Society be the delegate to the annual meeting of the American Engineering Council in January, 1925, and that the Vice-President be the alternate, and that hereafter this procedure be followed in naming the delegate and alternate to the American Engineering Council. The Secretary was instructed to notify A. E. C.

The matter of the financial status of the Society was discussed, and in view of the fact that it is not practicable to increase the revenue to the Proceedings Fund by additional advertising, the Secretary was instructed to request information from the Editor of the Proceedings as to whether he could suggest some means of reducing the cost of the Proceedings.

It was recommended that in order to keep up the standard of the Proceedings that the subscription price be increased, but no action was taken at this meeting on this recommendation.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

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

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

Minutes of the previous meeting were read and approved.

The President announced that this meeting was to be held under the auspices of the local chapter of the American Society of Military Engineers, and in the absence of the Chairman of that Society the meeting was turned over to Colonel W. B. Gregory, who presided.

The technical exercises of the evening consisted of a very interesting address on "Camouflage," illustrated by slides, by Major H. S. Bennion, District Engineer, Fourth Mississippi River District.

After the address considerable discussion followed.

The speaker was tendered a rising vote of thanks.

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

F. A. MUTH, Secretary.

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DOUGLAS ANDERSON, Editor.

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LOUISIANA ENGINEERING SOCIETY

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Building, Jackson Square.

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7705 Willow Street, New Orleans, La.

PROCEEDINGS

OF THE

LOUISIANA ENGINEERING SOCIETY

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EDITORIAL NOTES AND COMMENT

Highway Engineering in Louisiana. The meeting of October 12th was of the nature of a symposium upon the above subject, papers being presented by five gentlemen, all closely associated with different phases of the general problem of the provision and control of proper facilities for handling the ever increasing traffic upon our highways and city streets.

The paper by Mr. W. B. Robert, State Highway Engineer, was upon the Location and Construction of Roads in Louisiana. Strong, centralized state control of highway construction begun in January, 1922, under Act 95, which created the Louisi-

ana Highway Commission, provided revenues for the construction and maintenance of the State Highway System. This State Highway Law also outlined some 7,000 miles of roads, covered by 98 routes, each of which was clearly defined in the Act. Of this total mileage 2,800 miles form a part of the Federal Highway System, receiving federal aid to the extent of as much as \$15,000 per mile.

The paper proceeds with an outline of the engineering features of the location and construction of these roads.

In conclusion Mr. Robert calls attention to the fact that traffic requirements are daily demanding improved types of roads and better surfacing, grades, bridges, railway crossings, etc. What would now be classed as a poor dirt road would not so many years ago have been considered to be a first class highway. Even our gravel roads are fast outliving their usefulness and are being replaced by more stable and permanent types of construction.

It is to be remembered, however, that the gravel road represents the logical type of construction for this portion of the country, and it is entirely suitable for highways upon which the traffic does not exceed 700 to 800 vehicles per day.

Mr. S. A. Theard, Maintenance Engineer of the Highway Commission, presented the next paper, this being upon the subject of Highway Maintenance as practiced in Louisiana. This is really the most important phase of the highway problem, and Mr. Theard gave a very interesting account of the organization and method of operation of his department.

In this connection it is of interest to note his statement to the effect that our gravel roads are wearing away at the rate of from one-half inch to three-fourths inch annually; in some cases, where traffic is particularly heavy, the wear is nearly one inch. The cost of replacing one-half inch of wear on the 3,900 miles of gravel roads now under maintenance would amount to \$1,250,000. For this reason the Commission is now engaged in an extensive series of experiments to determine the type of hard surfacing best adapted to our local conditions.

Proposed Highway Research in Louisiana was the subject of the third paper by Mr. John H. Bateman, Research Professor of Civil Engineering at Louisiana State University.

Investigations in the problems of highway design and construction are being carried on constantly by the United States Bureau of Public Roads as well as by various other public and private organizations. While the information coming from these sources is generally available for all parties interested, there are still many problems of a special nature confronting those who have charge of the construction and maintenance of highways in Louisiana. For the accomplishment of this end the State Highway Commission has entered into a cooperative arrangement with the Louisiana State University in the establishment of a highway laboratory. While the work will center about this laboratory, there will be a great deal of it, of course, which will be done out in the field itself.

Some of the outstanding problems, as stated by Professor Bateman, are materials, the character of the soil, the importance of sub-grade and drainage, and the rapidly developing questions of an economic and efficient type of paving for certain highways upon which the burden of traffic is very heavy.

The paper by Mr. Bryson Vallas, City Engineer of New Orleans, was a presentation of some of the problems of the city street as illustrated by local conditions.

In its superficial area one of the largest cities of the whole country, the population of New Orleans is such as to make the density of population rather low in value. This in itself contributes a fundamental problem to the question of street paving, and it is a factor not always taken into account by the casual visitor who criticizes our badly paved and "mud" streets.

New Orleans, however, has made great strides in the matter of better paving within the past few years and prospects are much brighter in this direction for the future.

From the engineering point of view Mr. Vallas points out that one of the most difficult phases of the paving problem in New Orleans is the provision of drainage and a pavement sufficiently strong to withstand the rather unusual conditions due to subsequent shrinkage and settlement of sub-grade.

"Mechanical Traffic Aids in Highway Safety" was the subject of the last paper presented very briefly and practically in

abstract by Mr. Paul Habans, Commissioner of Public Safety of the City of New Orleans. Owing to the press of other duties Mr. Habans has been unable to put his remarks into shape for publication in time for this issue of the Proceedings.

It is to be noted, however, that in any discussion of the city street as a phase of the highway question the handling of traffic thereupon is the most difficult point of the problem. And it is particularly difficult in the business district of New Orleans with its old world heritage of narrow streets and no alley-ways.

Our American characteristic of a disregard for law and order is nowhere more strikingly exhibited than in our attitude toward the traffic regulations of our city, both with regard to reckless driving and to prohibited parking. Mechanical aids have their right and proper place in the regulation of traffic, but the greatest factor is the education of the general public in respect for the law and in consideration of the rights and privileges of the other fellow.

Our Southern Trees. At the November meeting of the Society, Director R. D. Forbes, of the Southern Forest Experiment Station, proceeded to tell the engineers in a most interesting manner some of the things they did not know about our southern trees.

After briefly reviewing the importance of wood in so many of our industries and engineering projects Mr. Forbes devoted the greater portion of his address to what is undoubtedly the most important phase of the whole question: viz. our extravagance in the use of our timber resources and our lack of a definite policy of replacement of these resources through proper methods of reforestation.

Aside from the wasteful and extravagant methods of lumbering used in the past, forest and grass fires constitute the greatest menace to our timber supply. It appears to be a fact that if our forests and timber lands were adequately protected against fires, natural reforestation would prove equal to the task of keeping up our supply of timber.

While we do not have in this part of the South the spectacular forest fires of other portions of the country, there are the

much more insidious grass fires which destroy the tiny seedlings and seriously stunt the young trees which have already gotten their start at growing.

A State Geological Department. It is a singular state of affairs that Louisiana, with all of its natural resources, such as oil, gas, sulphur, salt and other mineral products, does not have a State Geological Survey. Since coming to the Department of Geology in Tulane University, Professor R. A. Steinmayer has interested himself in the question of having this Survey, which was once in existence, re-established. Professor Steinmayer, by his own work, has shown the importance of the geologist, or geological engineer, in the preliminary study of such projects as the development of the lake front of the city now in progress under the Orleans Levee Board, and the contemplated bridge across the Mississippi at New Orleans.

The matter has been brought to the attention of the Society and a committee appointed by the President to consider the whole question of the proper presentation of this matter before the next meeting of the Legislature. This committee consists of Professor R. A. Steinmayer, Major Frank T. Payne and Mr. Alfred F. Theard.

A Branch of the Society at Baton Rouge. Professor John H. Bateman, of the Louisiana State University, has brought to the attention of the Board of Direction the matter of the organization of an engineering club or society at Baton Rouge, with the idea of having it a branch of the Louisiana Engineering Society. There seems to be considerable merit in this suggestion particularly in view of the fact that more and more engineers are coming into the Baton Rouge territory with the growing industrial importance of the city. A branch society such as this would also afford an opportunity to the engineering students of the Louisiana State University to become student members as the Tulane engineering students do here in New Orleans. President Garsaud has appointed a committee to go to Baton Rouge to look over the situation and report upon the feasibility of this plan.

Nominations for 1926. At the December meeting of the Society the following nominations were made for officers for 1926:

For President, Farrar P. Hamilton.

For Vice-President, E. S. Lanphier.

For Secretary, Frank A. Muth.

For Treasurer, Walter B. Moses.

For Director, Frederick H. Fox.

The election is by letter ballot, the ballots being opened and counted at the annual meeting in January.

PAPERS AND DISCUSSIONS

LOCATION AND CONSTRUCTION OF ROADS IN LOUISIANA.

By W. B. ROBERT,
State Highway Engineer.

Read Before the Society, October 12, 1925.

Introductory. Although there has been a central State body in Louisiana, whose duty it was to supervise the construction and maintenance of State Highways, since the passage of Act. No. 49 by the State Legislature in 1910, strong centralized state control of highway work was not accomplished until January 1, 1922, when Act No. 95 of the State Legislature of 1921 became effective.

During the period between 1910 and 1922 the State Agency, which had authority in state highway matters was the State Highway Department, but that department had small funds for expenditure, and was, therefore, able only to exert its influence in the way of supervising the construction of highways which the several parishes were able to finance. The State Highway Department necessarily had a small organization, which was kept busily engaged in supervising the work financed largely by the parishes.

However, Act No. 95 of 1921 cleared the way for a great increase in state highway activities by creating the Louisiana Highway Commission to take over this work and by providing state revenues with which to finance the construction and maintenance of the State Highway System. Moreover, this new state highway law specifically outlined some 7,000 miles of state highways embodied in ninety-eight routes, each of which was clearly defined in the Act.

As a result of the passage of Act No. 95 and subsequent amendments thereto by the Legislature, annual revenue for state highway work, derived from auto license tax, chauffeur's license tax, and gasoline tax, increased from year to year as the number of vehicles operating within the State increased and the gasoline consumption increased. This is as it should

be, but, as is generally the case in public improvements, the needs of the public increase faster than the revenues for supplying the needs increase. In this most important phase of furnishing the public with transportation lanes, it has been found that the demands are increasing by leaps and bounds each year, so much so that those charged with the responsibility of constructing and maintaining the system feel that the task is one of enormous proportion.

Location of Roads. Of the 7,000 miles in the State Highway System, 2,800 miles are in the Federal Highway System and are eligible to receive federal aid not in excess of \$15,000 per mile. At the present time a total of some 3,700 miles of the state's system has been constructed, of which 2,675 miles are on the Federal Highway System, leaving only about 125 miles to be built on that system.

I think it is not improper nor unfair to the various State Highway Departments to say that the requirements of the Federal Government in the location and construction of federal aid highways have tended to improve conditions. To say the least, in Louisiana our practices have been very much improved and it has been found advantageous to follow government requirements on our state projects as well as on federal aid projects. This plan, of course, makes for uniformity as well as for efficiency.

In order to keep up with location work it is necessary to keep several parties (some times as many as eight or ten) in the field. The first step in locating a designated highway is to make a reconnaissance of the route between control points, that is between points designated for the highway in question, in Act No. 95. As a result of this reconnaissance or preliminary survey which necessarily takes into account stream and railroad crossings, etc., a route map is prepared and, if a federal aid project, this map on a scale of about one inch to one mile showing in a very general way the topography of the country, all streams, towns, railroads, etc., is submitted to the federal bureau for approval. Next the detailed location survey is made, establishing on the ground the location to be followed and furnishing to the head office of the Commission at Baton

Rouge full and complete field notes from which plans and estimates may be made and the project advertised for construction.

The field notes include transit alignment with topography sketches in detail, level cross section notes and field profile plotted in roll form on scales of one inch to one hundred feet horizontal and one inch to ten feet vertical. These field notes are then transmitted to the Baton Rouge office where detailed plans and estimates are made so that the project may be advertised for bids. However, before the plans are finally completed a set of blue prints is made and is taken into the field by an assistant engineer of the head office, whose duties are confined to a certain specific subdivision of the State. The State is divided into three districts, each one of which is under the supervision of an assistant engineer. The assistant engineer goes over the project with plans in hand and checks the various engineering features on the ground. He notes and checks the sizes and types of drainage structures proposed, indicates on the drawings the grade line, which, in his opinion, should be adopted, notes the alignment at stream crossings, railroad crossings, etc., with a view to making any changes which might be desirable, and in short, makes a final engineering inspection of the entire project so as to improve the plans in every way possible. These plans are then returned to the office, the final plans are prepared therefrom and the project advertised. In the meantime, if a federal aid project, a project statement, together with map somewhat more in detail than the route map, is submitted to the Government for approval. The statement gives a fair, accurate estimate of cost of the job.

In the final preparation of plans careful thought and attention is given to the grade line, which, in hilly sections, is balanced in cut and fill by means of the mass diagram, and which, in flat country, is placed above high water mark in order to avoid overflow; and to the location and type of drainage structures, with a view to the selection of the most suitable type. In the selection of the proper type of drainage structure consideration is given to foundation conditions obtaining as well as to the cost of construction and probable cost of maintenance of various probable types of structures. Small bridges and cul-

verts are included in road plans, but invariably large bridges, whether built of timber, concrete, or steel, are handled as separate projects and are advertised separately from the road project proper.

Where bridges are to be constructed across navigable streams it is essential to have the approval of the War Department before the bridge is built. Plans are, therefore, submitted to the War Department showing the location, type and general dimensions of the proposed structure and, when approval is received, detailed plans and specifications are then prepared. Many of Louisiana's larger streams, in fact most of them, are such as to require extensive investigations before plans can be made for bridging same. It is, therefore, often necessary to make special bridge surveys including investigations as to foundation conditions. This work includes taking borings and soundings at the bridge site.

For federal aid projects, the plans, either those for roads or for bridges, when completed, are forwarded to the United States Bureau of Public Roads for approval, and after approval has been received the project is then advertised for a period of generally thirty days in length.

Construction of Roads. The first problem encountered in constructing a highway is the acquisition of necessary right of way for same. This work is left to the authorities of the parish in which the project is to be built. One of the provisions of the construction contract which always is signed by the commission, contractor and the president of the Police Jury of the parish in which the work is to be done is that all right of way shall be procured by the Police Jury of said parish and furnished to the Commission free of charge. In ordinary road projects sixty feet is the standard width of right of way required, and this is the minimum amount which is acceptable to the Government for federal aid projects. But in flat sections of the State where the high water mark requires a high embankment it is oftentimes necessary to provide a much greater width of right of way, some times as great as 200 feet. The required width of right of way is shown in the plans and must be acquired before construction work is allowed to begin.

To each road or bridge project is assigned a resident engineer, who has full charge of construction in the field under an assistant engineer from the Baton Rouge office, who visits the project from time to time. A resident engineer may have several projects assigned to his supervision or he may have only one, depending on the location and size of the project or projects and on the ability of the resident engineer. In spite of the great care exercised in making surveys, designing and planning the projects, it is often found necessary during the course of construction to make changes. Such changes are called field changes and are made on recommendations of the resident engineer and assistant engineer and the approval of the State Highway Engineer, except on federal aid projects, which must also be approved by government authorities. In making field changes a detailed estimate of cost is submitted with the recommendation for change and the matter is carefully considered and checked before final approval is granted.

Traffic requirements are every day demanding better highways, better as to alignment, better as to grade, better as to surfacing, better as to stream and railroad crossings, and better as to maintenance. This is exercising an influence on the work being done by the highway commission, and it may be said that both our location and construction work are improving all the time.

It is important to note, in connection with the improvement in highway construction now under way, that only a few years ago what would now be termed a poor dirt road was considered a first class artery of traffic, and even the gravel surfaced highway which five years ago was considered an excellent highway is now fast outliving its usefulness and must in many places soon be replaced by higher type surfaces. This condition is reflected in frequent requests the commission is now receiving from a number of parishes for constructing higher type pavement where gravel has heretofore served, and the commission has taken cognizance of this condition by deciding to experiment in the very near future with various types of bituminous surfaces on the Baton Rouge-Hammond Highway near Baton Rouge. A small mileage of the highest type of concrete and

asphalt pavement has already been built in some of the larger parishes where the congestion of population and commercial activities have caused vehicular traffic to increase so greatly as to make the old gravel surfaced highway unserviceable. The commission is also favorably inclined towards surface treating some of our gravel surfaced highways, hoping to preserve same and to reduce the dust nuisance at nominal cost. Experiments will probably be made along this line also. At the present time it is impracticable for the State to finance high type pavement construction work except where such type of pavement is absolutely essential, and then it can finance it only with the assistance of the parish where the work is to be done. The result is that most of our work for some time to come will undoubtedly be of a gravel type surface, and I might say that this type of surfacing is entirely suitable for those highways on which the traffic has not increased beyond say seven or eight hundred vehicles per day.

MAINTENANCE OF HIGHWAYS AS PRACTICED BY THE LOUISIANA HIGHWAY COMMISSION.

By S. A. THEARD,
Maintenance Engineer.

Read Before the Society, October 12, 1925.

Adequate maintenance of highways is a prime requisite to economical and satisfactory transportation in the business world, not to mention the inestimable service rendered in the interest of the social welfare of the State. The automobile and the highway have made us, not citizens of one town or locality, but citizens of the State wherein those of north Louisiana are neighbors of you here in New Orleans. It is appropriate to compliment those who conceived the idea of the State Highway System and also those who have been responsible for its construction up to this time. It is a great work and something of which the State can be justly proud. Tourists are loud in their praise of our roads and are surprised at their continuity; one can travel between practically all of the larger towns over the length and breadth of the State on excellent highways. The experience of falling off into a mud hole at the end of a stretch of perfect road has been eliminated from the main highways of Louisiana. It is worthy to mention that this has been accomplished in an unusually short time.

The Highway Commission was created by Act 95 of the Special Session of the Legislature of 1921. It met and organized in January, 1922, shortly thereafter accepting for maintenance about 1,800 miles of gravel roads. The Maintenance Department was organized and began to function in March, 1922, only three and a half years ago. Many of the roads accepted at that time were of a construction not comparable with those being built today. There had been no systematic upkeep, consequently much effort was required to restore a large percentage of this mileage to a satisfactory condition. Even to this day the cost of maintenance is higher on some of these roads than it ordinarily should be. The Legislature of 1921 provided a tax of one cent per gallon on gasoline, the revenue from which was applicable solely for maintenance purposes. On account of

the inadequacy of this fund the recent Legislature provided a two cent tax on gasoline which was effective August 1, 1924. It is estimated that this will make available a fund of \$2,100,000 for the calendar year 1925. At the present time 3,958 miles of highways are being maintained by the department.

The State is divided into ten districts for the purpose of maintenance. The mileage in each varies from 220 to 535 miles at the present time; based on the geography and facility of supervision. A patrol, which ordinarily maintains from 20 to 35 miles, consists of either a heavy truck or tractors for pulling one or two graders, and an extra truck for miscellaneous hauling. Sometimes, however, additional power is required when cleaning ditches. One man motor graders are used, but their operation is restricted chiefly to surface work.

The Highway Commission received a considerable amount of surplus war supplies from the Government. This included trucks, tractors, replacement parts and a general supply of miscellaneous material. To date, of all the equipment received the three ton army truck has proven most valuable. It is used, almost exclusively, in the heavier work and is reliable and economical. Its general utility appeals to one engaged in the work. It is available as a power unit as well as for hauling.

Each district has a superintendent who directs the work through foremen or patrol leaders. This work is handled by parishes, a foreman being in charge if there is sufficient mileage to warrant it; otherwise two and sometimes three parishes are under his supervision. When this arrangement is not feasible, a leaderman, usually the truck driver or a graderman, carries out the instructions of the superintendent. At the headquarters of each district there is a shop with mechanics to keep the equipment in proper condition. A small stock of supplies is kept for emergencies.

All purchases are made by the commission on the recommendation of the Maintenance Engineer. The District Superintendent submits to the Maintenance Engineer a requisition for all supplies. Except in emergencies, the superintendent is permitted to make purchases so that necessary equipment may be kept in operation. This privilege is limited to a fixed sum,

confirmation from the commission being required for any excess expenditures. This absolutely centralizes and controls the buying of materials and supplies, thereby preventing the superintendents from acting as purchasing agents. As a result of this method much economy has been obtained.

The men in the field are paid by check, thus rendering a certification of their work and time, and insuring to a great extent the accuracy of the payrolls. About 1,000 men are now employed and payment by this system is effected without delay.

A three ton truck pulls two graders at the rate of three or four miles per hour and will completely drag from shoulder to shoulder, on an average, from eight to ten or twelve miles of road a day. A few yards of gravel are carried along at the same time, the material being shoveled off into the depressions as they go along.

The methods of maintenance of gravel roads are seasonal. During the long dry periods considerable difficulty is experienced in keeping the surfacing from becoming loose. The binder dries out, pulverizes and is blown away rapidly on the highly traveled roads. The patrols are kept busy at these times supplying additional clay binder required to keep the gravel set. This explains the muddy and sometimes slippery condition of the highways after rains. When this occurs the excess binder is bladed off the surfacing to the shoulders of the road for future use. Practically all of the binder now being used is obtained from the roadside at a considerable saving. Since drainage is at all times a very important factor in the upkeep of a road, ditches and culverts must be kept open to give quick and unrestricted run-off.

Roads are built twenty-four feet wide, usually with ten feet of surfacing, according to the present standards. The tendency in maintaining them is to widen them. This work is often seriously handicapped by the lack of sufficient right of way. The present requirement is a minimum of sixty feet.

The blading or dragging of a road is governed by three factors, namely, the amount of traffic, the weather conditions and the type of road. It has been observed that when traffic exceeds 600 vehicles per day more effort is required to maintain

a smooth surface. Dry weather accentuates the above fact and corrugations begin to appear especially in the sandy roads. When there is an excess of clay binder pot holes result. The wash gravel type of road has proven to be satisfactory in localities where the proper kind of binder is available.

The corrugations are more easily bladed out in wet weather. The type of equipment used is the ordinary road grader with a flat drag blade instead of the regular cutting bit. This drag blade is of high carbon steel, usually $\frac{5}{8}$ " x 8" x 10'-0", and besides costing less and outlasting the other, the same results may be obtained. Shaping up of the roadway and cleaning out of ditches requires the use of the cutting bit on the grader.

Traffic over the highways has increased 300 per cent since 1922, and as a result the dust nuisance has also increased. This is minimized to some extent by the use of good clay binder in many cases. Dust blown from the road represents a loss of binder besides being offensive to the traveling public, and to the forces that maintain them. To overcome this, the State of Michigan is now trying an experiment in night maintenance. A saving of road material was effected by this system, in that the dampness at night reduced the dust and what little was stirred up resettled on the road. In some States calcium chloride and light oils are used as palliatives. The cost of calcium chloride is approximately \$400 per mile; however, light oils may be applied for less.

Gravel roads are wearing at the rate of half an inch to three-quarters of an inch yearly. In some instances on heavily traveled roads the year is nearer one inch. The cost of a half inch replacement on the 3,900 miles now being maintained is conservatively placed at \$1,250,000. For this reason the present commission has established a department to experiment with various types of hard surfacing in order to determine that best suited to our local conditions. About seven miles of experimental road is to be built immediately, representing nearly all types of hard surface construction. Under actual use it will then be determined those types which are best. The testing laboratory in connection with this department analyzes all materials and supplies used in construction and maintenance. An

interesting experiment conducted by the State College of Washington brought out the fact that the difference in cost between riding on a smooth road and on a rough one is two and a quarter cents per car per mile, where gasoline and tires only are considered. Overloaded trucks and busses traveling at high speeds are very instrumental in causing rough gravel surfaces.

The present system of signs and markers is inadequate. A new system, approved by the United States Bureau of Public Roads, for use on inter-state highways will be made state-wide.

The gasoline tax now in effect is not going to be sufficient to carry on the future maintenance of our roads. We are among the few lowest utilizing this method of taxation for highway maintenance. The public, realizing the benefit derived from good roads, will not hesitate to provide sufficient funds to insure their proper upkeep and improvement. Good roads mean progress, and every effort should be made to increase and preserve them.

PROPOSED HIGHWAY RESEARCH IN LOUISIANA.

By JOHN H. BATEMAN,

Research Professor of Civil Engineering, Louisiana State University.

Read Before the Society, October 12, 1925.

In an address delivered before the Second National Conference on Highway Engineering and Highway Transport Education, Professor W. K. Hatt, Director of the Advisory Board on Highway Research of the National Research Council, made the significant statement that "the practice of research is necessary for the advance of the art of the highway engineer to overtake the demands of highway transport that have arisen so quickly and increase so rapidly. Routine thinking has not met the needs of the present, and will not serve the needs of the future."

Those States which are recognized as leaders in the field of highway construction and maintenance are also leaders in the field of research. The development and application of facts obtained through intelligent investigation of existing conditions is absolutely necessary if we are to arrive at efficient and economical means of carrying out large highway programs. This principle is an accepted fact in industrial life today and it is just as applicable to public enterprises.

Much of the information developed through research investigations is of general application. Such for instance is much of the work which has been carried on by the United States Bureau of Public Roads, by several States and by various organizations which are semi-private in character. Valuable as this work has been, there still remains a very large field in each State for intelligent investigation and analysis of conditions which are peculiar to that State.

The State of Louisiana has approximately 7,000 miles of state highways, of which somewhat over 3,500 miles have been improved with gravel, a material with which the State has been abundantly supplied by nature. The time has been reached, however, when many of these highways must be resurfaced with a more permanent material which will better enable them to care for the traffic which has come, and will come, upon them.

In other words, the natural development of highway traffic in the State has reached the point where construction must soon involve a change, in many locations, from a low to a higher type of road surface. As time goes on this condition will obtain in more and more sections of the State.

In order to increase the facilities for making a careful study of conditions throughout the State and to assist in the solution of the State's highway problems the State Highway Commission has entered into a cooperative arrangement with the Louisiana State University whereby the facilities of the University may be utilized for the benefit of the State as a whole. Under this arrangement a highway laboratory, with reasonably complete equipment, has been placed at the disposal of the commission. The change from the old location of the University to the new has made this step quite easy of accomplishment. This laboratory has been equipped not only to carry on the routine examination of materials for the Highway Commission, in itself an important step, but also to be of whatever assistance it can in the prosecution of research problems. Lest I might be misinterpreted let me say that all highway problems can never be solved in a laboratory alone. But a laboratory, when properly utilized and its work coordinated with design and construction, is a most useful and valuable part of the equipment of a large highway department.

There are many problems which confront the State in connection with the development of its highways, and in the brief time allotted to me I can refer to them but briefly and in a very general way.

The material situation presents a very real and important problem. This State has been abundantly supplied by nature with gravel, in general of excellent quality. Unfortunately, however, this gravel consists largely of particles of small size. This fact may have an important bearing upon its use for various purposes.

Soil conditions present another very interesting and profitable field of study. The extent of the importance of the subgrade in connection with the design of pavements and highway drainage systems has only recently been understood and more

attention is daily being given to this feature preparatory to design.

All of these, and other conditions, have a very apparent influence on the selection of type of road or pavement to meet the conditions encountered in the different sections of the State.

The gravel road system, to which reference has been made, presents a problem of real importance which will require very careful consideration in order to reach the solution which will be most economical and satisfactory in all cases. It seems apparent to the speaker at the present time that no method of general application will be found to be the solution but that each given set of conditions must be considered on the basis of the individual merits of the situation.

In this connection the Highway Commission is now planning on carrying on a series of tests to determine the application of certain types and methods of construction of pavements to various traffic conditions. It is anticipated that in the near future several different sections of bituminous pavements will be constructed using an old gravel road as a base. The work of such men as Mullen, Macnaughton, Hubbard, Milburn and Skidmore, in the study of the factors which contribute to the stability of bituminous mixtures, points to developments and accomplishments far beyond what has previously been obtained through general practice in this type of construction. If Louisiana can utilize its gravel roads as bases for higher types of road surfaces in even a small percentage of its mileage, and still further if local materials can be utilized to a large extent in such cases, the economic benefits derived will be large.

THE PROBLEMS OF PAVED STREETS.

By BRYSON VALLAS,

City Engineer of New Orleans.

Read Before the Society, October 12, 1925.

I have taken the liberty of confining the scope of this paper on the problems of paved streets to our local problems, as with these I am more familiar from an intimate acquaintance of several years.

While other cities have paving problems closely resembling those to be found near home, yet I believe that New Orleans has several of her own particular brand, the solution of which, while providing many a worrisome moment for the engineer, has furnished compensation to him because of their interesting and local nature.

The problem of the right of way with which the highway engineer is immediately confronted is presented to the municipal engineer in a slightly different form.

The location of city streets has usually been fixed years previous to paving operations, at the time the sub-divisions of the larger tracts were made into lots and squares and before the need of a modern pavement was dreamed of or the requirements of traffic indicated the direction or width of the right of way.

As a general rule, in the older sections of New Orleans which surround our business section, these streets are too narrow, and, being forced to act as traffic arteries or feeders for a greater part of our traffic, we find them today poorly adapted to our present traffic needs. As the city grows and our traffic becomes more intense, property will have to be acquired on either side of present rights of way through these sections and the street repaved to a greater width. New Orleans already finds itself immediately confronted with this street widening problem as in the case of Common street and in Dryades street. Already it has been necessary to actually undertake this widening operation as on James and Baldwin streets (now Fontainebleau drive) and on North Rampart and St. Claude streets. The undertaking, though expensive, is comparatively simple

in the outlying sections, such as was the case in Fontainebleau drive, but will certainly be more complicated and considerably more expensive on streets such as Common and Dryades.

With several wide avenues or boulevards through them, later sub-divisions, however, giving street widths of fifty and sixty feet, have permitted the planning of roadways and banquettes with more thought and latitude as to the needs of traffic using them.

While our nearly level terrain has been conducive to the introduction of some problems in paving, it has also assisted in the solution of others. The numerous canals necessary for drainage purposes have deeded to New Orleans a large amount of very wide, radial streets on which a paving sub-division or plan can be laid out with some regard to the needs of present and future traffic.

On these wide avenues the engineer is loath to surrender any portion of the so-called "neutral ground area," and after providing for a proper sidewalk or banquette width and a roadway on either side sufficient to accommodate present traffic in a one way direction, he is inclined to hold tenaciously to the central neutral ground strip left, for by it he may later, without great cost, add to the width of this roadway and thus economically and sensibly provide for the demands of traffic that are to be anticipated over these boulevards.

How wide shall the sidewalks be and how wide shall the roadways be, and yet be consistent with economy and safety? This is another problem of paved streets.

The sidewalk or banquette strip in business sections or semi-business sections should be wide enough to provide a safe and comfortable walk-way for the greater number of pedestrians using it. Usually widths of ten and twelve feet will suffice. However, exceptions must be made to these widths, as in the case of Canal street, where the demands and needs of pedestrian traffic equal those of vehicular traffic. These banquettes should be paved full width. In the wholesale business section, sidewalks may be made narrower and more street area must be allotted to vehicular traffic. In the residential section, however, sidewalks and banquettes should be wide enough to pro-

vide, if possible, a grass strip next to the property line with a paved walk-way wide enough to accommodate two persons walking abreast, and a planting strip for trees between this walk and the curb line.

In the past, it has been customary to think of roadway widths in terms of feet. The engineer now finds it necessary to think in terms of traffic lanes. As an instance, through a residential section, where parking on either side in isolated spots is encountered, and where the usual width of right of way is found to be fifty or sixty feet, a width of twenty-six feet between curbs is provided, which, in terms of traffic, means a parking lane on either side and one moving lane through the center. Often the right of way width requires a reduction of the size of these lanes, so that twenty-nine or thirty feet roadway widths are often used. Through the business section the requirements of traffic demand roadways as wide as possible, often meaning the sacrificing of banquette areas to accomplish this.

Types of wearing surfaces to be laid and thickness of foundation slabs to be provided also require some thought, for while the volume and weight of traffic indicate in some sections whether or not a street should be surfaced for heavy, medium, or light traffis, some thought should be given in order to provide a proper surfacing material for future traffic, particularly in growing cities like New Orleans. with its ever expanding commercial area.

Another problem with which we are often confronted is the problem of providing pavements for heavy traffic through sections of the city where the abutting property, assuming the entire burden of cost, is residential and of such a character as to ill afford to meet the obligations placed upon it by the cost of these expensive types of pavements.

It may be that five or six blocks of a thoroughfare should in the opinion of the engineer be paved with an expensive type of foundation and wearing surface to supply the demand and requirements of a heavy traffic artery, yet the balance of the thoroughfare, bordered by property of similar and sometimes of greater value, may be called upon to pay the cost of a much

cheaper type of pavement on account of the medium of light traffic using that section of the thoroughfare.

The problem of properly and fairly proportioning charges for paving improvements has occupied the minds of municipal engineers and other authorities for some time and the system used in New Orleans of requiring abutting property owners to pay the entire cost of paving seems to have been generally adopted throughout the United States. Yet, in the writer's opinion, it seems unfair, under the conditions above stated, that one section of a street should have to pay a greater cost per front foot than another section almost adjacent to it, due entirely to the necessity of providing a proper pavement for the heavy or light traffic, as the case may be, using it. In other words, traffic has in a measure penalized the owner of property in some sections and derived full benefit from the penalty.

The most impressive local problem that presents itself is the problem of drainage with the additional problem of providing an economical and yet sufficiently strong paving base to withstand the unusual conditions later imposed on it on account of the subsequent shrinkage and settlement of the sub-grade.

The greater part of New Orleans is about or below average lake level. The condition of the clay soil forming the sub-grade for pavement foundations is of almost constant saturation which has well entitled it to its local classification as "mud."

The level terrain does not permit of a very satisfactory removal of this ground water by any other means than an elaborate system of sub-surface drains placed several feet below the surface.

It is unfortunate that this system of drainage cannot be installed several years in advance of permanent paving operations, as a troublesome shrinkage factor would be considerably reduced. The present system of providing sub-surface drainage as an adjunct or part of paving, however, forces the installation of these drains immediately in advance of the actual paving. The consequent quick removal of surface water with the additional drainage of the sub-surface by means of storm and sewer lines removes this ground water after the entire improvement has been completed.

The result is a subsidence or settlement of the soil under the pavement slab which imposes upon the slab the duty of carrying the load without support at all points from the sub-grade.

It is remarkable under these conditions that our pavements have lasted and given as good an account of themselves as they have. The proper and final solution of this problem would be, in the writer's opinion, to install all sub-surface drainage required in streets to be paved, several years in advance of paving. This, however, would entail the investment of considerable amounts, which investment under present laws would have to be made by the City of New Orleans until the street was actually paved, at which time the law permits the city to reimburse itself at the expense of the property owner.

As a temporary solution, a thicker pavement foundation slab has been used in some sections of the city and in others the pavement has been reinforced with steel mesh or welded bars having an approximate weight of about forty or fifty pounds per 100 square feet. These departures from the usual six inch slab of a rich mix, plain, concrete base has been used recently and sufficient time has not yet elapsed, in my opinion, to determine which of these is the better solution or if they may be even classified as solutions. It might be stated, however, that during the construction of one thoroughfare in this city, on which paving operations followed closely upon drainage operations and in a section of the city where the terrain was level and about two feet below lake level, the steel reinforcement method was used in that section of the pavement immediately over the fresh fills of sub-surface drainage areas which were located about in the last quarter of the roadway. This street is now three years old, and it is noted that the sidewalk and the curbs and gutter bottoms adjoining the reinforced sections of this pavement, together with the buildings on the street, have settled from several inches to one foot or more, yet the pavement slab has held its own and is today apparently well cantilevered over a considerable area of subsided sub-grade.

These are in brief some of the problems of paved streets that confront us locally and which on account of the limited time allotted for this paper have permitted their being touched only on the surface.

Discussion.

THE PRESIDENT: The Chair would like to announce to the gentlemen who were kind enough to talk to us that the papers after being corrected by them, if they wish to do so, should be turned over to the Secretary, as it is the customary procedure of the Society to publish the papers in the Proceedings. We feel that the issue which will contain this symposium will be one of the most interesting that has ever been published by the Engineering Society. I am going to request the speakers, if their papers are in proper shape, to turn them over to the Secretary tonight, or to mail them to him if there are any changes to be made.

I want to make a few remarks on one or two of the papers, upon points that struck me as important when the papers were being read.

The Highway Engineer told us about the asquisition of right of way as being one of the most important features, and as being generally left to the Police Juries of the parishes, the right of way being acquired before the contract was let. When I was in the highway business I believe the right of way was acquired, as I understood you to say tonight, Mr. Robert, just prior to construction. Is that still the case?

MR. ROBERT: There is a rule which we lay down to that effect, but the right of way is not always acquired before the contract is signed.

THE PRESIDENT: I had a very large contract one time; it was delayed considerably and it cost the contractor a good deal of money on that very phase of it; when we reached a certain point, the right of way had not been acquired by the Police Jury. Some of those juries are very slow in moving, nothing is done in that direction, and when the construction reaches a point where the right of way is not acquired, the road is skipped, and the road costs more to build. It seems to me to be a very important point for the Highway Commission to take up, the acquisition of the right-of-way before the signing of a contract. This is not meant as a criticism, but I think it is a very good point to bring out.

As I understood the Maintenance Highway Engineer to say the appropriation was something like two million dollars for the upkeep of the roads, which would make it about five hundred dollars per mile per year for maintenance. If that is the case, the work is being very economically done. In my travels lately, I have seen nearly all of our gravel roads, and they are in very good condition, and if you are doing it on five hundred dollars a year, I believe it is being done very economically.

Did you say that the old three ton army truck was the most efficient truck? Do you mean the Quad truck?

MR. THEARD: I mean the Liberty truck. I have several of those that have been in Germany. The Quad trucks are the next best to the Liberty.

THE PRESIDENT: A point brought out by Mr. Vallas was very important, the one in which he said that some property in one part of a thoroughfare might be required to pay more than its share for the building of a street. I was generally impressed with that about two years ago when I was engineer of one of the committees of the Association of Commerce. I was also working for a client, a man that owned some property on one of the streets of the City of New Orleans which was being paved; it seemed that he was being charged an unfair amount for his paving. I told him there wasn't anything to be done about it, but the unfairness of it struck me then. This party owned a great deal of low class property on Howard street, where a neutral ground exists. It was all cheap property of very small value, and low assessment. The price of paving, per lineal foot, on that street due to the fact that it was a double street, was nearly twice the price of the paving on the same street on the other side of Louisiana avenue, where the property is residential, and of a higher class or value. That is a very unfair condition, but there is nothing for the property owner to do. The only solution of that problem would be some means of letting more contracts, or for the city to absorb a certain amount of the cost.

The other point in Mr. Vallas's paper was the possibility of installing sub-surface drainage prior to the putting down of the pavement. That was one of my recommendations to the

Association of Commerce Paving Committee. It is a hard problem to solve, and it is a problem that has a great many angles to it, but I believe it is big enough to be tackled, and it ought to be tackled very quickly. I think that the installation of sub-surface drainage in the city ahead of paving is one of the problems of today. I believe it can be done. In the long run, while it may appear to entail a higher cost, you will find that the upkeep of the streets will be so much less that it will actually be a saving to the city. I think your idea is very good on that, and ought to be worked out along those lines.

I was also very glad to hear Professor Bateman say that the gravel roads should serve as a basis for the hard surface type of pavement that may be installed later on. I believe that applies to our city streets. I am very sorry to see a tendency in some of our streets today to pave them with gravel. Not that I object to gravel streets, but to the way in which it is being done.. There is no criticism of the present administration, or the commissioner, or the engineer. I believe they agree with me. The idea of paving a street with gravel, two feet above grade, and four or five years later to tear it up to get down to the original sub-grade is wrong. The way we should gravel our streets is to sub-grade them first, and then lay the gravel, so that the top of the gravel will be the grade of the bottom of the concrete when you pave it. Then you will have a crust and the base of the pavement will have a larger chance to hold than by simply graveling the street, and then cutting it down to the original sub-grade. It is like going on a country road and finding a good dirt road a little out of grade, and digging the crust out to get down to the dirt. I had an engineer do me that once. The road was too high, and he made me cut the crust out. By the time I got to grade, I only had about an inch of crust left. I believe the solution of our paving problem is to establish that crust and maintain it.

As to the question of signs on the road, I have traveled the road between Baton Rouge and New Orleans several times at night, and the signs are more of a handicap than a help to me. Either they are in the wrong place or they should be lighted or be of a different color. At night you don't see them until you

are on top of them, and the sign looks like a cow in the middle of the road instead of a sign. I have had several men tell me they are a hindrance, rather than a help. The angle at which they are set, or their height, or color, or something is wrong with them.

Does any member of the Society, or any guest, desire to make any remarks on any of the papers? Have you anything to say, Mr. Kerr? I saw you smile while I was speaking. I think Mr. Kerr could give us some information, if he will, from his experience when he was with the Highway Department.

MR. KERR: I don't think I could add anything of value or interest at this time to what has been said. I thoroughly enjoyed the several papers, and the experiences of the speakers are similar to my own in the old days.

I know the Highway Department is carrying on the good work in good shape and that everything possible is being done to complete the system of state roads originally planned. In the last eight months I have been in thirty-eight States in the United States, and I find one important thing: none of them are really ahead of Louisiana in the point of actual miles of road built. Of course, many of them have more mileage of higher types of surfacing than we have; but, when it comes to getting anywhere I think we can get around as well as any of them, and far better than most. The point about a gravel road being a good base for a future hard surfaced road is well taken. In this State, where our natural foundation isn't any too good, the gravel road has its advantages and ought to provide the foundation for the higher type road of the future when increased travel and ample finances will justify higher types of pavements.

WHAT WE DON'T KNOW ABOUT SOUTHERN TREES.

By R. D. FORBES,

Director, Southern Forest Experiment Station, New Orleans, La.

Read Before the Society, November 9, 1925.

Outside of the forestry profession itself there is probably no other profession which has greater reason to be interested in a continuous supply of wood than you gentlemen in engineering. Not only does the profession use wood in enormous quantities in its business of industrial activity, but it also finds a considerable part of its employment in the forest industries. The latter is particularly true here in Louisiana, where saw-milling, pulp and paper manufacture, and allied enterprises, comprise the most important manufacturing industry we have. Possibly my ignorance of the engineering profession leads me into error when I say that by and large you men know far less of the structural material known as wood than you know about metal, concrete, or other similar materials. No doubt one reason why relatively little is taught in the engineering schools concerning the properties of wood is the bewildering variety of woods at the command of the American consumer. In Europe the problem must be very much simpler, since there are only about a dozen native species of trees are of commercial importance. In America, on the other hand, we have from 75 to 100 commercial tree species, and each of these is produced in many grades.

No talk on our forests before engineers would be complete without mention of the work of the Forest Products Laboratory of the United States Forest Service, at Madison, Wisconsin. Some of you may have visited this laboratory. I believe that nothing short of a visit to it can give you an adequate conception of the important and diverse investigations of the mechanical, physical, and chemical properties of wood which are being carried out there. Striking progress has been made at the laboratory in determining accurately just what the woods of the different trees can be used for, and the most economical and efficient way of using them. The laboratory has supplied the greater part of the technical information necessary to the

standardization of lumber, a project fostered by the Government, and backed by every thoughtful producer and consumer of lumber. America has been guilty of an incredible waste of one of our great basic resources, because of the extraordinary diversity of sizes and grades in which we have come to manufacture wood products. Originally designed to meet the needs of the industries which converted the rough lumber into finished products, these sizes and grades have not changed with changes in the industry and in economic conditions. Just because in the early history of the nation the material was cheaply available, billions of feet of the finest quality of lumber have been used, and are still being used, for purposes to which inferior material is just as well suited. Industries long accustomed to receive rough lumber from the sawmill in certain sizes, readily obtainable from vast supplies of virgin timber, continue to demand these same sizes now that virgin supplies run low. To supply these sizes the sawmills must waste great quantities of now valuable wood. The Forest Products Laboratory at Madison is the great agency of the Government through which our waning forests are being made to go just as far as possible.

And indeed there is desperate need for us today to make our present supplies last as long as they can. The American public is now consuming, or permitting to be destroyed by fire, decay, and similar agencies, roughly twenty-four billion cubic feet of wood every year. We are growing about six billion cubic feet. The difference, of course, represents a drain upon our forest capital—the virgin forests—which cannot be continued indefinitely. It does not greatly matter whether the virgin forests will be completely exhausted in a little over fifty years, as at present predicted, or whether they will last for seventy-five years. Long before the virgin forests of the nation as a whole are exhausted there will be local shortages; failure of supplies of individual species of high technical quality; and a freight bill of staggering proportions placed upon the shoulders of a public whose parents forgot that lumber could be brought to the manufacturing East and the agricultural Middle West from the Pacific Northwest only at transportation charges of \$10 or

\$15, to say nothing of additional charges of similar proportions involved in supplying a market with raw material from a source two or three thousand miles away.

This brings me to what I feel is a second reason for the lack of interest in wood which is a little apt to characterize your profession. This is the increase in substitutes for wood. Why worry about wood when steel, concrete, brick, and other stronger and more durable materials are available? The counter-question is: are they really available? Europe, which has faced a shortage of wood for decades and even centuries, has replaced far less than 1 per cent of her wood railroad ties with steel, glass, and concrete. To come directly home, what are we going to substitute for long-leaf pine piles in the foundations of New Orleans' future skyscrapers? Again, the substitutions sometimes engender other uses for wood. Some systems of concrete construction actually require the use of more wood, and in larger sizes, than if the building itself were all of wood. A six-room brick house takes only two-fifths less wood than a frame construction. Finally, substitutes in some fields are offset by new uses for wood. Is it not inevitable, for example, that gasoline and similar exhaustible fuels will one day give way to those which may be produced year after year—that can never be exhausted? Surely then wood, a source of alcohol, will come into its own.

It is the business of the foresters of the United States to learn enough about our trees to enable us to bring the annual growth of timber in the United States from its present level of six billion cubic feet to twenty-seven billion cubic feet. The latter is the Forest Service estimate of the amount which could be produced in American forests under a degree of intensive handling comparable to that achieved generally by the foresters of Europe, and of parts of India and Japan. By such crude measures of forestry practice as the elimination of fire as an important factor in tree destruction, and the leaving of a few trees for seed, it is estimated that America could grow fourteen billion cubic feet of wood. Closing the gap between fourteen and the eventual twenty-seven is the task before the Forest Experiment Stations.

Because the Southern Forest Experiment Station entered a field in which less is known of the trees than in any other section of the United States, and because the station has been in existence only four years, I have chosen as the title for my talk "What We Don't Know About Our Southern Trees." We have learned something about them, but we do not begin to know them as we must. At the present time we are the largest forest experiment station in the country. Our staff now consists of seven trained foresters and a corresponding clerical force, together with temporary technical help. Our annual appropriation is a little less than \$40,000. But with this force and with these resources we are expected to solve the timber-growing problems of nine States from South Carolina to Oklahoma and Texas, a territory which it is expected will furnish from one-fourth to one-third of all of the wood raised in the United States in future years under intensive forestry practice. I need hardly add that we need the interest and support of every intelligent body of men and women in the South, and that we consider as a very important part of our work the encouragement of all other agencies which we can persuade to indulge in silvical research. Although the time is not ripe for it, we have no doubt that sooner or later we shall have need of engineering advice and skill.

The remainder of my talk will consist largely of comments on the slides which I am about to show.* The pictures will not only relieve me of many words of explanation, but will be, I feel sure, a great relief to you gentlemen who are by now weary of generalities.

Among the first questions which inevitably occur to any one whose attention is directed to timber-growing in the South is this: is it really true that the forests of the South have been seriously depleted, and if so, to what extent has any one attempted their rejuvenation? In answering the latter question I want to touch briefly upon the work of the experiment station in evolving measures whereby they may be rejuvenated. We have better figures concerning the supply of pines in the

*The Editor regrets that it is not practicable to reproduce these illustrations as a part of this paper.

South than we have concerning our very important supplies of hardwood and cypress. Roughly ninety-five million acres out of a total of one hundred and fourteen million acres of pine land not yet converted to agriculture have been cut over. Nearly half of the remaining nineteen million acres of virgin timber is in the single State of Florida, and considering the present situation in that State I think you will agree with me that the future of those Florida pine lands is extremely dubious. No doubt every one of the nine million-odd acres of pine lands will be in city building lots within five years—at least if we take the word of the Florida real estate operator for it.

The first slide is a typical scene in some of these ninety-five million acres of cut-over pine lands. It is a scene of desolation, which no consideration of the admirable purposes to which no doubt the lumber taken from the ground was put can ever fully justify. Here is land which for hundreds of years was green with as fine a stand of longleaf pine as grew in the South. Almost overnight, certainly within a year, it was converted into what is to all intents and purposes a desert. In fact, there are large portions of the real American desert in Arizona, where I have personally worked, which I think would be ashamed to be as unproductive and valueless as this. This condition is the result of cutting the original forest growth absolutely without thought for the future, and of uncontrolled fires. The fires, by the way, were at work long before the saws were, as may be seen from the next picture. You may have seen a recent press notice of ours in which we called attention to the fact that in 1924 fires within the station territory were estimated to have covered twenty-four million acres of ground, or 84 per cent of all of the land burned over in the entire United States this year, and that they caused a loss to the South of twenty-seven million dollars. These figures have been attacked on the ground that the losses to mature standing timber, which the public is apt to regard as the only real loss from fires, was only a part of the total—about 25 per cent. Although we can sympathise with certain lumbermen whose bankers, in the face of such destruction as this, have grown uneasy over loans on their standing timber, we cannot help feeling that damage to

mature trees, of which this is only a small sample, are sufficiently serious to warrant public concern. Moreover, we know that the Forest Service estimates of damage in 1924 were extremely conservative, and are determined through future investigations to clinch our point by an investigation of this kind of loss. Of fire I will have considerable more to say later on.

In cheering contrast to the pictures just shown are a few illustrations of fine young growth that has come back naturally on Southern pine lands which have had some degree of accidental fire protection. I also show some scenes in properties which were cut over originally with an eye to a second cut, years before a real second crop of timber can mature. Just how far this idea of cutting only the larger and more thrifty of the trees in virgin stands can be extended to the cutting of all virgin stands we do not yet know, but we present a scene in an experiment of our own which we hope will furnish valuable information on this point. It is interesting to note that one company in Alabama, which for a few years early in the century followed the recommendation of the Forest Service in cutting its timber on some such system as this, has since found that the results were even better than expected and has expressed deep regret that it did not continue the policy. Had it done so, it might be looking forward today to indefinite operation of its mill, instead of facing the prospect of going out of business within a comparatively short time.

The slides just shown have illustrated the second growth which will occur naturally, under a degree of fire protection, on those lands which were left with a reasonable supply of seed from standing trees. We know in a general way that a comparatively small number of trees above perhaps ten or twelve inches left on every acre will result in the natural reforestation of most pine lands. Any more definite information we lack, but you may be sure that we are investigating the matter. That is, we are investigating it in the pine types, although we lack the funds for even most preliminary research in the thirty million acres of hardwood lands we have in our territory. But the scene of desolation which I showed you first cannot be changed to a state of productivity through natural reforestation. Where

land is without seed trees we must resort to artificial reforestation. Here are some scenes in our experimental nursery beds, which will indicate that we are giving some attention to the problem of reforesting artificially the ten million acres of utterly denuded pine land in the South.

If all of our forest land in the South is not at work growing trees, why isn't it? The first and overwhelmingly important factor in the idleness of forest land is fire. In the next few slides are shown the destructive effect of typical fires. Because the fires which annually burn over millions of acres in those Southern States are still without fire protective systems are not spectacular, and appear to destroy only useless grass and brush, we forget that they are killing the seedling trees which must succeed the mature timber. It is surprising how ignorant even those who live in the country are of the destructive effects of these fires. In order to convince people of what fires will do, we have had under observation, on what we call permanent sample plots, certain areas of young timber, a portion of which is burnt at each of the four seasons, and compared with other portions which are kept "rough." Not only do we have record of the actual death rate among the weaker trees, but we also will know from careful measurements the loss in growth represented by the stunting of the trees which survive.

Other factors in the failure of our cut-over lands to reproduce, and to grow the volume of wood which they should, are grazing animals, insects, and disease. The picture shows the familiar razorback hog, to the building of whose lank carcass thousands of young longleaf pines have contributed. Insects, to a degree which we had not suspected from casual observation, have destroyed the forests of the South, both young and old. Disease, or as we commonly speak of it, rot, gnaws at the vitals of trees which might otherwise produce good solid wood. Although fires are more frequent in pine lands than in hardwood lands, competent authorities have estimated that 90 per cent of the rot in Southern hardwoods may be traced indirectly to fires. Finally, among the major enemies of the future forests of the South may be listed reckless and wasteful turpentine methods. Understand that the turpentineing of trees, even

young trees, is not necessarily an economic crime, any more than the practice of using young spruce for Christmas trees can be classed as such. If land can be made to produce a greater cash return to the acre when a crop of Christmas trees is raised on it in ten or fifteen years, the foresters can see no reason why the owner should be required to raise pulpwood on it in forty or fifty years. By the same reasoning we do not object to the chipping of young trees for turpentine and rosin, provided the operation really pays for itself, and provided the work is not so done as to kill the young trees and prevent their coming to maturity as crossties or sawlogs. That trees may be chipped without fatal results, and at only a moderate sacrifice in growth, we are finding in our own experiments at a branch station in Florida. Here are some scenes in this small orchard of ours, in which we are also testing the actual amount of gum produced by trees of different sizes. If smaller trees are shown to produce so little gum as not to return the costs of working, we think that the knowledge will automatically result in the abandonment of turpentine of small stuff.

Provided protection is given the trees against various destructive agencies, our Southern timber grows with amazing rapidity. The Experiment Station, in cooperation with a number of other agencies, has recently completed a study of the rate of growth of our Southern pines from Virginia to Texas, and is almost ready to announce the results through a bulletin. We have gone far enough to be sure that the growth of these pines, particularly in the first thirty years, is surpassed by very few species of trees in America. The only two trees which we are certain will grow faster than loblolly and slash pines are the redwood of the West and our own Southern cottonwood. In general, this study shows that pulpwood can be produced in from fifteen to twenty-five years, and sawlogs in from thirty to fifty years. Taken in conjunction with the areas which we have down here suitable to the growth of the Southern pines, this is extraordinary growth, and the basis of our production that the South can produce from one-fourth to one-third of the nation's wood under intensive forestry. It should be remembered that the figures given are for natural stands, which have never had the benefit of any care, and scarcely any fire protec-

tion, beyond the period necessary to render them resistant to winter fires. We have also made a preliminary study of tupelo gum in the Atchafalaya River Basin of Louisiana, which, as the slide shows, grows extremely thriftily.

Just how much faster Southern trees may be made to grow as a result of thinning and similar cultural measures we are only beginning to learn. Some work began by the Forest Service at Urania, Louisiana, ten years ago shows that we can raise very much more valuable material, and in a shorter time, by removing from the stand at intervals such of the trees as are crowding their more desirable neighbors without hope of developing into valuable trees themselves, than we can in natural stands. It has only recently appeared from studies made by the Madison Laboratory that judicious thinning at the right time in the development of a young stand will produce wood of greater strength than that found in unthinned stands. Trees whose early rate of growth is maintained or increased have been found to have a heavier wood, which means a stronger wood, than trees which grew rapidly in their youth, but later fell off in growth. Thus thinnings will not only increase the average size of the tree, but will maintain or increase its strength.

In view of the ease with which we believe we can reproduce the Southern forests, the progress which seems possible to make in the control of their enemies, and the rate at which they grow, it would seem that every owner of forest land would lose no time in raising a second crop. But in spite of favorable natural conditions, the business of timber growing in the South faces the same economic obstacles that it faces in other parts of the country. Chief among these is the lack of immediate returns; this means that large amounts of capital are necessary to invest at the beginning of the enterprise. To meet this situation in part it has been proposed that timber raising be combined with stock raising on certain of our Southern lands. In order to determine the feasibility of this combination we have undertaken an experiment which the slide illustrates. If it should prove that livestock, or at least cattle, can be raised on cut-over pine lands up to the time that they begin to produce valuable

wood, current revenues will be always available, and we will have removed one of our chief obstacles to forestry. In the same experiment we expect to learn the truth in the long controversy we have had with the stockmen over burning the range. Probably 75 per cent of the fires in the South are caused by stockmen in the honest belief that it improves the range. Every indication at present is that the fire is just as detrimental to grazing as to forestry, but until we are sure of it through experimentation we can make no public announcement.

Other economic obstacles to forestry are taxes, and the lack of markets for our smaller trees. Progress already made by two Southern States, one of them Louisiana, in the matter of taxation of forest lands we hope will be emulated in other States. A nation-wide study of taxation will be undertaken this winter by the Office of Economics of the Forest Service, and should result in putting us in possession of much information necessary to tax reform. As for markets, an ever-increasing population, and the upbuilding of a great industrial system in the South, of which we see many signs, are solving the problem for us. Already in North Carolina and Virginia, just a little to the north of us, second-growth trees of all sizes down to six inches in diameter are being utilized at a profit in numerous ways. The need for more trees is so apparent that landowner after landowner in the South is going into the business of raising them. It is the task of the Forest Experiment Station to evolve and teach the most successful methods of growing more trees.

MINUTES OF MEETINGS AND BUSINESS OF THE SOCIETY.

Regular Meeting of Board of Direction, October 12, 1925.

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

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

Letter of October 8th from the Editor of the Proceedings was read and after contents were carefully noted it was voted that no further action be taken at this time toward readjustment of the subscription price of the Proceedings, and the letter was ordered filed.

Communication was read from Professor Steinmayer in regard to the re-establishment of a Geological Survey in the State of Louisiana. Professor Steinmayer appeared before the Board as requested and after he had given an explanation of the needs for the re-establishment of the Geological Survey, on motion duly seconded, it was voted that the President of the Society be authorized to appoint a committee of not to exceed three persons, from the Society to look into the matter and submit report with necessary resolutions at the November meeting of the Society. Action on the resolutions to be considered then. The following committee was subsequently appointed in accordance with the foregoing: Professor R. A. Steinmayer, Chairman; Major Frank T. Payne, Mr. Alfred F. Theard.

There being no further business the meeting adjourned.

F. A. MUTH, Secretary.

Regular Meeting of the Society, October 12, 1925.

The meeting was called to order with President Garsaud in the chair, F. A. Muth, Secretary, and forty members and guests were present.

The minutes of the previous meeting were read and approved.

The technical exercises of the evening consisted of a most interesting and helpful Symposium on Highway Engineering, participated in as follows:

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

"Maintenance of Highway 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 Professor John H. Bateman, Louisiana State Highway Commission.

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

These papers were followed with interesting discussions which were enjoyed by all. A rising vote of thanks was then tendered the speakers, three of whom had come from Baton Rouge to present their addresses.

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

F. A. MUTH, Secretary.

Regular Meeting of Board of Direction, November 9, 1925.

The following members were present: Messrs. Garsaud, Moses and Muth, but in view of the fact there was not a quorum no business was transacted.

The meeting then adjourned.

F. A. MUTH, Secretary.

Regular Meeting of the Society, November 9, 1925.

The meeting was called to order with President Garsaud in the chair, F. A. Muth, Secretary, and present twenty-nine members and guests.

The minutes of the previous meeting were read and approved.

Letter of November 5th from Professor John H. Bateman was read relative to formation of an engineering society or club in Baton Rouge which might become a local branch of the Louisiana Engineering Society.

On motion duly seconded it was voted to refer the matter to the Board with power to act and the Secretary was instructed to so notify Professor Bateman.

The matter of including a clause in the new Building Code to cover the requirements for signing of drawings by civil engineers registered under the laws of the State of Louisiana for structural engineering features, etc., was brought up.

On motion duly seconded it was voted to authorize the engineering members of the Advisory Committee to draft a suitable clause or clauses to that effect.

The Society then listened to an interesting paper on "What We Don't Know About Our Southern Trees," by Mr. R. D. Forbes, Director, Southern Forest Experiment Station, New Orleans. The paper was illustrated with many slides. An interesting discussion followed. A rising vote of thanks was then tendered the speaker.

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

F. A. MUTH, Secretary.