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THE EQUIPMENT OF THE ARMY, in the late war, is reported upon by Quartermaster-General M. I. Ludington. In 3½ months an army of 275,000 men was uniformed, armed and equipped with supplies, and an army of 16,000 men was sent to Cuba. In the war period the animals purchased cost $3,871,690; wagons and harness cost $358,449, and 83,078 tons of coal were purchased. The movement of troops by rail aggregated 17,863 officers and 435,569 men. The department chartered on the Atlantic coast, to June 30, 43 vessels, with a total of 104,201 tons and these had a carrying capacity of 1,287 officers, 22,335 men, 6,746 animals, and the arms, ammunition and camp subsistence and medical supplies; four water-boats, of a total capacity of 820,000 gallons, tugs and barges were added to this fleet. On the Pacific coast 14 ships were chartered, aggregating 41,152 tons, capable of carrying 629 officers and 13,059 men, and their stores. These vessels cost $186,632 for fitting up; and there was paid for the service of these ships $1,007,952 on the Atlantic side, and $319,764 on the Pacific side. After June 30, other vessels were chartered or purchased, increasing the total tonnage to 111,099 tons, and the carrying capacity to 25,000 men on the Atlantic; and to 61,287 tons and 20,000 men on the Pacific. Fourteen ships, aggregating 61,298 tons, were purchased for $5,431,000; including other vessels and lighters bought, the aggregate expenditure on this account was $6,476,300.

MEDICAL STATISTICS OF THE AMERICAN-SPANISH War, as reported by the Surgeon-General of the U. S. Army, stand as follows: From May to September, inclusive, and representing an army of 167,168 men, there were reported in full 1,715 deaths. Of this number 640 were due to typhoid fever; 97 to malarial fevers, and 363 to diarrhœa and dysentery. The death-rates of May and June—.46 and .70, were not in excess of those of the army in peace times; in July the rate reached 2.15 for the month, or 25.80 per 1,000, which does not much exceed that of well cared for cities. But in August the rate became excessive, or 4.08 per month, or 48.96 per 1,000 per year. In September the conditions improved and the death-rate fell to 2.45, or 29.40 per year. The records of the Civil War show that a high death-rate in August was generally continued for months after, and Dr. Sternberg ascribes the improvement noted in September to the stricter sanitary measures adopted.

THE FIRST VOLUNTEER REGIMENT of Engineers, largely made up of men from New York, arrived from Porto Rico, on the S. S. "Minnewaska," on Nov. 24. In Porto leading to it, at Guanica; it rebuilt many masonry bridges on the military road between Ponce and Albonito, destroyed by the Spaniards; built an ice-making plant at Ponce, and also a water-works system, and did other work of similar character.

FIFTEEN NEW WARSHIPS are asked for by Secretary of the Navy Long, in his annual report. These are classified as follows: Three sea-going battleships of about 13,500 tons trial displacement, estimated at $3,600,000 each, exclusive of guns and armor; three armored cruisers of 12,000 tons trial displacement, estimated at $4,000,000 each, exclusive of guns and armor; three protected cruisers of 6,000 tons trial displacement, estimated at $2,120,000 each, without guns or armor, and six cruisers of 2,500 tons trial displacement, estimated at $1,141,800 each, exclusive of armor and armament. This fleet would cost over $36,000,000. The Secretary deems these vessels necessary, and he asks that construction be commenced at once. He also recommends to Congress the revival of the grades of Admiral and Vice-Admiral; a new system of rewarding merit and conspicuous service by naval officers; the amalgamation of the line and the engineering staff of the navy; the transfer of all military transport service from the War to the Navy Department; the encouragement of a national naval reserve maintained by federal appropriations; and the addition of 99 officers in the new line of the navy. Of the $29,973,274 appropriated to the Navy, out of the national defense fund, $618,447 remains unexpended. The maximum fighting force of the navy at the close of the war was 196 vessels of all kinds, manned by 24,132 men. The total naval casualties during the war were 17 men killed and 84 wounded; of the latter, 54 went back to duty, and one died of his wounds.

CRUISERS OF MODERATE TONNAGE, with great speed, many guns, but no armor, promise to be a favorite warship of the future. As a direct result of the lessons gained from the Santiago fight, Russia is said to have ordered several 3,000-ton ships with 25-knot speed and heavy guns; and England is reported to be building five 3,000-ton cruisers with 25-knot speeds. The Russian Vice-Admiral Makoroff, head of the navy department, is reported as saying that the Spanish cruisers were provided with well-placed heavy armor, but it could not avert their destruction; they lost the battle because they were lacking in gunners and in guns. Admiral Makoroff argues that with given great speed and heavy armament, four 3,000-ton unarmored cruisers are more advantageous in war than one 15,000-ton ship.

THE FOUR NEW MONITORS, according to plans finally adopted by the Naval Construction Board, on Nov. 23, are to have single turrets, with two 12-in. guns, as originally planned; but will be lengthened 27 ft., giving an added displacement sufficient to permit bunker capacity for 200 tons more of coal. The contractors have agreed to lengthen the vessels for the sum of 103,145 in addition to the original contract price.

THE SHELLS USED BY THE UNITED STATES NAVY, the guns for firing them and the powder charges in each case, are given in the following table:

	Shells.				Guns			Total
Designation.	Diameter, ins.	Wght, lbs.	Length in ins.	Ch'rge contain'd, lbs.	Wght, lbs.-tons.	Lgth in ft.	Firing chrg, lbs.	cost of firing once.
1-pdr.	1⅜	1	3⅝	200*	100	5	...	$1.12
3-pdr.	1⅞	3	6¼	900*	500	7	...	.....
6-pdr.	2 3/16	6	8⅝	1,400*	920	9	...	5.70
4-in.	4	33	12¼	2	1¼	14	14	....
5-in.	5	50	16⅜	3	3¼	17	30	33.00
6-in.	6	100	20⅜	4½	6	21	50	40.00
8-in.	8	250	22⅝	11	15	29	115	65.00
10-in.	10	500	30	20	28	31	240	....
12-in.	12	850	36	40	45	37	425	....
13-in.	13	1,100	42	50	60	40	550	296.00

*Grains.
Note.—For 13-in. armor-piercing projectiles the total cost of firing is $588.00.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred, Nov. 27, on the Boston & Maine R.R., near South Berwick, Me., in which the engineer and fireman of a snow-plow engine lost their lives. The plow was being pushed through the heavy snow when it suddenly left the track. The engine followed, going down an embankment and burying the engine crew in the wreck.

A BOILER OF A RIVER STEAMER EXPLODED near Stockton, Cal., on Nov. 27, killing 6 men and injuring 10 others.

SOME AMMUNITION EXPLODED in a house in Havana, Cuba, on Nov. 28, killing or seriously injuring 38 persons. The house contained a considerable quantity of powder, and five rooms filled with obsolete types of cartridges. Those injured were engaged in emptying the cartridges, the intention being to sell the powder.

A LARGE ICE-BREAKER, for use on the Baltic Sea, has been launched in England for the Russian government. The vessel has a bow-propeller, to assist in breaking the ice, and the stern is provided with a recess in which the bow of a ship to be towed can be lashed. This boat is built for the purpose of attempting to keep traffic moving in the Baltic in winter; and besides convoying merchant ships, the breaker can itself carry a large cargo.

ANOTHER OLD CANAL IS TO BE ABANDONED. The Pennsylvania Canal Co., controlled by the Pennsylvania R. R. Co., announces that the consent of the legislature will be asked to the abandonment of the Juniata Division, extending up the Juniata Valley from its junction with the Susquehanna to Newton Hamilton. The entire system of the Pennsylvania Canal Co., 248 miles in extent, carried 250,526 tons in 1897, and earned $59,662. Its operating expenses were $58,405, and the charges for interest and taxes were $151,022. The section which is to be abandoned is a part of the famous old Pennsylvania state canal system and was originally a link in the through line of transportation from Philadelphia to Pittsburg in connection with the old Portage Railroad over the Alleghenies. It was sold by the state to the Pennsylvania R. R. Co. in 1857.

THE PORT ARTHUR CANAL CHANNEL & DOCK CO., says a Beaumont, Tex., item, has received a favorable decision in the Supreme Court of Texas in the injunction suit brought by the property holders near Port Arthur. The decision is claimed to remove all objections to the completion of the ship-canal now under construction, with 4½ miles practically finished. The right to condemn land, under the canal company's charter, was questioned and an injunction was granted by a Jefferson county court.

THE PASS-A-LOUTRE CREVASSE, at the mouth of the Mississippi River, was closed on Nov. 13 by the contractors, Stewart & Co., of St. Louis, after one year's very hard work. The work done was to sheet-pile a length of 7,000 ft. across the Pass. The work was accepted by the U. S. Engineers, and on the next day, a heavy storm caused two breaks—of 102 ft. and 68 ft., respectively—in the eastern wing of the sheet-piling. The loss, amounting to about $8,000, will fall upon the government, but it would have little effect upon the general purpose of the work if these breaks were never closed, as the main body of water is now diverted into the Southwest Pass. The sum of $250,000 was appropriated for the repairs at Pass-a-Loutre; of this sum $195,000 was paid to Stewart & Co., $10,000 was used in surveys of the Southwest Pass, and the balance was practically consumed in incidental expenses. Another appropriation from Congress will thus be needed to close the last breaks.

THE NEW YORK ANTI-TICKET SCALPING law has been declared unconstitutional by the Court of Appeals of that state, which has just handed down a decision in the test case brought by a New York city scalper shortly after the law went into force in 1897. The court's decision is based on an opinion written by Chief Justice Parker, and the court stood four to three in declaring the law unconstitutional. In his opinion Judge Parker says:

The provisions of the statute in question have reference to the selling of valid tickets, regularly issued by a transportation company. Can the legislature declare such sales to be fraudulent or prohibit them on the ground that it tends to prevent fraud? It is not contended that the business of ticket brokerage is in itself of a fraudulent character. The business can be honestly conducted, and the most that is asserted is that there are some men engaged in the business who have imposed on the public. The same assertion can be made with equal truth of every business, trade and profession. The real motive for the enactment of this law, it is suggested, is to enable transportation companies to keep others with which they may enter into pooling arrangements from secret violation, which is frequently the outcome under the present ticket brokerage system. The granting of monopolies or the exclusive privilege to corporations or persons has been regarded as an invasion of the rights of others to follow a lawful calling and an infringement of personal liberty from the times of the reigns of Elizabeth and James. Argument certainly is not needed in the light of decisions of this court to support the assertion that the "liberty" of this relator (Tyroler) and other citizens of this state to engage in the business of brokerage on passage tickets is sought to be interfered with by the state under consideration: for brokerage in such tickets has been a lawful business for many years. The statute is in contravention of the state constitution, and is void unless its enactment by the legislature constituted a valid exercise of the police power.

As stated the anti-ticket scalping law was passed in 1897, after a hard fight, the scalpers contesting its passage by the legislature at every step. The test case just decided was brought almost immediately after the law went into force. Ticket scalping meanwhile has gone on about as actively in New York city, at least, as before.

TWO NEW FAST EXPRESS TRAINS between New York and Washington, composed of observation, parlor, cafe, smoking and dining cars, the entire equipment being especially made for the service by the Pullman Company, have recently been put in operation by the Baltimore & Ohio R. R. The two trains will leave New York and Washington simultaneously at 3:30 p. m. each day, and they will be exact counterparts in every respect. The parlor cars are 70 ft. long and have 34 seats. They have wide vestibules with anti-telescoping device; empire decks, steam heat, Pintsch gas, air pressure water system, and all modern improvements. The observation, cafe and smoking car is of the same general exterior appearance as the parlor cars, except that the observation end is recessed with a deep platform. The full seating capacity of this car is 33 persons, including 14 chairs in the smoking compartment. All the cars are richly equipped and decorated, and the train will be called the "Royal Limited."

THE PLATINUM PRODUCTION OF RUSSIA, according to Mr. W. R. Holloway, U. S. Consul-General at St. Petersburg, for the year 1897, was over 95% of the entire amount mined in the world, or about 6 tons. Most of this came from the following mines:

Mines of	Count P. P. Shuvaloff	1 ton 396 lbs.
"	Count Demidov San Donato	1 ton 144 "
"	J. Burdakov & Sons..................	1,512 "
"	Kolly.	1,404 "
"	Andreieff heirs	1,188 "
"	Koenigsberger	1,008 "
"	P. A. Konukhoff	792 "
"	19 small proprietors	1,620 "

EARTH SLIPS ON THE JORDAN LEVEL MARL BEDS OF THE ERIE CANAL.

By Geo. A. Morris.*

Beginning at Otisco or Nine Mile Creek, the Erie Canal for about four miles west runs through low, swampy land, comparatively level and about at the elevation of the present tow-path, making the canal a through cut, 11 ft. deep. At the surface the formation is a covering of muck, and below is

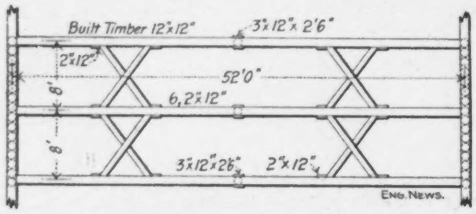

Fig. 1.—Original Method of X-Bracing Struts Across Canal Prism Through Jordan Level Marl Beds.

found marl over a soft clay, then a cemented gravel. The marl is generally near the surface, but the cemented gravel varies from 2 ft. below surface to 65 ft. below. The valley is narrower at the eastern end (about one-half mile) and widens out on the north side of the canal to about 1½ miles. The old canal followed the foot hills on the south, but on the enlargement the alinement was changed to make long tangents. During the construction of the enlargement three firms of contractors were compelled to abandon their contracts, because of earth slips caused by the subsidence of the marl beds, and the work was finally completed by the State under force account, and after many difficulties had been overcome.

The stratum of marl is of varying thickness, the limit being about 15 ft. The following table gives the elevation of the top of the marl as actually shown from cross-section notes, datum being 1 ft. below the new canal bottom.

Station 208 = + 10	Station 240 = + 6	Station 410 = + 10
Station 220 = + 12	Station 368 = + 10	Station 420 = + 8
Station 238 = + 14	Station 380 = + 13	

The marl and clay can be readily handled when dry, but when wet the mixture weighs from 80 to 83 lbs. per cu. ft. An excellent quality of Portland cement is made from equal parts of marl and clay by the semi-humid process. The "Engineering Record" of July 16, 1898, has the following analysis of this material as it is used by the Empire Portland Cement Co.:

	Per cent. Marl.	Per cent. Clay.		Per cent. Marl.	Per cent. Clay.
$Si\ O_2$	0.26	40.48	$Mg\ O\ Co_2$	0.38	0.99
$Al_2\ O_3,\ Fe_2\ O_3$	0.10	20.95	Loss, ignition.	4.64	8.50
$Ca\ O\ Co_2$	94.39	25.80			

As the elevation of surface of the water during navigation is 2 ft. lower than the tow-path and the latter is about on the level of the swamp, the canal necessarily had to take all the drainage. When the contractors commenced to excavate in the prism they built coffer-dams across the channel at short intervals and diked the sides, then used powerful steam pumps to drain their work. When the pressure from the sides was removed, the pressure from above would raise the material in the bottom (similar to squeezing paint from a paint tube) and it was soon discovered that more material was being removed than was shown on the cross-sections and that the slope walls were sliding into the canal and that the berme and tow-path banks were settling. Immediately it became necessary to devise means for stopping the sides and to confine the material. Various plans were suggested, but they all carried a considerable expense with them. Different methods that were economical in design were tried, each taking time to try the experiment. Piles were driven 8 ft. c. to c. with waling piece and sheet piling, then 4 ft. c. to c., then a close row of piles, but the piles would not enter into the cemented gravel, and as the material had become thoroughly saturated, they would lean over into the canal and occasionally would pop up out of the ground (Fig. 4). It was finally decided to abandon the attempt for that season and to drive a close row of piles during the season of navigation, then when the water was drawn in the fall, to put on a waling piece to start the slope on, and to build only a short stretch at a time. This course was adopted. The piles were driven during the summer, but as the piles did not penetrate into the cemented gravel, and the material around the piles was in solution, it was soon discovered that we would have to resort to an original and expensive plan and place struts across the canal, as shown in the accompanying plans. We found that the method of X-bracing (Fig. 1) was expensive and that the brace at right angles to the strut (Fig. 2) would answer. The latter was adopted. The plan as finally adopted proved very successful and was used for 3,700 ft. of canal in one place and 500 ft. in another.

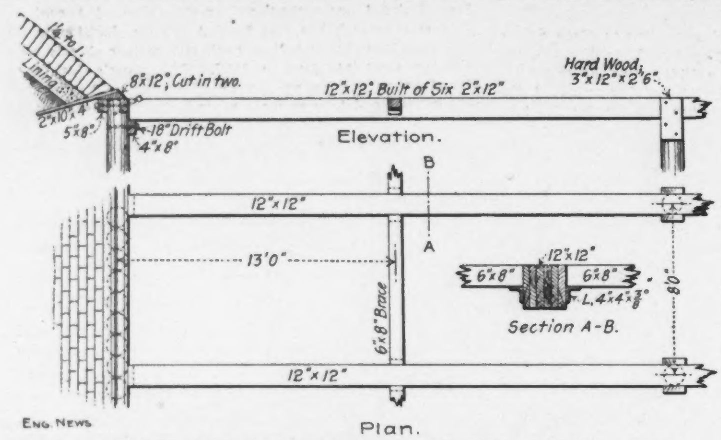

FIG. 2.—ADOPTED METHOD OF BRACING STRUTS ACROSS CANAL PRISM THROUGH JORDAN LEVEL MARL BEDS.

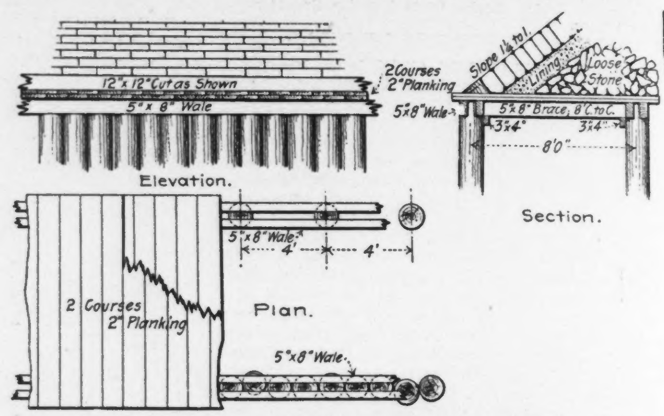

FIG. 3.—METHOD OF UNDERPINNING SLOPE WALL THROUGH JORDAN LEVEL MARL BEDS.

The greatest difficulty was encountered between Stations 370 and 410, and occupied our attention during both closed seasons, but during the first season the adjoining swamps were full of water. During the season of 1898 a drainage ditch was made on both sides of the canal, emptying into Nine Mile Creek at the east end and White Bottom Creek at the west end. This ditch took all surface drainage, so that the only water in the canal was from percolation, which was considerable. Because of this drainage ditch about two miles of slope wall was built on both sides of the canal without using struts, but with only a close row of piles with a waling piece to start the wall upon (Fig. 3). This portion had formerly caused the most trouble and cost the most to build, and we had anticipated that it would be the most difficult to handle. But inside of two months the prism was excavated to grade and two miles of full depth wall built on both sides. This work was prosecuted by digging the excavation trench for the waling piece, putting the waling piece in place, and building the wall ahead of the prism excavation. Another advantage this work had in its favor was that it was done in the latter part of March, April, and the first of May.

The difficulties encountered on this section of the canal were so many and varied, that it is difficult to describe them in general, for the reason that until the struts were used all we had done proved unsuccessful in the aggregate, although quite a number of the plans used proved successful under certain conditions. A severe cold winter, instead of a very mild one, would probably have eliminated any of the difficulties, and the work would have been done wihout any additional cost or without any one being aware that there was a suspicion of what actually did occur.

In one of the photographs sent with this article (the photograph is too dim for engraving.—Ed.) is shown a pile with the head very near to the bottom of a 30 ft. pile-driver. The piles used for a long distance either side of this point were 42 ft. long. In describing the driving of this pile, I will state that what is true of this one is also true of all the others. When this pile was raised the head was 12 ft. or more above the top of the leads. As soon as the fastenings were removed, the pile settled with its own weight into the marl until its head was below the top of the leads. A small rope was fastened to the pile and two men pulled it down to where the hammer could be placed upon it, and with simply the weight of the hammer it settled to where it is shown in the photograph. A light blow drove it to the cemented gravel layer. There was a crust a few inches thick over this layer which the pile could be driven through, but which then became so hard that great care had to be taken not to hit the pile too heavy a blow, as it was liable to break it, or throw it out of line, and a pile out of line could not be forced back. The only remedy was to pull it and redrive it. Some of the piles that were driven to resistance have lifted to the extent of 8 or 10 ft., as shown by Fig. 4, which also shows how they would move bodily into the canal. Just

Fig. 4.—View Showing Manner in which Piles Rose and Tipped After Driving, Jordan Level Marl Beds.

before the opening of navigation in 1897, the tow-path in stretches from 500 ft. to 1,500 ft. in length settled anywhere from 2 ft. to 8 ft., and in all cases where it broke away from the main land it was a vertical fracture.

At Newport Bridge we encountered a difficult

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problem in rebuilding the abutments, vertical wall on tow-path side and slope wall on berme. Before the bottom courses of the old abutment on the berme had been removed in winter of 1896-'97, great fissures were discovered running either side of the excavation. We removed all of the excavated material from the bank and drove piles at the foot of the slope wall, but the fissures extended and the banks began to settle, the wall sliding toward the canal and pushing the piles we had driven with it. Great cracks exhibited themselves in the foundation to Dwyer's Hotel. We drove piles 50 ft. long as near to the hotel as the pile-driver could approach it, but they moved bodily toward the canal.

Under the foundation to the berme abutment piles 57 ft. long were driven with two courses of 12 x 12-in. hemlock foundation timbers securely fastened on them. On this the masonry was built. Cinders were used as back filling. When the back filling was about half completed the abutment moved bodily into the canal about 3 ft. and settled about 6 ins. It is supposed that the bottom of the piles remained stationary, and that the tops leaned all together, as the abutment did not move on the timber foundation and did not get out of line. As the bridge was in place when the abutment moved, the parapet walls on both abutments were destroyed. We immediately put four struts across the canal between the foundation of the berme abutment and the vertical wall on the tow-path side and below canal bottom. These struts remained until this spring.

The slope wall, however, kept sliding into the canal and finally laid flat. Two close rows of piles were driven 6 ft. apart, capped and floored with two courses of 3-in. plank, to make a foundation to start the wall. The embankment to build the wall upon was made of loose stone and coarse gravel from 4 ft. to 16 ft. back. Even with this precaution the wall would settle in one place and push out in another, and was rebuilt the second time in March and April, 1897, and in December about 300 ft. of the upper 4 or 5 ft. had to be relaid.

The vertical wall on the tow-path side kept settling all summer, and notices had to be put up cautioning the boats to keep on the berme, as the wall as it settled on top would raise on the bottom. In order to maintain the tow-path the contractors kept adding stringers and filling in with cinders during the whole season of navigation. In Fig. 5 it will be seen how much the wall settled below the tow-path. It was, of course, necessary to rebuild this piece of wall. Great vertical fissures developed running parallel to the tow-path, which kept growing wider, and the ground for 150 ft. each side of the bridge settled, in some places 2 ft., for 30 ft. back. We began the foundation and wall at the point furthest away from the bridge and worked toward it, meeting under the strut. Struts were used across and under the canal between the foundations of the vertical and slope walls, and between abutment and vertical wall.

The cost of this work is, of course, known, but whether it would benefit the public or not is a question not easily answered. The contract prices were used in paying for everything that could be measured. As there was no known way of ascertaining the amount of excavation, it had to be done under a force account. The cost of redriving piles, rebuilding foundations and walls, rehandling of all kinds of material, building runways and coffer-dams, keeping ditches open, and the many other items too numerous to mention or remember, all went toward the aggregate cost. The contract prices were reasonable, being as follows:

Excavation, cts., per cu. yd.	27½
Embankment, cts., per cu. yd.	30
Lining, per cu. yd.	$1 00
Piles, delivered and driven, cts., per lin. ft.	18 to 25
Hemlock timber, per M. ft., B. M.	$16.00
Spruce timber, per M. ft. B. M.	$17 00
Bridge abutment masonry, per cu. yd.	$7.00
Vertical wall in Portland cement, per cu. yd.	$[illegible].00
Slope wall, per sq. yd.	$2.47
Portland cement concrete, per cu. yd.	$5.00

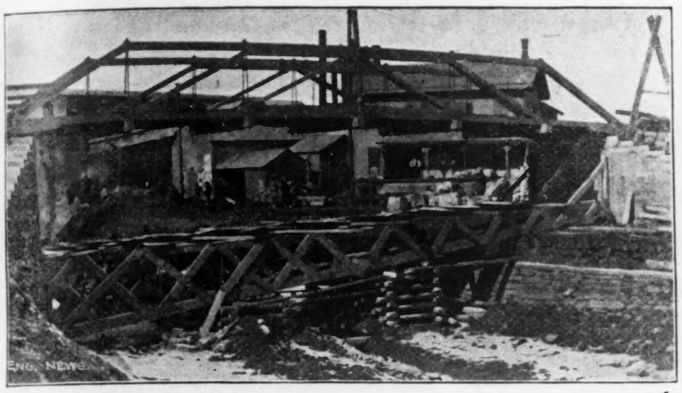


FIG. 5.—VIEW SHOWING SINKING OF VERTICAL WALL AND MANNER OF BRACING BRIDGE ABUTMENTS TO PREVENT SLIDING.

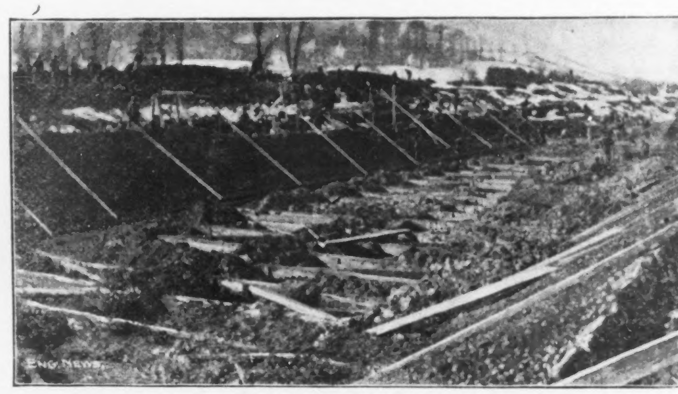


FIG. 6.—VIEW OF CANAL PRISM, SHOWING BOTTOM BRACES IN PLACE AND SLOPE WALLS UNDER CONSTRUCTION.

There was a deduction for all material found in the work that could be used. Mr. M. B. Palmer, of Clinton, N. Y., was the Assistant Engineer in charge of the work for about a year, and then Mr. Wm. B. Landreth, M. Am. Soc. C. E., of Cortland, N. Y., was in charge for nine months, or until the contract was completed.

COMPOUND ENGINE IN THE POWER-HOUSE OF THE BUDAPEST ELECTRIC RAILWAY.

(With full-page plate.)

The stationary engine illustrated in our insert sheet is one of three which are in use in Budapest, Hungary, in the power-house which furnishes current to the electric street railways and the underground railway. It was designed and built by L. Lang, of Budapest. The "Zeitschrift der Vereines Deutscher Ingenieure," from which we reproduce our cut gives a very brief description of the engine, from which we take the following:

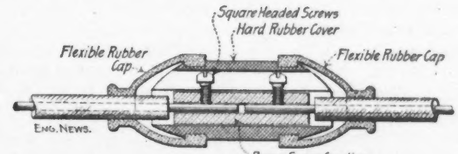
The engine has its cylinders arranged on the Collmann system, which affects the balancing of the reciprocating parts, the two cranks being set at 180°. A vertical engine of similar construction was in operation at the Electro-Technical Exhibition at Frankfort in 1891. The diameters of the cylinders are 18 and 32 ins., the stroke is 33 ins. The normal speed is 135 revolutions per minute; this number can be varied 6% either way. The high pressure cylinder is fitted with the Collmann valve gear.

An inspection of the cut shows that this engine possesses many features that are quite novel to most American readers. Among them we notice especially the following: The fly-wheel is "dished" like a cart wheel, apparently with the object of getting its center of gravity closer to the bearing than is the case with the common wheel. The cylinders are placed neither tandem nor alongside, but in echelon, the high pressure cylinder being both forward of the low pressure cylinder and alongside of the piston-rod of the latter. With the cranks at 180° this arrangement is more compact than the cross-compound plan, at the same time making it possible to balance the reciprocating forces and to divide the work between two cranks, which cannot be done with the ordinary tandem engine, although it is very successfully done with the Wells balanced compound engine, which has two tandem cylinders, the low pressure piston having two piston rods, the high pressure cylinder lying between them. The valves on the high pressure cylinder are of the poppet valve type, controlled by a fly-ball governor, and multiported slide valves are used on the low pressure cylinder. Each cylinder has four valves, and all the valves are driven from eccentrics carried by a secondary shaft, which is driven by a miter-gear from the main shaft.

While the engine is no doubt well designed, and embodies many good ideas, it is likely to impress an American engine builder as being very complex and costly for a moderate sized stationary engine, only 18 and 32 ins. x 23 ins. stroke, and he will probably doubt the need of balancing such an engine, as to its reciprocating parts, when it is run at a piston speed of only 518 ft. per minute.

A HANDY INSULATOR FOR JOINTS IN WIRE.

We illustrate herewith a novelty in the way of an insulator for use in connection with railway motors, or in fact wherever the common brass sleeve screw coupling is used to splice wires. At present whenever a motor is removed from the truck, for repair or any other purpose, the insulating tape which has previously been carefully wound about these screw couplings has to be cut and thrown away. This entails the use of new tape, and as there are from four to six such connections for each motor, the time consumed is also quite an item. The device here illustrated consists of a tube oval in section, composed of semi-hard rubber, which is slipped over the screw coupling, and two flexible end caps which hug the



Longitudinal Section of the Osgood Insulating Cover for Screw-Coupled Wire Joints.
Methuen Electrical Co., Methuen, Mass., Makers.

wire and close down into grooves in the oval shell, as will be seen in the figure, thus making a sightly, safe and watertight joint which can be very quickly put on or removed, and can be used over and over again. The cost of this device is less than taping, and its advantages as a time saver will be only too apparent to those who have taped screw-coupled joints. This insulator is manufactured by the Methuen Electrical Co., Methuen, Mass.

THE NORTHEAST WATER TUNNEL AT CHICAGO was completed Nov. 21 by the contractors, Messrs. Fitz Simons & Connell. The land sections of the tunnel, known as the northwest land tunnel, are not yet completed, and there is litigation pending over this part of the work. The lake section will, however, probably be used during the winter, as the intake crib has been specially designed with a view to preventing trouble from ice.

RECENT IMPROVEMENTS IN CENTRIFUGAL PUMPS.

By J. Richards.*

The writer in 1896 was called upon to prepare designs of pumps for the great drainage plant, or plants, at New Orleans, and after a careful examination of the various means, other than centrifugal pumps, for raising and impelling large and variable volumes of water, came to the conclusion that the conditions, including the relative efficiency of different methods, made the use of centrifugal pumps preferable. This opinion was shared by Mr. Charles Brown, C. E., of Basle, Switzerland, who acted as my colleague, and who is, perhaps, the most eminent authority in such matters that can be referred to.

The power to impel the pumps at the various stations, scattered over the city and on the line of outfall, was in most cases to be transmitted by wires from a central power station and applied by electric motors, and therein arose a serious impediment in the adaptation of the speed of the pumps to that of the electric motors to drive them. A large number of motors were required, aggregating, as now remembered, over 7,000 HP., and the economic limitations of the speed or rate of revolution for the motors was such that the pumps had to be adapted accordingly.

As the proper circumferential speed of centrifugal pumps differs only in a slight degree from the velocity due to the head, being about 8.5 $\sqrt{H}$, in feet per second, and as the head in some cases was only a few feet, pumps constructed on the ordinary lines were out of the question. The impellers to produce the required speed became less in diameter than the suction pipes to convey the water at a velocity of 8 ft. per second.

This difficulty led to the adoption of the "Conoidal" system which it is the purpose of this article to explain. The name "conoidal" was applied by Hon. Henry H. Bates, of Washington, D. C., and relates especially to the impellers, as will be explained hereafter.

Reverting further to the designs of the pumps for the drainage works at New Orleans, these were prepared under the impression that the machinery could not be submerged. Fig. 1 represents a pump to raise 84 cu. ft. per second, or 37,800 gallons per minute under a head of 3 ft., the pump and motor making 125 revolutions per minute.

The drawing with the dimensions given make the construction so clear that no explanation is required except in respect to the impeller. This, it will be seen, is a double conoidal spindle, provided with the usual vanes. It is buoyant in the water to the extent of its displacement, which about equals its weight, thus relieving the pump shaft from the pressure due to the weight. It will also be seen that the conoidal form distributes the work equally over the width of the impeller from the inlet to the center, completely changing the course of all the water before it reaches the center. To provide against any possible lateral disturbance around the impeller, a diaphragm (a) is introduced so that the two sides of the pump will operate independently and balance the thrust on the shaft.

The impeller is of the same diameter as the bore of the pipes, and the vanes have, in this case, no entering curves because the field of the water's revolution extends back into the suction pipes to some distance not yet determined by experiment. The discharge way was a rectangular parallelogram 66 by 24 ins., as shown in the drawing. The pump illustrated is of average size, many of them being larger.

After preparing the designs for the New Orleans draining plant, I proceeded to investigate this system of constructing centrifugal pumps, not only in respect to their being driven by electric motors, but for all purposes to which such pumps are applied. This investigation led to the development of tables for proportions so as to bring the design of the pumps as nearly as possible within an organized system of manufacture.

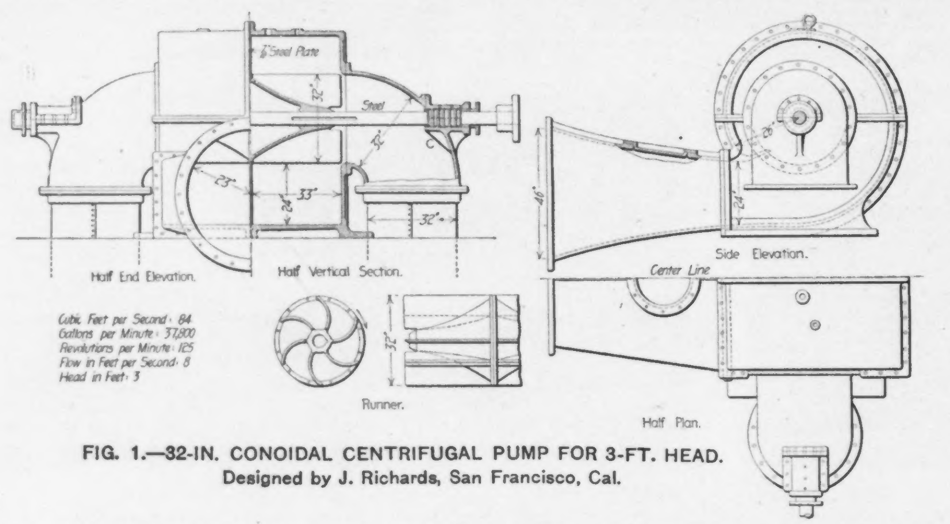


FIG. 1.—32-IN. CONOIDAL CENTRIFUGAL PUMP FOR 3-FT. HEAD.
Designed by J. Richards, San Francisco, Cal.

Fig. 2 is a drawing to scale of a conoidal pump of 10 ins. bore, or discharge, adapted to average conditions for heads from 10 to 50 ft., but as modification for the various heads is required in order to attain full efficiency, the tables referred to had not only to include constant dimensions and quantities, but also variations therefrom. The system is about to be subjected at San Francisco to regular trials for efficiency, the results of which will in due course be published. The letters on the drawing refer to tabulated dimensions.

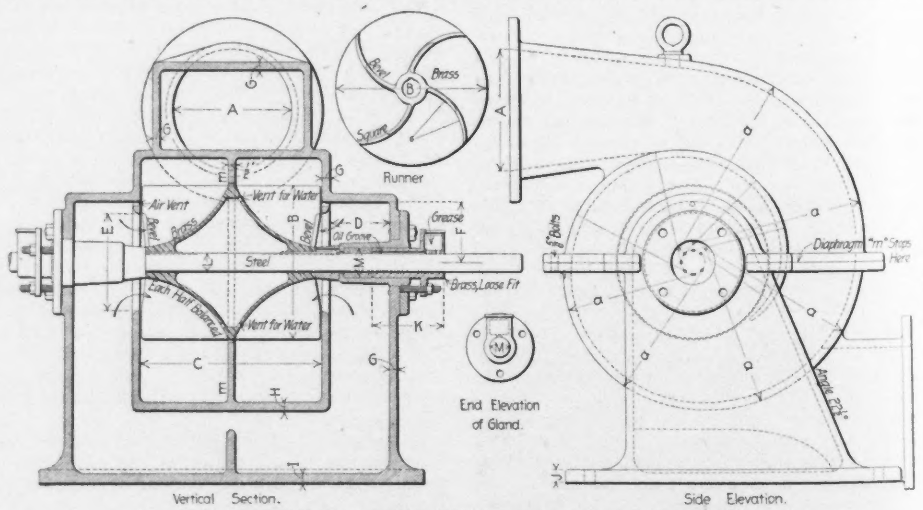


FIG. 2.—CONOIDAL PUMP FOR HEADS FROM 10 TO 50 FT.

Fig. 3 is an elevation of a conoidal centrifugal pump erected for pumping from a ditch or river, and gives the contour and appearance, which is quite uniform for pumps from 5 to 60 ins. bore.

The most important conditions in centrifugal pumping are the efficiency, endurance, and first cost, and as may be seen by examination of the drawings, the two last-named features have due recognition in the present system. Endurance can be inferred from construction, but the calculation of cost is more intricate. It may be explained from some rules of common application. For example: The relative dimensions, weight and cost of a rotative machine of almost any class or type, are inversely as the speed of revolution. The cost of centrifugal pumps is roughly as the square of their extreme dimensions; that is, a pump standing 6 ft. above its base will cost four times as much as one that measures 3 ft. above its base, and so on. By these rules it may be seen that the conoidal system will greatly diminish the cost of pumps for a given volume of water, because their dimensions are in most respects reduced inversely as the rate of rotation.

The technical features affecting efficiency could be discussed here, but as a good deal may be disclosed by experiment, this part of the subject will be laid over for a future article.

*22 California St., San Francisco, Cal.

THE GEOGRAPHIC WORK OF THE COAST AND GEODETIC SURVEY.

By John F. Hayford,* Assoc. M. Am. Soc. C. E.

(With full-page plate.)

The United States Coast Survey first became permanent in 1832, although the original act providing for a survey of the coast and making an appropriation for that purpose was passed in 1807. A formal reorganization took place in 1843. In it the plans for the survey which had been formulated and acted upon in former years by F. R. Hassler, the first Superintendent, were continued in force. The scientific organization of the Survey may, therefore, be properly said to date from 1832. The survey was to be made primarily for the benefit of commerce, was to extend twenty leagues from shore, and special observations were authorized even beyond that limit, as far as the Gulf Stream, when in the opinion of the President such observations might be especially valuable to the commercial interests of the United States.

In the course of time the Coast Survey proved to be an organization of such vigor, its results proved to be so uniformly trustworthy, and there were found among its officers men of such acknowledged ability, that the scope of its duties was gradually but steadily widened to include a great variety of operations allied in various ways to its original duty. Now, after a little more than a half century of activity, the Survey finds itself rendering more valuable benefits to commerce, by way of making the navigation of the coasts safe, than ever before; and also finds itself actively engaged in many other forms of geographic work.

The requirements of the original acts of organization of the Survey might, perhaps, be considered to be fulfilled when accurate charts of all parts of the coast had been made. This, the fundamental work of the Survey has been carried on vigorously and steadily. Commencing with a few of

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the more important regions on the Atlantic coast the work of chart making was gradually extended until the charts now cover (although the original surveys do not) every part of the Atlantic, Gulf and Pacific coasts of the United States, and a large portion of the Alaskan coast. From time to time, as the interests of commerce demanded, the surveys in certain special localities and important harbors have been repeated in greater detail, and the new information embodied in new charts—often of larger scale than before. Meanwhile the commercial interests involved have increased to such an extent that the demand for surveys for charting purposes is as great as ever, resurveys in greater detail in some regions and original surveys in regions where the charts now depend upon compiled data.

The Survey at present issues over 500 different charts and maps varying in scale and character according to the objects for which they are designed. Nearly all of them belong to one of four general classes, viz.; 1st, sailing charts, on a scale of 1-1,200,000, which exhibit the approaches to a large extent of coast, give the offshore soundings, and enable the navigator to identify his position as he approaches from the open sea; 2d, general charts of the coast, on scales of 1-400,000 and 1-200,000, intended especially for coastwise navigation, and showing the configuration of the shore, the positions of islands, rocks, and shoals, the light-houses, life-saving stations, and other natural and artificial landmarks; 3d, coast charts, on a scale of 1-80,000, by means of which the navigator is enabled to avail himself of the channels for entering the larger bays and harbors, and to recognize the beacons, buoys and light-houses by their distinctive features and positions; 4th, harbor charts, on large scales, intended to meet the needs of local navigation. The work of the Coast Survey is closely co-ordinated to that of the Light-House Board, and all changes in lights, beacons, or buoys, are promptly indicated upon the charts by correcting them up to date by hand entries at the last moment before they leave the office. The charts, except certain editions classed as preliminary, are printed at the Survey office from copper plates made by the Survey's corps of expert engravers. They will stand the closest scrutiny as to the accuracy and neatness of work upon them as well as to the reliability of the information which they furnish. That the mariner appreciates these charts is indicated by his demand in ordinary times for 25,000 of them per year, at a cost to him of about $11,000. Another 25,000 or more are distributed annually to various departments of the government and to libraries.

The Coast Survey charts are a reliable basis upon which to design proposed harbor improvements, and they have been extensively so used by the Corps of Engineers of the Army. In those cases in which one or more resurveys of a harbor have been made the charts are of unusual value in this connection, for the changes observed to have taken place in the intervals between surveys serve to indicate what changes must be guarded against in the future, and what favorable changes may be relied upon, and to indicate the probable effect of proposed structures upon depths in their vicinity.

The officers of the Survey have made accurate topographic surveys of 38,000 square miles, mainly in connection with the work of making charts.

In addition to the charts the Survey now issues the "Coast Pilot" in nine quarto volumes, and other volumes are now being prepared. The "Coast Pilots" are issued for the same purpose as the charts, to conduce to safety in navigation. They give, in elaborate detail, descriptions from the mariner's point of view of the coast, of the shores of harbors, of the character of available anchorages, and of the known dangers to navigation, together with sailing directions for entering harbors. The volumes are illustrated by views of portions of the coast which may serve as landmarks, and by portions of charts.

When considering the contributions of the Coast Survey to geographic science, it should be kept in mind that its charts and "Coast Pilots" are in the main the results of original surveys and observations, made by its own officers, the data compiled from other sources forming but a small proportion of the whole. These original surveys have, as a matter of course, brought to light hundreds of shoals, banks, sunken rocks and other dangers to navigation which were before unknown. In several cases they have also incidentally made known unsuspected safe channels for entering harbors. The main ship channel now used in entering New York harbor was discovered by a Coast Survey party during its regular operations at a time when a much poorer channel was in use and was supposed to be the best. A Coast Survey party operating at the mouth of the Yukon during the past summer discovered a new channel carrying a depth of 8 ft. across the bar at low water. This channel will save much time and distance, and a trans-shipment, for vessels of sufficiently light draft to use it.

A study of the tides forms an essential part of the work of charting a coast. Along this line the Coast Survey has been particularly active, both in taking observations and in making tidal predictions. Over one hundred stations have been occupied with self-recording continuous-record gages, and the total length of such record is equivalent to a continuous record for more than three hundred years at a single station. In addition to this, short series of readings have been taken from staff or box gages at 2,500 different stations. Based upon these observations upon our own coasts and upon the compiled results of observations upon foreign coasts, the Survey publishes annual volumes of tidal predictions for the whole world. The volume for 1899 shows the predicted time and height of every high and low water throughout the year for 24 stations in the United States and for 46 foreign stations. These primary predictions are based upon a harmonic analysis of records from self-recording gages. In those cases in former years in which the predictions have been carefully compared with the actual tides as subsequently observed, the discrepancies developed have been so small that it is probable that they were due almost entirely to meteorological causes. These primary predictions are extended to about 3,000 secondary stations, with various degrees of accuracy, by means of tidal differences and ratios derived from short series of observations at those stations.

The shores of the ocean, and the bottom near the shore, are continually being modified by the action of waves, currents and winds. The Survey has rendered important service both to geographic science and to commerce by carefully noting such changes in certain localities, and by noting the mode of operation of the causes which produced them. The safety and efficiency of public works for the improvement of harbors often depend upon an accurate conception of these causes.

One of the most interesting problems of physical hydrography is that presented by the Gulf Stream. What explanation can be given for the existence of this great current of unusually warm and salty water; apparently acting as one of the controlling factors in the climate over an ocean and upon the coasts of two continents; seemingly resistless in its motion, and yet so sensitive to disturbing forces that in its current the varying effect of the moon's attraction has been detected? Through the observations made by the Survey the status of this problem has been greatly changed. Formerly it was easy to find a theory which would seem to explain the few observed facts, and accordingly many theories were extant and unrefuted. Now, such an abundance of facts are on record that none of the old theories seem to be adequate, and no satisfactory new theory has presented itself. The scientific world seems in this matter to be in a healthy state which is prophetic of true progress, viz., it is realized that while the facts so far established are sufficient to prevent unqualified acceptance of any extant theory, many more observations are necessary to satisfactorily refute old theories or establish a new one. The principal facts which have been established by the Survey depend upon soundings along the track of the stream and in the Gulf and Caribbean Sea; numerous and accurate observations of the density and temperature of the water at a great many points at all depths in the stream and the Gulf, serving to show the vertical as well as the horizontal distribution of these elements; and finally, observations of the current itself. The current observations are remarkable for the fact that they have been extended to great depths, never before explored by a current meter.

The mariner relies to such an extent upon the magnetic needle that a study of terrestrial magnetism is a necessity in connection with the duty of chartering the coasts. In harbors a knowledge of the dip and intensity is needed, as well as of the declination, in connection with the process of adjusting ship's compasses. Nearly all of the early, and many of the modern, surveys in this country having for their purpose the fixing of property lines were made with the compass, and therefore an accurate knowledge of the geographical distribution and secular changes of the magnetic declination in the interior of the country is of great practical value as a means of preventing and settling property disputes. The determination of the magnetic declination for the purposes of the mariner at various points along the coast formed the small beginning from which has developed a great magnetic survey which covers the whole country and which has proved to be of great scientific as well as practical value.

The operations of this magnetic survey may conveniently be classified as, 1st, magnetic observations by the officers of the Coast and Geodetic Survey; 2d, the compilation of results obtained by outside parties; 3d, the systematic correlation, discussion, and publication of the accumulated data.

Officers of the Coast and Geodetic Survey have made magnetic observations at some 1,200 stations distributed over the whole country (a few also in foreign countries), and many of these stations have been reoccupied several times with a view to determining the secular changes and to keeping the magnetic information up to date. Continuous series of observation have also been made at five stations (usually with self-recording instruments) covering a period of several years at each. These observations, together with those compiled from other sources, have served to determine the geographical distribution of the magnetic declination, dip, horizontal and total intensity for the whole United States, and a more or less extensive knowledge of their secular variations at many stations. The declination, which it is most desirable to know for practical purposes, has been determined at 3,500 stations, and there are 118 stations at which its secular variation has

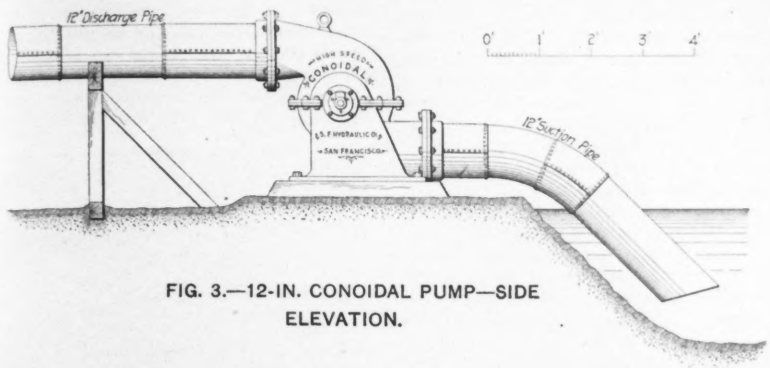


FIG. 3.—12-IN. CONOIDAL PUMP—SIDE ELEVATION.

been determined by observations at 13 widely separated epochs on an average. The series of appendices to the annual reports, in which the carefully digested results have been published from time to time, form an unrivaled repository of magnetic information pertaining to the United States. Assistant C. A. Schott, the author of this series, had recently been awarded a prize of 5,000 francs ($1,000) by the French Academy as a recognition of the scientific value of his researches in terrestrial magnetism.

From the beginning, the surveys of the coast were based upon triangulation of a secondary and tertiary order in the immediate vicinity of the hydrographic and topographic operations. The desirability of an adequate control over this coast work when it extended over great distances led to the execution of primary triangulation extending some distance inland. Later, as the desirability of connecting the Atlantic and Pacific surveys became evident, and as it also became evident that inland triangulation was of value to the states traversed by it and to various inland interests, the transcontinental triangulation was projected, the Coast Survey was directed to furnish accurate geographic positions to the several states, and the name of the organization was officially changed from Coast Survey to Coast and Geodetic Survey (in 1878).

At the present time the triangulation covers an area of 350,000 square miles and determines accurately the geographic positions (latitudes and longitudes) of nearly 29,000 points. See full-page illustration showing areas covered by completed triangulation, together with reconnoissance and proposed triangulation. The elevations of 2,800 of the triangulation stations have been determined by measured vertical angles. In connection with the triangulation, over 5,000 miles of precise leveling has been done, and this serves to fix the elevations of more than 1,000 permanent bench marks, and to control the elevations derived in part from trigonometric leveling.

A geodetic survey is geographic work on its grandest scale, for it furnishes a measurement of the earth as a whole, even though the area covered by the survey may be but a small portion of the earth's surface. Aside from two other short arcs (8° in aggregate length) the Coast and Geodetic Survey has now nearly complete an oblique arc from Calais, Me., to Fort Morgan, Ala., 22° of a great circle or 1,500 statute miles in length, and an arc of the 39th parallel 48¼° or 2,600 statute miles in length. These four arcs have an aggregate length measured on a great circle of 57°, whereas the combined length of the available arcs (measured by various nations) used by Clarke (in 1880) in deriving the figure of the earth was 82°. Evidently the United States is an *active* member of the International Geodetic Association. It is also noteworthy that the different Coast and Geodetic Survey arcs are all connected so as to form a single system, and therefore have greater weight, or efficiency, in the determination of the earth's figure and size than they would have if disconnected.

The figure and size of the earth are derived from the results of a triangulation by comparing the geodetic latitudes, longitudes and azimuths with the astronomical values of those quantities as directly observed. On the oblique arc, 14 telegraphic longitudes, 48 azimuths, and 61 latitudes have been observed; while on the transcontinental (39th parallel) arc the numbers are 35 telegraphic longitudes, 73 azimuths, and 109 latitudes. A few of these determinations are common to the two arcs.

The study of the station errors developed when these astronomic measures are compared with the geodetic measures also furnishes an interesting contact point between geodesy and dynamic geology, for the limiting magnitude of the station errors is a measure of the strength of the earth's crust—if it is permissible to use the word "crust" in the present state of our knowledge. Geologists have shown that in the past there have been immense quantities of material transported in various ways to considerable distances along the earth's surfaces, by glacial action and the action of running water, for example. Such transfers of material must produce stresses in the rigid (?) earth and must also produce station errors, the distribution of matter being changed from what it must have been when the whole globe was made up of fluids and the station errors were each zero. In those cases in which the transportation is continuously in one direction, as for example, that caused by running water, the stresses and the station errors must go on increasing indefinitely unless there is a yielding on the part of the rigid (?) earth. Any yielding and counter transference of material beneath the surface must reduce both the stresses and the station errors. The station errors furnish, therefore, a measure of the accumulated amount of transportation in those regions in which such amount is small; and furnish a measure of the strength of the material composing the earth in those regions in which the accumulated amount of surface transportation is very large and the station errors and stresses have both been reduced by yielding until the stresses could be borne by the material.

The formation of the great telegraphic longitude net, covering the United States and spanning the Atlantic, is a geographic feat worthy of especial note. This great net comprises no less than four transatlantic telegraphic determinations (1866, 1870, 1872, 1892), serving to connect the longitude system of this country with Greenwich and Paris. The whole system, including the European connection, is composed of 45 stations connected by 72 determinations of difference of longitude. The average value, without regard to sign, of the corrections to the separate determinations arising from the least square adjustment of this great net is only one-fiftieth of a second of time, and the maximum value is $0.^{s}069$ (to a determination in 1866). The probable error of an adjusted longitude difference is $\pm 0.^{s}024$.

In that grandest of geographic undertakings, the measurement of the earth as a whole, another method of attack is by the use of the pendulum for the measurement of gravity at various points upon the earth's surface. The activity of the Coast and Geodetic Survey along this line may be inferred from the fact that its observers have occupied over 60 home stations and 28 foreign stations.

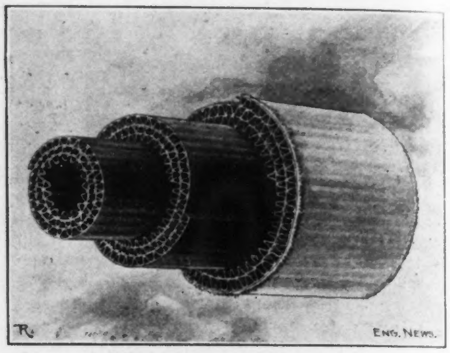
The importance of a geodetic survey can not be properly judged by the number of points directly established by it. It bears the same relation to other surveys covering the same territory that the Supreme Court does to lower courts. Its results are of such a high degree of accuracy that it stands in the position of a court of last resort among surveys; it serves to prevent too great an accumulation of error in other surveys; to decide as to the right when two or more determinations by different surveys disagree; and to furnish indisputable points of departure for new surveys. It is in this relation to other surveys that the great geographic value of a geodetic survey lies. To the geodetic survey must properly be ascribed a part of the value of every survey based upon or controlled by it.

The relations of the Geodetic Survey of the United States to other surveys may be illustrated by a few instances taken almost at random. The Massachusetts State Survey, serving among other purposes to fix the township boundaries, is based upon the work of the national geodetic survey; two of the latest municipal surveys, that of Baltimore and that of the Borough of the Bronx* (a part of Greater New York), are based upon and controlled by the geodetic work of the Coast and Geodetic Survey; the topographic work of the United States Geological Survey is based upon triangulation by the Coast and Geodetic Survey in the regions covered by their triangulation; disputed portions of many of the state boundaries have been finally fixed by the Coast and Geodetic Survey. Among the latter cases, and within the last ten years, may be mentioned the oblique portion of the California-Nevada boundary now being located and marked after years of disputes and resurveys by various parties; a portion of the Maryland-Virginia line; the north boundary of Delaware; and the Indiana-Ohio boundary. The surveys on the part of the United States in connection with the disputed Alaskan boundary have been made by the Coast and Geodetic Survey.

*Eng. News, May 19, 1898.

AN AIR CELL PIPE COVERING.

The pipe covering shown in the accompanying illustration, known as the "Gast Air Cell Covering," is designed to insulate effectually ammonia or brine pipes. It consists of corrugated and flat sheets of light straw board made up together in the form of split tubes. In placing the covering, after the pipe is clean and perfectly dry, the first section is sprung about the pipe, drawn tight, and the flap cemented down with paste or glue. The second and third sections are placed in the same way, except that each is slipped back, as shown in the cut, so that joints are broken. The total thickness of the covering for pipes up to 1½ ins. is 1½-in.; above this 2 ins. is used. The coverings are made in 3-ft. sections, the outer one having



Corrugated Paper Insulating Covering for Pipes.

a canvas cover. In making elbows, tees and short bends a special filler with molded covers is used.

The peculiar construction forms a series of small air cells, one overlapping the other, the whole precluding the outside air from gaining access to the pipe. In this way no moisture can reach the pipe, and the formation of frost or ice on its exterior is, therefore, impossible. At the same time the circulating liquid is practically unaffected by temperature changes of the atmosphere or surrounding objects. The covering is also recommended for protecting water pipes from freezing in cold weather. It is made in sizes to fit ½-in. to 8-in. pipe, the former costing about 40 cts. per ft. and the latter $1.25 per ft., when in place; the other sizes ranging between these limits. The New York Fireproof Covering Co., 26 Cortlandt St., New York city, are the manufacturers. A steam pipe covering employing the same principle, using, however, asbestos paper instead of the corrugated straw board, is manufactured by the same company.

THE TRAINING AND WORK OF THE ENGINEER.*

By Chas. Wallace Hunt, Pres. Am. Soc. M. E.

A change has been taking place of late years in the work required of professional engineers. This has largely come from the development of our manufacturing establishments from the position of being a minor factor in our economic life, to being one of great importance, and the necessary employment of skilled engineers to conduct their technical affairs.

The engineer of the user and the engineer of the maker have widely different duties. Consider how different may be the information required in practice by two classmates, whom we will designate as "A" and "B," who graduate from college as engineers. "A" secures a position in the engineering department of a city, and commences his work, which may be the designing of a new water pumping station. His college course has fitted him for the work. His text-books were suited to problems of this character. He finds abundant information on all branches of the subject in data published in the proceedings of scientific societies, in technical literature, and in annual reports of city departments. The forms of contracts to be entered into are at hand, all found elaborately drawn, with every point safeguarded, and need only a little selection and adaptation to suit his case. They place in his hands the power to decide absolutely and without appeal all questions which may arise in carrying out the work.

*Extract from the Presidential Address before the American Society of Mechanical Engineers, Nov. 29, 1898.

"B" obtains employment in the engineering department of a manufacturing corporation, which in due time estimates and submit tenders for the pumping plant for which "A" has issued specifications. He will find that the form of contract proposed by "A" has many minute and carefully worded clauses to bind and limit the supplier. The tender to be submitted for the work must in its scope and wording protect the interests which "B" represents not only in a general sense, but in every one of the clauses of the proposed contract. Every obscure phrase and every adjective used by "A" must have definite consideration and be clearly defined in both an engineering and legal sense. "B" here finds that the information derived from his college course is largely inapplicable, and there is no technical literature which he can use, either as a general guide for making a form of tender or the proper expressions to use to define or limit the obscure clauses or words found in the specification.

Looking at the subject from a purely technical point of view, we see quite as great a variation in their work. "A" would require only a general knowledge, while "B" would require the most thorough and exhaustive information of the qualities of constructive materials, and shop practice available in that particular location. The farther we carry the comparison of their work, the more clearly it is seen that the educational requirements are becoming more complex to correspond with the growing specialization of engineering work.

Engineering Practice Abroad.

There is another phase in engineering practice represented by the duties of "A" and "B" which now becomes interesting if the work of American engineers is to take the place in the world at large to which the indications now so plainly point. In other countries it is a common practice for "A" to make all the general designs and all of the details, and the supplier has no responsibility either for the design or for the efficient working of the plant when completed. If errors or omissions are found in the drawings or specifications, the cost of the changes required are paid by the purchaser, in the usual bill for extra work. In this case the duties of "B" are small or disappear altogether.

American Engineering Practice.

The American practice is tending to the method of making the requirements issued by "A" of a general character which will cover the results sought, and leave to the supplier, "B," the work of designing the particular means to accomplish the desired end. Business has become of such a magnitude, and so complex that one mind cannot fully grasp, and readily handle, the new discoveries, new materials and new practices, which now come so rapidly. For efficient and economical results, each phase must be handled by an expert. There will be many "B" engineers to respond to the requirements of "A," and each will present for consideration different ideas, different materials, and different shop practices. "A" must select from these various plans and details submitted, the one which best promises to fulfill the requirements. It is a division of labor between "A" and "B," each of whom, by tastes and training, is especially fitted for his part of the work. We may paraphrase their duties by saying that "A" is a judge, "B" is a counsellor.

Post-Graduate Needs.

At the present time we cannot expect our technical schools, painstaking and perfect as they are, to prepare both "A" and "B" fully for such new and varied duties, or even to have their instruction in the practice of engineering fully abreast with the latest practice, or at least not until progress in the arts and sciences has substantially ceased. It takes time for a new practice or a new result to be recorded, published, considered, and adopted by the teaching staff. This difference between the teaching and the engineering practice of the day is not only an indication of progress in engineering, but in some measure an index of its rate. The student then must expect, as a normal proceeding, to supplement his graduating acquirements by further study, together with association with his professional brethren, in order to place himself abreast of the times, and to be fitted for the most effective and useful service.

Engineering theory and practice are rapidly extending with the general advancement of our economic interests, and the engineer, whether he be a young graduate or otherwise, who does not make use of the modern aids to information, among which are to be counted scientific societies and literature, and a personal association with his brethren, with the innumerable hints and suggestions which come from these, will soon be found struggling with what seems to him adverse fate, but what, in reality, is inferior knowledge, behindhand knowledge; or, plainly speaking, ignorance greater or less. The engineering world has passed by him, and he must then view the working out of the law of the survival of the fittest, with what grace he may.

The advance made in the accumulation of useful data and more accurate knowledge in practical engineering gained one season, is presented to a scientific society the next, and still later it will be embodied in text books for the instruction of students who are soon to take our places and carry on our work. Until attention is called to the subject, we are not likely to realize that in their essential parts the great bulk of the engineering data available to us

WEATHER TABLE FOR OCTOBER, 1898. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.)				Wind. Velocity in miles per hour.		Wind. Direction at time of max. velocity.	Precipitation—Rain or melted snow. (Inches.)		
		Average.	Max.	Min.	Range.	Average	Max.		Total.	Heaviest in 24 hours	No. of rainy days
Northern Cities.	Northfield, Vt........	46.6	80	20	60	8.2	34	S	2.87	1.02	14
	Portland, Me........	50.0	81	31	50	8.2	37	S	5.90	1.63	13
	New York City........	57.6	80	38	42	14.3	52	NE	9.14	1.55	12
	Pittsburg, Pa........	56.0	86	32	54	6.1	20	SE.	3.84	1.46	11
	Chicago, Ill........	50.6	75	30	45	18.3	63	SE.	3.26	0.86	16
	Omaha, Neb........	50.0	82	27	55	9.5	30	NW	2.54	0.87	8
	St. Paul, Minn........	45.8	81	26	55	8.6	30	SE	5.81	1.74	10
	Duluth, Minn........	43.8	79	28	51	11.4	34	SW	3.39	1.60	12
	Bismarck, N. Dak....	39.4	67	19	48	11.5	46	W	2.66	1.18	9
	Average............	48.9	79	28	51	10.7	38	—	4.05	1.26	12
Southern Cities.	Washington, D. C....	57.8	83	30	53	6.6	28	E	3.54	1.04	12
	Louisville, Ky........	58.2	90	31	59	8.3	32	S	2.85	1.02	12
	St. Louis, Mo........	56.0	86	32	54	10.7	39	SW	4.34	1.48	13
	Savannah, Ga........	67.6	89	39	50	10.2	60	NE	4.46	2.85	12
	Kansas City, Mo.....	53.4	89	30	59	10.5	33	NW	4.40	2.61	7
	Jacksonville, Fla....	70.0	90	40	50	8.3	60	W	6.74	3.59	17
	Chattanooga, Tenn..	59.0	87	32	55	7.4	34	W	4.08	1.42	11
	New Orleans, La.....	67.6	89	43	46	8.4	35	NW	1.77	1.07	6
	Memphis, Tenn......	60.8	90	35	55	10.4	40	SW	3.14	1.27	9
	Palestine, Tex.......	66.1	97	34	63	6.4	36	NW	2.42	1.00	8
	Average............	61.6	89	35	54	8.7	40	—	3.77	1.74	11
Western Cities.	Helena, Mont........	40.8	65	21	44	7.2	37	SW	1.10	0.37	8
	*Port Crescent, Wash	47.2	60	32	28	3.5	20	SW	4.80	1.62	19
	San Francisco, Cal..	61.2	81	50	31	7.6	30	W	0.86	0.45	4
	Salt Lake City, Utah.	48.2	76	30	46	5.2	34	SW	1.57	0.74	4
	Santa Fe, N. Mex....	49.4	73	22	51	6.1	30	NE	0.54	0.54	1
	Denver, Colo........	49.0	84	20	64	8.3	40	SW	1.05	0.54	6
	Yuma, Ariz..........	—	—	—	—	—	—	—	—	—	—
	Average............	49.3	73	29	44	6.3	32	—	1.65	0.71	7

* Port Angeles closed, station moved to Port Crescent, 10 miles distant.

now have been first presented to a scientific society, and there permanently preserved until the time came for their utilization or application. It is from this great fund of information, principally accumulated during the last century, that we draw upon for the materials for our text-books, our general treatises, and our engineering hand-books.

Scientific associations aim to add to the great fund of information available to every engineer the world over, and not for the benefit of a limited clientage. The greater the availability and the publicity given to the published proceedings of a scientific society, the more nearly has the society accomplished the chief object of its existence.

Industrial Progress.

It has long been evident that we are making rapid progress in perfecting our manufacturing machinery, as well as organizing and developing our industries, thus constantly increasing the efficiency of our labor, until we have lately reached a point where an hour's labor with its facilities produced more of our principal products, and transported them further, than an hour's labor would do in any other part of the world.

Commencing under adverse conditions and developing in a field of restricted capital, with scarce and high-priced labor, engineering in America has applied the forces and materials of nature to the uses of man in a characteristic way. Freedom from mediæval traditions and the hampering conditions found in the older countries, left them substantially free in the choice of means to accomplish their end. Influenced as our engineering has been by the experience and the work of other parts of the world, yet we cannot escape the fact that its development was essentially independent, and in some phases unique. Improvement has followed improvement in technical matters, profits and savings have been added to the capital invested in our industries until the continent, two hundred years ago an untraversed wilderness—one hundred years ago a struggling nation—struggling with industrial difficulties and serious political problems—has triumphed over these early limitations, and has developed into a nation which, in numbers, prosperity, and wealth takes a prominent position among the great nations of the world.

Effect on the Mind and Character.

The life of the engineer has a full measure of the labors, the trials, the discomforts, and the disappointments which are found in this, as in every other walk of life. But it also has the successes which come from well-directed labors. It is not, however, either the useful work or the successes of life which bring happiness. It is man's ideals which make him happy.

Whichever way engineering may develop as time rolls on, its elevating influences are constantly at work on the mind and on the character. The work is carried on under unchangeable laws, which must be rigorously applied and adhered to, or failure is sure to result. Man builds to master, to resist, or to guide the forces of nature. If he has rightly judged the conditions, his work stands as a permanent monument of the fact; but if otherwise, the irresistible laws of nature will develop the defect and discover his ignorance, incompetence, or error to every observer.

Hence he laboriously seeks out the unseen laws and forces, then expresses the revelation in a workable form for his daily use. He tests his materials with painstaking refinement. He measures electric resistances with an accuracy now reaching the point of one in four millions, time to the one three-millionth part of a unit, divides a circle with a mean error not exceeding the one-millionth of the circumference, makes surfaces 6 ins. square with a variation from absolute flatness of less than one-two hundred thousandth of an inch, rules lines which vary from absolutely perfect spacing by only one-three millionth part of an inch, sees clearly the spectrum of samarium when one part is diluted with three million parts of lime, and surveys lines 11 miles long in the open air with an average variation in three measurements of only four-tenths of an inch.

The Basis of Ethics.

The effect of living and working in such a sphere of action, where it is inconceivable that an engineer could knowingly be otherwise than exact in his work, should tend to influence the whole trend of his life and character, and makes them to a greater or less degree a reflex of his daily work. He of all men has the most unchangeable and exalted basis for his ethics—the clearest of all knowledge of the disastrous results which will surely follow the violation of law. The very qualities of his mind which makes his work a pleasure and a success will all tend to bring his every act into compliance with the inexorable laws of the universe. If it is otherwise, and his conduct is not guided by the laws of right doing and right thinking, and his ethics not in accordance with them, then, and to that extent, he is not an engineer—not one who is skilled in the application of the forces of nature to the uses of man.

THE METHOD OF ERECTING EGYPTIAN OBELISKS has long puzzled the student of Egyptian antiquities, and the numerous documents and wall-pictures found do not explain it. In a late issue of "Construction Moderne," Mr. J. C. Kruseman suggests a possible method of handling blocks of stone weighing as much as 1,000 tons, and sometimes 131 ft. high and 10 ft. square at the base. These blocks were also placed on pedestals considerably raised above the actual level of the soil. Mr. Kruseman finds that these obelisks were generally placed in front of pylons or temples. He believes that the Egyptians first built a slightly inclined causeway of sand or other material, equal in height at one end to the obelisk to be erected; ending at the end in a strong wooden crib, and leaving a space between the crib and the temple for the obelisk. The base was then built and the space between the temple and the crib was about half filled with sand; and on the face of the crib a strong inclined chute was constructed leading to the base. The obelisk was then rolled up the incline on hard wooden rollers; and, with tackle leading to the temple, it was then allowed to tilt over the front of the crib, falling into the sand and guided by the chute. By slowly and carefully digging away the sand and hauling on the top of the obelisk it would thus be gradually sunk, until it would finally rest on its base.

A VENEZUELAN EXPOSITION, of natural, agricultural and manufactured products and works of art, will be held at Caracas, from Jan. 1 to April 27, 1900. The exposition is also to include methods of education, social economy, hygiene, public charity, colonization, etc.

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The greatest discrepancy between the engineer's estimates and the actual expenditure in the work upon the Erie Canal Improvement under the $9,000,000 appropriation occurred on Contract No. 4 of the Middle Division, located on the Jordan level of the canal. According to the Canal Investigating Commission, the bid on which this contract was awarded amounted to $154,471 at the quantities named in the preliminary estimate. Up to May 1, 1898, the State had expended $581,879 on this contract.

The difficulties encountered in carrying on the work on this contract, and the methods tried for overcoming them are described on another page of this issue by Mr. Geo. A. Morris, Resident Engineer of the Middle Division of the Erie Canal. The difficulties of building and maintaining embankments upon deep beds of soft material such as bogs and marshes are pretty well known to most engineers; but so little has been done in canal construction during the present generation that many engineers have forgotten probably that it is even more difficult to dig and maintain a water-carrying ditch through a bog than to build an embankment across it.

It is of interest to note that the sliding banks on the Jordan Level of the Erie Canal were closely paralleled by the heavy slides on the new Soulanges Canal in Canada, which occurred a year ago (Oct. 26, 1897). The latter were much greater in extent and occurred suddenly, while the earth movements on the Jordan Level were comparatively slow. Both, however, are examples of the difficulties involved in canal excavation through certain soils, especially when saturated with water. It is proper also to point out at this time when engineers are engaged on estimates for such important works as the canals at Nicaragua and Panama, and from the Great Lakes to the ocean, that the difficulty in making and maintaining canal excavations through the troublesome materials above referred to increases rapidly with the depths which the excavation must reach. Abundant experience was had, in fact, at Panama, in the excavation of the sea-level section through the marshes on the Atlantic side, with the difficulties in economical ditch digging under such conditions.

One huge Slaven dredge is said to have worked at one time for several weeks without moving from her position, the weight of the mud which she discharged upon the banks continually crowding in the banks and raising the bottom as fast as the material was excavated.

It sounds like the boom times of a dozen years ago to read that the United States Commissioner of Railroads proposes that the Government shall construct "a first-class, double-track air-line railway," from Kansas City, Mo., to San Diego, Cal. Probably most readers will be puzzled to know who and what the U. S. Commissioner of Railroads may be. The public and all railway men are fairly familiar with the Interstate Commerce Commission; but not one in ten thousand, probably, knows anything about the Commissioner of Railroads. We may explain, then, that he is an appendage of the Interior Department, and his duties appear to consist in watching to see that the government-aided Pacific railroads meet their obligations to the Government—and drawing his pay. Since the Union Pacific was reorganized and the Government's lien was wiped out, the Commissioner's time seems to have hung heavily on his hands, and we presume he has hatched this scheme for a Government railway to amuse his leisure hours. To do him perfect justice we will give the substance of his argument for the enterprise in his own words:

The annexation of the Hawaiian islands, and the probable control of the Philippine and Ladrone islands, must open up new trade relations of such growing proportions with them as to so materially increase the business of all the bond-aided roads that it is within the scope of reason to anticipate their ability at an early date to pay principal and interest of their debt to the United States.

The vast volumes of wheat and other cereals which now find their way from the middle-western grain prairies to Asia and to other countries of the western hemisphere, via the Atlantic seaports, will, in a very few years, reach these same destinations via Pacific seaports, and with this changed condition will come vastly increased tonnage and revenues to all the trans-continental lines. The diversion of this very traffic on this idea is now receiving the careful attention and consideration of the executive and managing officials of some of the leading lines between Chicago, St. Paul and other middle-western grain centers and the Pacific slope.

It may be timely just now to suggest that the government construct and operate a first-class double-track railway from Kansas City, Mo., to San Diego, Cal., by air-line route. This will open the shortest line, measured by the map, from Boston, New York and Philadelphia to the Pacific coast, along and near the coal fields of the east and of the west this side of the Rockies, and making the most direct line from our great commercial centers to the Sandwich islands and the Philippines.

This, with other lines now working overland, may prove ample for the wants of commerce to the Pacific coast and the Orient, holding trade and travel within our borders pending the experiment of a canal through the fevered climate of the isthmus.

As trade increases it may develop the importance of a direct and a similar line to Seattle, in Washington state. St. Louis, Mo., is a little south of the direct line between New York and San Diego, but the topographical features of the country indicate that possibly a better route may be found from that point, and the bridge over the Mississippi River at St. Louis may prove an important consideration. A survey, therefore, by direct lines should be made from each on these points.

It is news to us that "vast volumes of wheat and other cereals" were being shipped from the Mississippi Valley to Asia. The Nicaragua Canal people have averred all along that one great object for their canal was to carry California's surplus wheat crop to a market in the East, because there was not enough market for it on the other side of the Pacific. However, if any such heavy traffic as the Commissioner anticipates is to be thrown upon the transcontinental railroads, it will not be necessary for the Government to undertake railway construction on its own account to add to their number. Private enterprise can safely be relied upon to furnish all the railways that the traffic can support; and public opinion will very promptly condemn any attempt to involve the Government in new Pacific railroad subsidies or construction.

The Washington Patent Law Association has recently reported upon the various bills pending in Congress for the amendment of the patent laws; and has secured the opinions of a large number of patent attorneys and officials familiar with the work and needs of the patent office and of the courts which try patent causes. The Association has found that general agreement exists upon three points in connection with proposed patent reforms. These are (1), the necessity of carefully studying out some plan to put into the best shape the mass of material piled up in the United State patent office, so that a thorough search might be made by the examining corps, by attorneys making validity searches and by the public generally in search of information; (2), that there are now too many appeals in contested causes in the patent office; (3), that the present arrangement of circuit courts of appeals as courts of final resort is a failure in the patent system, and that one final court is wanted whose rulings will cover territory co-extensive with the grant.

From the first of these conclusions there can surely be no dissent, and we can go further and say that the only possible method of effecting the desired end is through just such a classification of patents by their subject matter as the Patent Office has put into use. At the last session of Congress an appropriation was made for the purpose of improving and perfecting the present classification, and we may expect that no small amount of good will be effected by this. This classification, however, applies of course only to existing United States patents. It is at least worth considering whether the U. S. classification might not be extended and applied to existing British patents. The cost of doing this would be well repaid by the saving in the labor of the examining force and by the greater certainty which would attach to the final allowance of a patent. Of course the classification might be still further extended to cover existing patents issued by other countries; but the difficulty and expense in making use of these patents on account of the necessity of translation would probably prevent them from being generally used by the corps of examiners. The work would be of great value to all seeking to learn the state of the art in a particular field of invention; but if Congress should go so far as to make existing patents in the English language available for consultation, it would do considerably more than anyone expects.

A MODEL CITY CHARTER; THE REPORT OF A COMMITTEE OF THE NATIONAL MUNICIPAL LEAGUE.

In no one point has popular government, as it is carried on in the United States, been more criticised, than in its conduct of the affairs of cities. It is also true, we believe, that more hard work has been done in the endeavor to improve municipal administration than in any other field of governmental reform. State governments and our national government have gone on with little change in their methods of administration, in many cases, since their original establishment; but our cities have many of them had the most kaleidoscopic changes in the organic laws under which they are ruled, and the search for a city charter which shall make good government most easy and misrule most difficult still goes on.

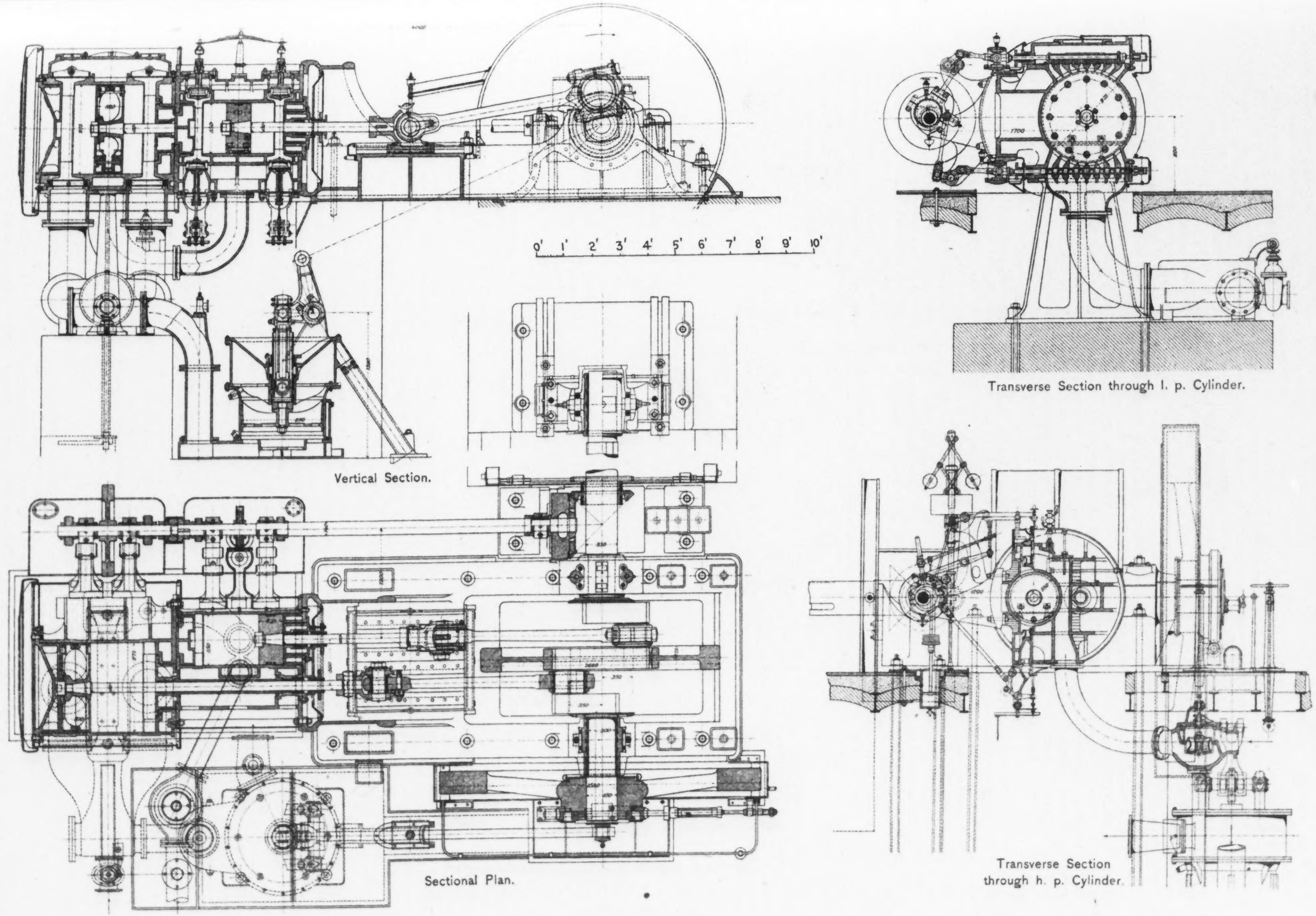
Up to the present time, however, the progress in city charter amendment has been too often a case of the blind leading the blind. Self-styled reformers have urged this or that change in a city charter, and have failed to foresee that certain evils as well as the expected benefits would attend the change. There has been need for a painstaking investigation by competent experts to determine just what form of administration will most conduce to good government. Such an investigation has now been made, and its results are made public at this week's meeting of the National Municipal League, at Indianapolis.

At previous conferences the good and bad points of American municipal government and charters have been discussed at length by many of our ablest students of municipal reform. At the meeting in Louisville, in May, 1897, the following resotion was adopted:

Resolved, That the Executive Committee appoint a committee of ten, to report on the feasibility of a municipal program which will embody the essential principles that must underlie successful municipal government and which shall also set forth a working plan or system, consistent with American industrial and political conditions, for putting such principles into practical operation; and such committee, if it finds such municipal program to be feasible, is instructed to report the same, with its reasons therefor, to the League for consideration.

In accordance with this resolution a committee was appointed, but with only seven members, as follows:

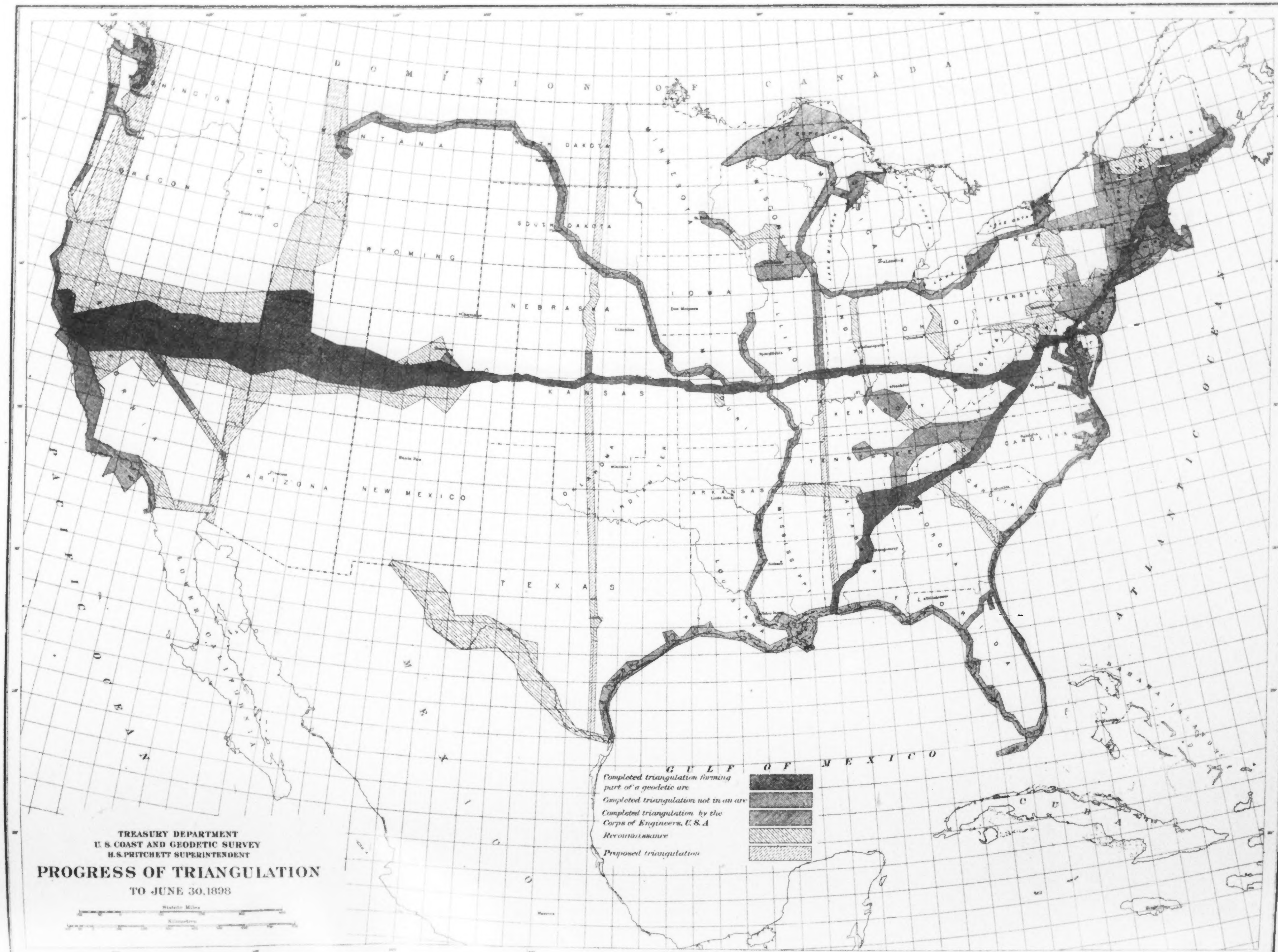
Messrs. Horace E. Deming, Albert Shaw and



COMPOUND ENGINE IN THE POWER HOUSE OF THE BUDAPEST, HUNGARY, ELECTRIC RAILWAY.

Designed and Built by L. Lang, Budapest.

CHAS. HART, LITH., 36 VESEY ST., N. Y.


TREASURY DEPARTMENT
U. S. COAST AND GEODETIC SURVEY
H. S. PRITCHETT SUPERINTENDENT
PROGRESS OF TRIANGULATION
TO JUNE 30, 1898
Completed triangulation forming part of a geodetic arc
Completed triangulation not in an arc
Completed triangulation by the Corps of Engineers, U. S. A.
Reconnaissance
Proposed triangulation
DOMINION OF CANADA
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
MEXICO
CUBA
OREGON
WYOMING
NEBRASKA
SOUTH DAKOTA
IOWA
KANSAS
ARIZONA
NEW MEXICO
TEXAS
ARKANSAS
KENTUCKY
OHIO
LOWER CALIFORNIA

Prof. Frank J. Goodnow, of New York; Geo. W. Guthrie, of Pittsburg; Chas. Richardson, Prof. Leo. S. Rowe and Clinton Rogers Woodruff, of Philadelphia. Through the courtesy of the last-named gentleman, who is Secretary of the League, we have received an advance copy of the report, supplemented by papers by Messrs. Deming, Goodnow, Shaw and Richardson, and also a paper by Mr. Woodruff, reviewing "The Advance of the Movement for Municipal Reform." The report and papers, with anticipated discussion, will occupy the principal part of the attention of the conference at Indianapolis this week.

Although the report has been the subject of much individual effort, and of many conferences between the different members of the committee during the past 18 months, the committee believes "there is haste in leisure," and recommends that the program, papers and discussion be referred by the conference

> to a committee to be appointed by the executive committee of the league, with instructions to complete the work thus begun and to report, for action, a municipal program at the next meeting of the league.

We have thought it best to place the main features of this program before our readers, a large proportion of whom are in close touch with municipal affairs,, as citizens, officials, or in a business way, while few, if any, of them are not indirectly affected, for weal or woe, by good or bad city government. The committee recognizes, and distinctly states, that it is in the technical, administrative side of municipal affairs that much of the best work has been done, a statement that all thoughtful persons, and many of our readers, especially, will confirm.

The committee found that while many of the features of its program are already included in some municipal charter, constitutional amendments would be necessary in most states before all the features could be adopted. The committee, therefore, submits what may be termed a "blanket" constitutional amendment, from which each state may select what is necessary. This shows both the thoroughness of the work done and the magnitude of that which must of necessity be left to others. Every one who has given the matter attention knows how difficult it is to secure constitutional amendments, especially when the prejudices and perquisites of rural legislators are involved. But it is often well to know in advance the difficulties in the way. Municipal reform is becoming a mighty force, which only needs direction, if it keeps on the increase, to insure a fair measure of success regardless of the obstacles it encounters. As already intimated, much of this program can be put into effect without constitutional amendments, while the most sanguine person does not, or certainly should not, expect a program like this to come into universal use in such a republic of republics as ours, where not only several score of states are concerned, but several thousand municipalities as well. The greatest value of any such program must lie in its exposition of the principles involved. Few cities are likely to immediately abandon their present form of government and begin wholly anew under a new charter. We think, however, that no higher praise could be given the committee than the statement that it has come marvelously near presenting an outline of government capable of universal adoption. The reason for this is that it has confined itself to an outline, instead of falling into the common error of going largely into details. A few broad and deep underlying principles, based on wide experience and observation, are presented in sufficient fulness to warrant their ready comprehension and their observance, when once adopted.

The first one of these foundation principles we shall name is that a city charter should confine itself to matters of State, as distinct from local policy, leaving the latter for the municipalities to work out, each in accordance with its local needs, and in the light of experience. Such a plan makes unnecessary and inexcusable that continual legislative interference which is the bane of city government. It also renders it perfectly feasible for cities with a wide range of population to work under one general municipal incorporation act. The extent to which this plan would simplify and clarify state legislation is amazing, as will be appreciated when one reflects, as the committee suggests, on the vast mass of special municipal acts passed by many of our legislatures each year. With a few exceptions these acts may be divided into three classes: (1) Those prepared by and in the supposed interests of the municipality concerned, vouched for by some member of the legislature and railroaded through with little or no change. As such acts are generally prepared by some one not legally responsible, and are enacted without any feeling of moral responsibility, they are likely to be highly objectionable. (2) Bills prepared by individuals or "rings" to compass some private end, which are passed under the party whip or by "log-rolling." (3) Bills prepared to meet local demands but contorted to aid the ends of party managers or to satisfy rural or local prejudices.

To put a final end to all such legislation would be a great benefit to the communities concerned, and it would enable legislators at our state capitals to give more adequate and statesmanlike consideration to the other measures that come before them.

Realizing that the mere removal of the necessity, real or apparent, for special legislation would not be sufficient, the program prohibits all acts not applicable to all the cities or inhabitants of the state, except such as may be passed by a two-thirds vote of all the members of the legislature, and then either approved by a two-thirds vote of the council of the city affected, or passed by the legislature over the veto of the city council by a two-thirds vote of all its members, "which two-thirds shall include three-fourths of the members of the legislature from districts outside the city or cities to be affected." This provision will go far towards satisfying those who feel that in case of emergencies the legislature should be able to pass special municipal legislation, either to meet peculiar local needs or to furnish a check upon local officials when all other means fail. It will be noted that the municipal corporation act itself can be amended at any time, either directly, or by independent legislation, provided such changes or additions are not contrary to the constitutional amendments and apply to all the cities or inhabitants of the state.

To give still more elasticity to the program, where most needed, it is proposed that cities having a population of 25,000 or more may frame their own charters, subject, of course, to the principles laid down in the constitutional amendments.

It may occur to some that with such broad general powers and such freedom regarding details, the government of different cities would take on still more of that regrettable lack of uniformity which already prevails. But it is more probable that the opposite result would follow, for in the first place we should have a large increase of uniformity by the adoption of the same act of incorporation, and next the program recognizes the existence and provides for the continuation of the exercise of supervisory powers on the part of central or state admisistrative boards, like State Boards of Health. Besides this, city controllers, or heads of the finance departments, officials with great powers, are required under the program to report fully to some state official on the financial operations and conditions of each city, in accordance with forms prepared by the state official.

Before leaving the general subject of state control, by legislative or other means, attention should be called to one point forcibly brought out by the report: Extremes of state legislation in local affairs are often nullified by what may be termed local legislation by municipal officers. That is to say, the legislature goes into the details of local legislation, and even of local administration, but its mandates are left to local officials for execution. They use their discretion in the matter, and to that extent usurp legislative power. If the state wishes to exercise administrative powers, for the sake of uniformity or any other reason conducing to the general welfare, it should do so through central administrative bodies.

This brings us naturally to another important principle laid down in this municipal program, viz.: That the legislative and administrative powers of a municipality should be placed in separate hands to the greatest possible extent. We have not space to go into this matter, nor does it seem necessary. The program aims to effect this separation by vesting all legislative powers in the council and all administrative powers in the mayor, and in administrative departments created by the council, but with their members appointed by the mayor. All but the heads of such departments must be chosen by the mayor from lists of candidates certified to by civil service commissioners, these officials also being appointed by the mayor. Each civil service appointment is to be made by the mayor from the three highest names on the list of available candidates, preference to be given to citizens, if of equal rank or grading, honorably discharged from the army or navy of the United States.

Examinations of unskilled laborers are to relate only to "their capacity for labor and their habits as to industry and sobriety."

Probably some persons will feel that the heads of departments should be recognized at least to the extent of providing that they may express to the mayor their preference for some one of the three available candidates in any case, but in considering this matter it should be remembered (1) that the intention of the program is that the mayor and the heads of all departments shall be in harmony, hence the mayor would naturally consult the heads; and (2) that we must divest our minds of the picture, now so common, of a clean sweep of employees with each change of administration, and think of the whole administrative force as very largely continuous. Promotions in the service are to be made in order of merit and seniority, in accordance with rules established by the Civil Service Commission, and the program has the following to say regarding tenure of office:

> No officer or employee in the administrative service of the city shall be removed, reduced in grade or salary, or transferred because of the religious or political beliefs or opinions of such officer or employee; nor shall any official in the administrative service of the city be removed, reduced, or transferred without first having received a written statement setting forth in detail the reasons therefor; a duplicate copy of such statement shall be filed in the office of the Civil Service Commissioners, and at the option of the official who shall have been removed, reduced or transferred, such statement of reasons, together with the reply thereto made by the officer removed, shall be made a matter of public record in the archives of the city. Subject to the foregoing provisions of this act, all persons in the administrative service of the city shall hold their offices without fixed terms and subject to the pleasure of the mayor.

The last sentence, coupled with other provisions of the program, seems to mean that heads of admistrative departments, as well as subordinates, are to hold office until removed for cause, which cause shall be neither political nor religious. The only difference between the appointment of heads of departments and their subordinates would also seem to be that the mayor can select the heads in entire independence of the civil service commission or examinations of any sort. This plan should give great stability to the whole administrative machinery of a city, resulting in trained public servants of high technical ability, where such are necessary, and a high grade of efficiency on the part of all the employees, since all know they will be retained if faithful and able and are very liable to have to go if not. It would lift a load of anxiety from many an engineer, superintendent of water-works, streets or sewers, for instance, if he knew he were not liable to lose his position at the next election.

The only appointment made by the city council, except those pertaining to its own officers and servants, is the city comptroller, or head of the finance department. But while the council is shorn of all appointments save these, its functions in other respects are very greatly increased, as compared with the general American practice at present. All legislative functions are lodged in it, instead of being deposited, as is now so common, in boards of public works and other bodies having both legislative and administrative powers. Two other additions to the dignity and importance of the individual councillor are (1) that the legislative body is composed of but one branch, and (2) that the term of office is for six years. The acts of the council are subject to the mayor's veto, but this may be overridden by a certain majority (left blank in the program). The mayor, and not the council, prepares the annual budget, and the council cannot increase, but it may decrease, any item. On the other hand, the council makes specific appropriations of available funds, which the mayor may veto in whole or part, but the veto may be overridden. The total indebtedness and the percentage of the tax rate to the total valuation of the city are to be limited in the charter, but the fixing of the limit is left to the discretion of the state legislature. Debts for revenue-producing works are to be excluded in determining whether the city has reached the bonded debt limit, while reports on this and other financial matters are to be made by the city comptroller to a state officer or commission, and are designed to place each city's officers under some surveillance.

The policy of each city as to municipal ownership of water-works, lighting plants, street railways, and all such undertakings, either through purchase or construction, is left to the council, and the exclusion of debts for these purposes from the aggregate used to determine the debt limit gives councils more scope in this matter than they ordinarily have.

When franchises are granted they must be in the nature of leases for 21 years, with a payment to the city of a percentage of the gross revenue, and provisions for ultimate acquisition of the works in question, the price to include nothing for the value of the franchise, and the method of determining the purchase price to be stipulated in the franchise. To the end that the city shall be possessed of full information regarding all franchise-holding companies, such companies must report fully to the city their financial transactions, and these reports shall be public records. To render the omission of such reports less likely, and to ensure the inclusion of the desired figures, the program provides as follows:

The accounts kept by a city shall, among other things, be designed to show in each case of a grantee of a franchise from the city rendering a service to be paid for wholly or in part by payments by users of such service:
(1) The true and entire cost of construction, of equipment, of maintenance, and of operation thereof;
(2) The amount of the cost collected annually from users of the service, and the character and extent of the service rendered to users in consideration for the payments by them;
(3) The amount of the cost collected annually from taxpayers as such, and the character and extent of the service rendered the city in consideration for the amount paid annually for such service by taxpayers.

We have urged for years that franchises should be limited as to length, and be drawn with more care for the interests of the cities concerned. We have also pointed out, if we remember correctly, the advantages to both companies and cities of having greater publicity in the accounts of franchise companies. These advantages are seen and appreciated by some holders of such franchises and corporation lawyers.

A novel feature of the program, so far as American practice is concerned, is the provision that heads of departments, ex-mayors and mayors, may participate in the deliberations of the council; of course they cannot vote. The councilmen are to serve without pay, and to be elected on a general ticket, instead of by wards or districts.

One feature of the program which is open to objection is the limitation of all contracts for services or material to five years. There are some services which can be rendered much more economically to the city under a contract for a longer term of years, such as garbage disposal, where an expensive cremation or reduction plant must be provided. Under a five-year contract the risk of failure to secure its renewal must be offset by higher prices. The same thing is true to a large extent of electric lighting contracts.

Somewhat in the same category is the provision that all bonds must be redeemed within 20 years. Indebtedness for some purposes might very properly be extended over a longer period, depending, somewhat, upon the life or availability of the thing acquired. Thus, real estate or water rights, which will appreciate, rather than depreciate, in value, and serve future generations, might be paid for in longer term bonds than those issued for a pumping plant. But the time limit on both contracts and bonds is right in principle, and it must be remembered that this is a propaganda of principles rather than of detailed requirements.

Finally, it is to be noted that the program provides for municipal elections separate from state or national elections; for minority, proportional or other form of representation in the city council, to be determined by the vote of the people, either when the question is presented to them by the council, or by a petition signed by a certain percentage of the qualified electors; and that all nominations to elective offices are to be made by petition signed by legally qualified voters. The last provision is designed to vest the nominating power in the people instead of in the managers of the political machines.

LETTERS TO THE EDITOR.

Comparative Economy of "A" Type and Riveted Trusses for Short Spans.

Sir: The article published in your issue of Aug. 25, 1898, "Bridge Work on the Kansas City, Pittsburg & Gulf R. R.," contains a description of the patented "A" truss designed for short spans, and gives stress sheets, details, etc., for 100-ft. single track through spans as actually built in 1893. The advantages claimed for this type are, to quote the article referred to, great rigidity in all directions, ease and cheapness of erection, and economy in metal when structures of this type are compared with structures of other types having equal strength and rigidity. The inventor "considered the ordinary through Pratt truss too light and vibratory, and the riveted truss as then built, clumsy, unscientific and uneconomical." The faults of the short span Pratt truss were so well known in 1893 that it is safe to say that this type had about ceased to be used for 100-ft. spans at that date, but an examination of some of the riveted bridges designed in 1893 or constructed previous to that year will show that the criticisms applied to this type are not well founded.

The span shown in Fig. 1 is one of several built for a leading railway in the latter part of the year 1891. These spans were designed for a live load approximating that used in the design of the "A" type spans described in the article referred to, but were built of iron and were consequently heavier than if they had been built under "steel" specifications. An examination of the drawing does not reveal a want of science or an appearance of clumsiness either in detail or in general design. Fig. 2 shows a span designed in 1893, but not built. The span was designed for practically the same live load as the "A" type span and the sections proportioned for "steel unit stresses." Comparing the trusses and upper bracing of the span with the "A" truss, since the floor and lower lateral system could be made the same for both spans, we find a difference in both weight and stiffness in favor of the riveted type as follows:

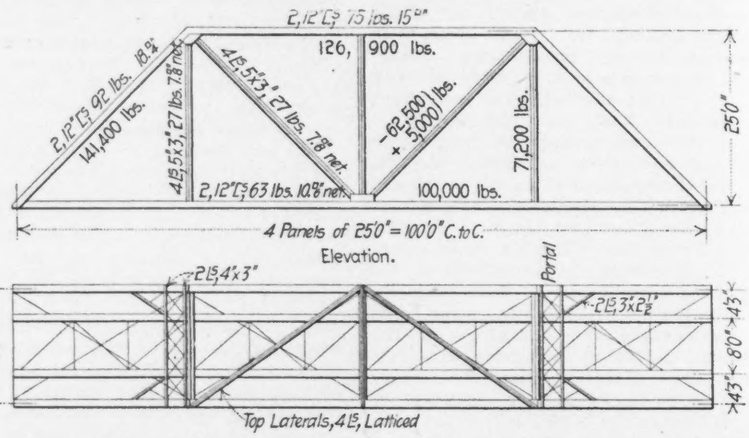


FIG. 1.—WROUGHT-IRON RIVETED TRUSS RAILWAY BRIDGE OF 100-FT. SPAN DESIGNED IN 1891.

	Type "A".	"Rvtd." Type.	Difference.
Weight, trusses and upper bracing, lbs.	66,900	50,700	16,200
Calculated max. live load, deflect'n, ft.	0.0453	0.0377	0.0076

With such a difference in both weight and deflection favorable to the "riveted" type it would seem that this type is by far the best for such crossings and has the additional advantages of presenting a pleasing appearance to the eye, which cannot be said of the "A" type. In the matter of erection the only difference would be in driving about 800 more rivets in the riveted type than the "A" type, a small disadvantage when the additional stiffness obtained by using rigid joints is considered. Should the riveted span be made to weigh the same as the "A" span the additional metal thrown into bracing or into the trusses would increase its rigidity greatly, a point in which it already has the advantage with its lighter weight.

Respectfully yours, H. C. B.

Philadelphia, Pa., Oct. 1, 1898.

(In accordance with our usual practice, we submitted a proof of the above letter to Mr. Waddell, and we append his reply below.—Ed.)

Sir: In answer to H. C. B.'s letter of Oct. 1, I would state that his principal point was well taken, in that the type of bridge he illustrates is good. I have been using it for the past year or two, and have found it very satisfactory. However, it was not in common use in 1893, and can hardly be said to be so to-day. My disparaging remarks concerning the riveted trusses of those days referred to the lattice girder or multiple intersection truss.

H. C. B.'s comparison of weights appears to be faulty, showing as it does that the A truss requires 16,200 lbs. more material than does the riveted truss. As a part of my office records, I have just completed a book of diagrams of weights of fixed spans of all ordinary kinds for all classes of the "Compromise Standard System of Live Loads for Railway Bridges," designed in strict accordance with the specifications of "De Pontibus." Referring to this I find the following weights of metal for 100-ft. spans of Class X, which is the standard adopted by the Kansas City, Pittsburg & Gulf Ry. Co., the owner of the structures under consideration:

A truss span........................1,240 lbs. per lin. ft.
Riveted truss span ....1,190 " " "

Difference in favor of the latter =... 50 lbs. per lin. ft. or 5,000 lbs. for the span.

This extra weight of metal is more than offset by the more expensive field riveting of the lighter bridge.

I must acknowledge that the result of my assistant's computations in respect to the weight of metal in these two types was a surprise to me, as I had not hitherto recognized such great economy of metal for the riveted type. As for the deflections, theoretical figures don't amount to much, especially on such short spans. H. C. B. finds maximum deflections of 0.54-in. and 0.45-in. for the A-truss and the riveted truss, respectively. The engineer who put up one of my 100-ft. A-truss spans found only 0.31-in. with the heaviest load he could get on the bridge, so it is safe to conclude that the maximum load would not have brought the deflection up to 0.4-in.

One great advantage of the A-truss bridge is the ease, rapidity and economy in its erection, while nothing that I have ever seen can beat it for rigidity. Moreover, its appearance is by no means unpleasing to the eye, as H. C. B. claims it is; at least, this is what everyone tells me who has examined this type of structure, and the accompanying view of one of the A-truss bridges erected on the line of the K. C., P. & G. Ry., as above noted, will also enable each reader to judge for himself to some extent in this respect.

Very respectfully yours,
J. A. L. Waddell.

Gibraltar Building, Kansas City, Mo., Nov. 12, 1898.

An Opportunity for Bridge Engineers to Practice Engineering Ethics.

Sir: We have heard a good deal about the "ethics" of the engineering profession from time to time, but beyond mere academic discussion nothing has been accomplished toward a code of action, and probably nothing ever will be from the nature of men and things, and from the fact that engineering is as much a business as a profession. While abstract preaching on such matters cannot be crystallized into concrete organized action among engineers, it has, however, its value in quickening the conscience, so that the individual may aspire to a greater reverence for the golden rule, and a respect at least for the eighth commandment, "Thou shalt not steal," which last injunction, by the way, was the sole platform on which a great political campaign was recently fought in an adjoining state.

The above remarks are apropos of the circular of the Quebec Bridge Co., issued to the bridge builders of this country. This circular affords the profession as represented by our great contracting firms an opportunity to exhibit the extent of their interest in the ethics of the profession. The Quebec Bridge Co. has in view one of the most difficult technical problems of bridge building ever presented to the profession. With a gall unparalleled, it has issued an invitation to contracting engineers to come to its aid and expend large sums of money to furnish it brains and experience, and binds itself to nothing in re-

It would seem as if the Quebec Bridge Co. were financially unable to pay for the information they are seeking, specifically avoiding, as they do, all obligation of any kind, and until they are in a position to bind themselves to a conclusion which would afford some protection to competing parties, it is sincerely hoped that our great engineering firms will let the enterprise severely alone, not only in the interest of good professional morals, but also of their own pockets. To be made use of is bad enough,

of the offence, if any. Particular cases are very seldom dealt with by the simple use of abstract principles or aphorisms, and with a little reflection, very rash applications of the eighth commandment would sometimes be avoided.

The undersigned hastens to repudiate, in behalf of the Quebec Bridge Co., any such intent or motive as is so freely imputed to the latter by your correspondent. The procedure decided on, to ask at once for competitive designs

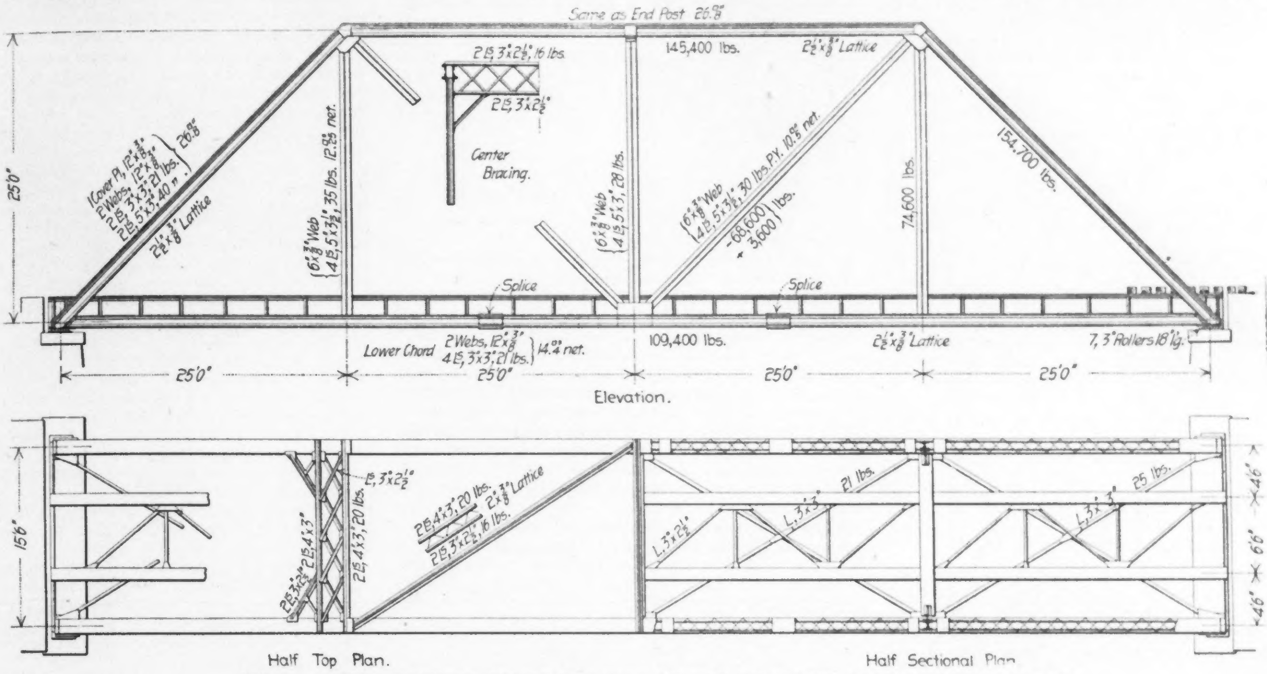


FIG. 2.—STEEL RIVETED TRUSS RAILWAY BRIDGE OF 100-FT. SPAN DESIGNED IN 1893.

turn therefor. It is known that this company has yet to be financed, and the magnitude of the enterprise makes it very doubtful whether it is commercially warranted, even with a liberal government subsidy or guarantee, which is hoped for, but not secured. The invitation is accompanied by an elaborate set of specifications covering the requirements which must be met, such as loads, strains, spans, grades, etc. Several variations of design are asked for under different conditions, any one of which is a special computation, involving vast labor. They will graciously receive anything in the suspension bridge or cantilever line, the only two possible directions in which the problem can be met.

This is a deliberate attempt to get something for nothing, and to obtain practical information at a great cost to everybody foolish enough to furnish it, with which the bridge company will endeavor to formulate a plan of financing on which to appeal to capital. If our contracting firms are fools enough to put at the disposal of such a concern as the Quebec Bridge Co., without compensation or a pledge of any kind, their computing room, and their drawing room, for three or four months, with their accumulated experience of years, they will only have spent their money for the pains, and receive a polite thank you (possibly) from the bridge company. It may be urged that the above method is pursued as a matter of common practice and is therefore not dishonest or immoral. In answer it may be said that most corporations furnish their own plans complete on which tenders are invited, and in other cases, when the contractor furnishes his own plans, it is for corporations prepared to proceed with their work, and on the understanding that the competition invited has a conclusion in a definite award. A contracting company will sometimes back an enterprise in promotion, spending large sums in plans and engineering, for a possible reward to accrue to itself alone, but this is its own affair and is dishonest to no one. But a cold-blooded attempt in cunningly appealing to the business instinct of greed and competition, for the purpose of obtaining, free of cost and obligation, the accumulated experience of the country, simply to find out what can be done so as to get something tangible to go before capital on which absolute cost can be predicted, should be met by our American contracting engineers with indignant refusal. If the engineers of the bridge company are unequal to design a structure to meet the problem, the honorable course to have pursued would have been to have offered a prize or prizes for the best plan, or better, to have selected some half dozen concerns or engineers of established reputation, paying them at least the cost of their outlay for preparing their plans, and submit the competition to a board of engineers for selecting the best and most suitable; the selected plan to be adopted and paid for, either by award of the contract to the successful party or on a per centage basis usual for such works.

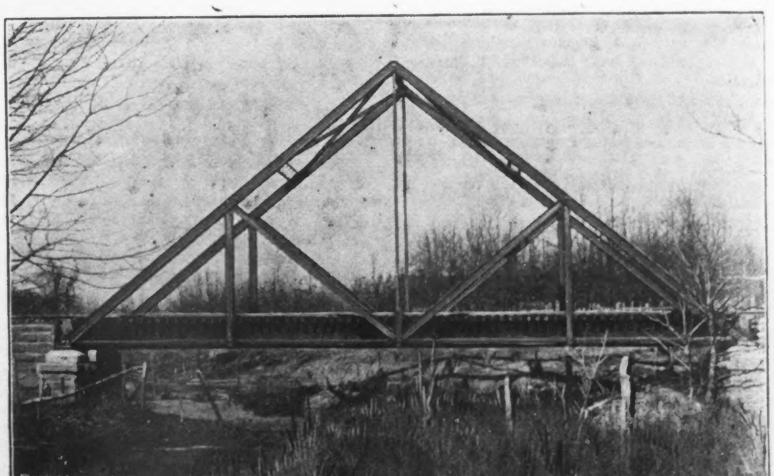
but to be made use of at a cost of some thousands of dollars, without the slightest contingent promise even, is a good deal worse. A. P. B.

New York, N. Y., Nov. 14, 1898.

(According to our usual practice, we submitted a proof of the above letter to the Quebec Bridge Co., Ltd., with the privilege of replying in the same issue to the criticisms contained in it. We append the reply received from the Secretary of the company.—Ed.)

Sir: The action for which the Quebec Bridge Co. is so severely arraigned before the tribunal of public opinion, is the fact of having at once invited tenders and competitive

and tenders, was no "deliberate attempt to get something for nothing," but the natural outcome of circumstances about which A. P. B. manifestly knows nothing. It was adopted purely and simply because it then seemed to be the speediest arrangement for the purpose in view. The prize competition system was not entertained, because it does not generally bring up the same reliable class of respondents as if coupled with a formal invitation to tender for the work. In the first case, a scale of money reward is offered for the two or three first best designs, because designs alone are in view; in the second, the prize, being the letting of the contract to the most deserving, is generally considered well worth the risk. At all events, I beg to affirm that the decision to ask bridge building firms to tender on their own designs was taken in



100-FT. SPAN A-TRUSS BRIDGE ON KANSAS CITY, PITTSBURG & GULF RY., NEAR JOPLIN, MO.

designs for a cantilever or a suspension bridge, without furnishing more than a general plan and general specifications. Your correspondent, A. P. B., condemns such a method as being a transgression of the law of ethics which he suggests should govern the engineering profession, but his own admission that there is not, and probably never will be, a written code to the effect be aims at, should have extenuated in his own judgment the gravity

good faith, with no such dishonest aforethought as is imputed by A. P. B., and that it was arrived at only after it had been ascertained that the arrangement would be accepted as perfectly honorable by a sufficient a number of big contracting companies to justify us in calling for tenders in that manner. As to those, if any, who would be inclined to share A. B. P.'s opinions on professional dignity, their course is very easily traced: it is to refrain from tendering, but it is no reason for attacking our bridge company in the way A. P. B. does, any more than for describing as fools those who are willing to compete at once for the designing and the construction of our bridge.

As to the financial aspect of the question, on which your correspondent bases his whole argument, we squarely deny his right and qualifications to discuss it. His imputation that this company, composed as it is of 200 of the best citizens of Quebec, is unable to pay a few thousand dollars for the technical information it requires, and that it attempts to collect that information by crooked ways without any practical intention to use it, plainly shows he does not know what he is talking about. He surely does not contend that a private company ought to take the public in the confidence of its internal arrangements. How then can he speak of this company's inability to finance, and of the special conditions of its understanding with capitalists, as well as with the government and the city of Quebec? I have just now explained that, at the time the tenders were advertised for, it was with the express purpose to save time and to award a contract on the best competitive design thus secured, after due analysis by a board of competent engineers, in order to be ready to start work as early as possible next spring. I fail to see what dishonesty there is in such proceedings. Your correspondent admits himself that "when the contractor furnishes his own plan, it is for corporations prepared to proceed with their work." Such being our case, his whole argument falls to the ground, and he might have spared your readers his eloquent, though unjustified, sermon on professional ethics.

Ulric Barthe,
Secretary Quebec Bridge Co., Ltd.

Quebec, Canada, Nov. 25, 1898.

NOTES ON THE DEFINITIONS OF SOME MECHANICAL UNITS.*

By William Kent, M. Am. Soc. M. E.

The following paper has been suggested by recent discussions in the Society for the Promotion of Engineering Education, in which considerable difference of opinion was shown to exist between the physicists and the engineers in regard to definitions of the commonly used terms: force, mass, weight, etc.

If a body at rest, but free to move, whose mass is M, be acted on by a constant force, F, during a time, T, it will acquire at the end of the time a velocity, V.

The equation of the four quantities, M, F, T and V, is

$$F\,T = M\,V,$$

provided that the magnitude of the units in which these four quantities are measured, in any system of measurement, is such that the unit force is that force which will give the unit mass unit velocity in unit time, so that we may write

$$1\,F = \frac{1\,M \times 1\,V}{1\,T}.$$

From the equation F T = M V, we may obtain the four equations:

$$F = \frac{M\,V}{T}.\ (1);\quad T = \frac{M\,V}{F}.\ (2);\quad M = \frac{F\,T}{V}.\ (3);$$

$$V = \frac{F\,T}{M}.\ (4);$$

and from these four equations we may obtain definitions of the four unit quantities, each in terms of the other three, as follows:

(1) Unit force is that force which will give unit mass unit velocity in unit time.
(2) Unit time is that time in which unit mass will acquire unit velocity when acted on by unit force.
(3) Unit mass is that mass which will acquire unit velocity when acted on by unit force for unit time.
(4) Unit velocity is that velocity which unit mass will acquire when acted on by unit force for unit time.

These four statements, however, are not really definitions. They are simply expressions of arithmetical equalities. They have their analogues in the definitions based on the electrical formula C = E ÷ R, in which C is current in amperes; E, electro-motive force in volts, and R, resistance in ohms. Thus, unit current is that current which unit electro-motive force will cause to flow through unit resistance. Unit electro-motive force is that force which causes a current of one ampere to flow through one ohm. Unit resistance is that resistance through which one volt will cause to flow a current of one ampere.

These three definitions, as well as the four first given, are examples of reasoning in a circle. The definition of each quantity is expressed in terms of the other quantities. We may have other definitions, however, in which each term is defined independently, without reference to the other terms. Thus, in electricity unit current may be defined as that current which will deposit in a given time a certain amount of silver from a standard solution; unit electro-motive force as the electro-motive force existing between the poles of a certain standard cell; unit resistance as the electrical resistance of a certain piece of metal under certain standard conditions.

So in mechanics, unit mass may be defined as the mass of a certain piece of metal, such as the British pound, or the gramme. Unit force may be defined as that force with which the standard pound is attracted to the earth at London, or as some fraction—say, 1 ÷ 32.2 of that force; or, it might be defined as that force which will stretch a certain spring a certain distance, or, as that force which will elongate a certain steel bar a millionth part of its length. Unit velocity may be defined as the quotient of a certain distance divided by a certain time, the distance being the length of a certain piece of metal. Unit time may be defined as 1-86,400th part of a mean solar day, or, as the time in which a certain pendulum makes one vibration at London.

Referring again to the equation F T = M V, and choosing our units so that the unit force is that force which in unit time gives unit velocity to unit mass, we may obtain the following statements of the relation of the four unit quantities, F, T, M, V:

F	× T	= M	× V
1 poundal	acting for 1 second	on 1 lb.	gives a velocity of 1 ft. per sec.
1 lb.	" " 1 second	on 1 massal	gives a velocity of 1 " " "
1 "	" " 1 second	on 1 lb.	gives a velocity of 1 gravital per sec.
1 "	" " 1 timal	on 1 lb.	gives a velocity of 1 ft. per sec.

The term "poundal" has been used by some English writers on mechanics. The terms "massal," "gravital," and "timal" have been invented for the purposes of this paper only. It is to be hoped that they will never be used in the text-books, and that the term "poundal" will soon be expunged from those text-books which have adopted it.

One pound force is the force with which gravity acts on the standard pound at London; 1 poundal is 1/32.19 of this force; 1 lb. mass is the mass of the standard pound; 1 massal is 32.19 lbs.; 1 gravital is 32.19 ft.; 1 timal is 1/32.19 of a second.

In the C. G. S. system, we have

1 dyne	acting for 1 second	on 1 gramme	gives a velocity of 1 cm. per sec.
1 gramme	" " 1 second	on 981 grammes	gives a velocity of 1 " " "
1 "	" " 1 second	on 1 gramme	gives a velocity of 981 " " "
1 "	" " 1/981 sec.	on 1 gramme	gives a velocity of 1 " " "

The "dyne" is a term used in the text-books. It is the force with which a mass of 1/981 gramme is attracted by gravity at Paris. New names might be invented for the quantities 981 grammes and 1/981 sec. 981 centimeters is 1 gravital, or 32.19 ft.

Out of the eight statements given above, we may select those that are most convenient for any given purpose, such as engineering practice, and throw away and forget the others, since the unnecessary multiplication of formulas, terms and definitions only gives rise to mental confusion and error. In engineering, with English weights and measures the third statement is practically the only one that is needed, and, translating the useless term gravital into its equivalent, we may write it: A force of 1 lb. acting on 1 lb. mass for 1 second, gives it a velocity of 32.19 ft. per second.

It may be convenient in electrical or stellar physics to use the dyne, or its multiple, the megadyne,but there seems to be no use in English measurements for the poundal, nor do we need any such terms as the gravital, the massal or the timal.

Prof. John Perry, in his work on "The Calculus for Engineers," London, 1897, says:

> I venture to say that there is not one practical engineer in this country who thinks in poundals, although all the books have used these units for 30 years.

The word pound is used in two senses, as the unit both of force and of mass (or weight). This need introduce no confusion, for whenever it may be necessary to make a distinction, we may say a pound force, a pound mass, or a pound weight.

We may rigidly define the pound force as the force which gravity exerts on the standard pound (a piece of metal) at London. The pound mass, or weight, is the standard pound itself.

It will be noticed that we cannot express the relation F T = M V in terms of the pound (or gramme) unit of mass and force, the second of time and the unit of velocity 1 foot (or 1 centimeter) per second, but in the English system we have either to introduce the numerical coefficient 32.19 or 1/32.19, and in the French system 981 or 1/981; or else, to invent a new unit such as the poundal, dyne, gravital, etc., in order to obtain an equation. If our unit of distance were 32.19 ft. of 9.81 meters, instead of 1 ft. or 1 centimeter, then we could express the equation without such a coefficient or new term, but the benefit would be infinitesimal in comparison with the confusion that would result from the introduction of a new unit of length. There is just as much reason, however, for using a new unit of length, such as a gravital, meaning 32.19 ft., as there is in using a new unit of force, such as the poundal.

The word mass, in what is said above, has been used in the sense in which it is used in the text books on physics, but it is used in another sense by most writers on engineering, namely, as the quotient arising from dividing the weight of a body at London by 32.19, or by dividing its weight (defined as the resultant of the attraction of gravitation upon it), at any other place by the acceleration due to gravity at that place, say 32.16 at latitude 45° at the sea level.

Some confusion often arises in the minds of engineering students from the use of the word mass in these two senses, and a like confusion sometimes results in the two senses in which the word weight is used. The definition of weight above given—the resultant of the attraction of gravitation—is not the definition used in commerce or in engineering. The common definition of weight is quantity of matter as determined not by bulk (which is one meaning of the word quantity), but by weighing it; that is, comparing it by means of an even balance or platform scale with a standard weight, such as the pound. In common language, we say that we weigh a body; determine how much it weighs; obtain its weight in pounds, and these pounds are standard units of weight, so declared by act of Parliament, and so defined in the dictionaries. Modern writers on physics, however, say that this language is all wrong; that we should use the term mass instead of weight, when we refer to quantity of matter, and not to the attraction of gravitation upon it. We should therefore say, perhaps, that we mass a body; determine how much it masses; obtain its mass in pounds, and that the act of Parliament was in error when it called the standard pound a weight and not a mass.

The definition of mass, commonly used by engineering writers, and sanctioned by such authors as Weisbach and Rankine, is the quantity of matter as expressed by the term W ÷ g, in which W is the weight of the body at London (either the attraction of gravitation on it at London, or its quantity as determined by comparing it with the standard pound anywhere on earth), and g is the London value of g, or the acceleration due to gravity at London, or 32.19. If, however, the weight of the body is that determined by weighing it on a spring balance standardized at London (which is not done in commerce or in engineering in the United States), then the mass would be the weight so determined, divided by the value of g at the place where the weighing is done.

The engineer uses the word weight in the sense in which the common people use it, and have used it ever since the word was known in the English language, and in the sense in which the physicist uses the word mass. The engineer uses the word mass to mean weight divided by 32.19, usually taken as 32.2.

Formulas commonly used by the engineer are

$F\,S = \frac{1}{2}\,M\,V^2$, formula for energy;
$F\,T = M\,V$, " " momentum;
$F = M\,A$, " " force causing acceleration;
$V = \sqrt{2\,g\,S}$, " " falling bodies, or for height due to velocity.

In the first three of these formulas the engineer always uses the pound as the unit of the force F, and for M he substitutes W, the weight in pounds, divided by 32.2. In the fourth formula, for accurate work, he must use the value of g for the latitude to which the particular problem in hand applies.

The difference between the physicist and the engineer is merely one of definition. There may be no objection to the physicist using for his own purposes the terms and definitions which he finds most useful or convenient, but it is an open question whether the physicist has the right to denounce the engineer's terms and definitions as improper, or whether it is advisable for the text-books used in teaching mechanics to engineering students, to use the definitions of the physicist instead of those of the engineer. The use of the term "poundal" is especially objectionable, for it is not used anywhere outside of the text-books, in any art, industry or profession. Much confusion in the minds of students of mechanics would be avoided if the term were denounced and dropped from the language.

*A paper read before the session of Mechanical Science and Engineering of the American Association for the Advancement of Science, Boston meeting, August, 1898.

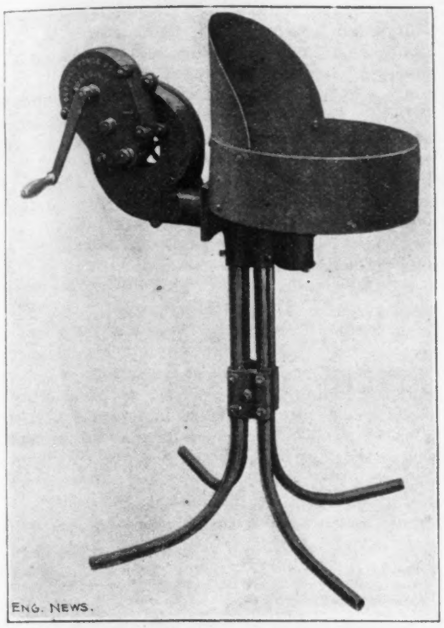
A HOTEL IN SAN FRANCISCO BURNED to the ground on Nov. 24, causing the loss of five lives, the injury of four persons, and the destruction of over $2,000,000 worth of property. It is understood that the fire started in the café kitchen, and at the time there were several hundred guests and employees in the hotel. The building, owned by E. J. Baldwin, was completed in 1877, at a total cost of about $3,000,000, including ground. It was irregular in shape, being 200 × 400 × 300 ft. and 6 stories high, and it contained a theatre and several large stores on the ground floor.

THE LOSS OF THE STEAMER "PORTLAND," of the Boston & Portland Steamship Co.,off Highland Light,Mass., occurred in a severe storm on Nov. 27. The entire crew and all passengers, numbering about 117, were lost. The accident is attributed to a breakdown in her machinery, which allowed the vessel to drift onto the shore during the severe storm of Saturday and Sunday. The "Portland" was built in 1890 at Bath, Me., and was a side-wheel steamer 250 ft. long, 42 ft. beam, and 13 ft. deep, with a net tonnage of 1,317.

A SUIT FOR INFRINGEMENT of the Hyatt patent on the use of a coagulant in connection with mechanical filters has been brought against the Jackson Filter Co., of St. Louis, by the New York Filter Mfg. Co. A hearing will be held on Dec. 13, in the U. S. Circuit Court, Eastern District of Missouri.

A PORTABLE FORGE WITH DETACHABLE PARTS.

The accompanying cut illustrates a new portable forge, manufactured by the Buffalo Forge Co., Buffalo, N. Y., which has some interesting features. For convenient packing and transportation it may readily be taken apart by loosening the clamp on the legs and the set-screws at the base. The crank is rigidly fixed to the shaft, which drives the gears enclosed in the dust-proof case, but the gear-case and the blower are both detachable from the tuyere pipe. No belts or chains



Portable Forge, with Detachable Parts.

Manufactured by the Buffalo Forge Co., Buffalo, N. Y.

are used in the driving gear, which consists of four spur gears, the two larger wheels having respectively 108 and 90 teeth, and the two pinions each 16 teeth, thus increasing the speed 37.96 to 1. The blast wheel is 9 ins. diameter, with five curved blades riveted to a sheet steel flange on each side. With 30 revolutions of the crank shaft per minute the peripheral velocity of the blast wheel is 2,684 ft. per minute.

The body of the fire pan is made of No. 14 sheet steel. The total weight of the forge set up for use is 125 lbs. When taken apart and packed for easy carrying, it may readily be carried about scaffolding by one man. The gears are machine cut, the fan wheel is balanced, and the bearings are well finished, all contributing to ease of operation.

THE BURSTING OF SMALL CAST-IRON FLY-WHEELS.*

By Chas. H. Benjamin, M. Am. Soc. C. E.†

Of late years the failure of large fly-wheels have become alarmingly common. Every month brings its record of one or more disasters of this sort, some of them entailing loss of life and serious destruction of property. It is not the purpose of this paper to discuss the causes of such accidents, further than to notice the fact that the high belt speeds and close regulation required in electric plants have been indirectly responsible. Many of the fly-wheels have failed on account of excessive speed due to disarrangement of the governor and consequent racing of the engine. In some instances it has been difficult to determine the cause on account of the destruction and excitement at the moment. In no small number of instances, however, the wheels have burst at speeds but slightly above the normal and when the factor of safety was apparently ample.

Mr. James Stanwood, of this Society, was the first to point out the condition of stress existing in a fly-wheel rim and to show that the bending due to centrifugal force might reduce very materially the bursting speed (Trans. A. S. M. E., Vol. XIV., p. 251). This subject was further developed by Professor Lanza, and the probable amount of stress due to bending was indicated as well as its effect upon rim joints (Trans. A. S. M. E., Vol. XVI., p. 208). It occurred to the writer that a series of experiments on small cast-iron wheels might throw some light on the causes of failure and lead to more rational formulas for design.

The quality of the metal in a small wheel is better than in a large, and the stresses due to uneven cooling are much less. The linear speed of rim at which a large wheel will burst will therefore be less than that obtained by experiments on small wheels.

The experiments about to be described were conducted under the immediate direction of the writer at the laboratories of Case School of Applied Science. The wheels were all of cast iron and were clean, perfect castings. Two diameters were used, 15 and 24 ins., and each wheel was a scale model of some actual fly-wheel designed by a reputable firm. The wheels numbered 1 to 10 had solid rims, with the exception of No. 5. Wheel No. 11 was a special wheel, as will be explained later. The wheels numbered 12 to 17 had each two joints in the rim and were 24 ins. in diameter. All the wheels numbered from 1 to 10 were reduced models of a solid-rim fly-wheel 10 ft. in diameter now in use on a 12 × 30 Allis-Corliss engine in the laboratory. The wheels numbered 12 to 15 were models of the same wheel on a larger scale, with rim joints designed by the writer. The two wheels numbered 16 and 17 were models of the fly-wheel of a Corliss blowing engine. Tables I. and III. give the dimensions of the wheels in detail.

To give to the wheels the speed necessary for destruction, use was made of a Dow steam turbine capable of being run at any speed up to 10,000 revolutions per minute. The turbine shaft was connected to the shaft carrying the fly-wheels by a brass sleeve coupling, loosely pinned to the shafts at each end in such a way as to form a universal joint, and so proportioned as to break or slip without injuring the turbine in case of sudden stoppage of the fly-wheel shaft.

One experiment with a shield made of 2-in. plank convinced us that safety did not lie in that direction, and in succeeding experiments with the 15-in. wheels a bomb-proof constructed of 6 × 12-in. white oak was used. The first experiment with a 24-in. wheel showed even this to be a flimsy contrivance. In all subsequent experiments a shield made of 12 × 12-in. oak was used. Even this shield was split repeatedly and had to be re-enforced by bolts. The wheels were usually demolished by the explosion. No crashing or rending noise was heard, only one quick, sharp report, like a musket shot.

The determination of the speed offered some difficulties at first, it being too great for the successful use of a counter or tachometer. A commutator of one break was arranged on the fly-wheel shaft and this connected through the battery circuit with an earphone in an adjoining room. This arrangement worked satisfactorily, giving a clear, musical tone, and the number of vibrations corresponded closely to the speed as measured by a reducing counter shaft and speed counter. It was soon discovered that the audible tone produced by the machine itself when running at a high speed corresponded exactly to the tone in the ear-phone, and consequently the ear-phone was discarded. Two observers, having trained musical ears and provided with tuning forks, had no difficulty in determining the pitch within half a tone, the quarter tones being estimated. The error due to this method did not exceed 5%. The bursting speed of the wheels having rim joints was too low to produce a musical tone with any distinctness, and it became necessary to resort to the tachometer, a counter shaft reducing the speed from two to three times being employed.

Fifteen-Inch Wheels.

Test pieces cast from the same ladle as these wheels were broken in the testing machine, and the following average values obtained for the breaking strength: Tension, 19,000 lbs. per sq. in. Cross-breaking, 39,000 lbs. per sq. in. These wheels were all turned on the face and edges of the rim, and were carefully balanced by winding copper wire around the arms near the rim.

The shape of fracture at the outer ends of the arms in all the wheels usually indicated that the rim broke first midway between the arms, and that then the two parts of the rim flew outward and broke off at the arm.

Wheel No. 5 had two joints in the rim at opposite extremities of a diameter. The strength of the joints was designed to be one-third the tensile strength of the solid rim, but the wheel burst at only 2,925 revolutions per minute with a centrifugal tension of less than one-fourth that of the solid wheels.

Nos. 6, 7 and 8 had only three arms, every other arm having been removed from the pattern before casting. The object of this was to show more clearly the bending of rim due to centrifugal force.

Wheels Nos. 9 and 10 were of the original six-armed type, but with rims turned down to exceeding thinness. The results are summarized in Table I. An examination of the column containing the value of v in feet per second will show that as the segments of the rim between the arms become weaker as beams, either through increase of length or decrease of thickness, there is a falling off in the bursting speed.

TABLE I.—Particulars of 15-in. Wheels Tested.

No.	Area rim, sq. ins.	Weight of wheel, lbs.	Bursting speed: Revolutions per min.	Bursting speed: Feet pr sec. = v.	Centrif'g'l tension $= \frac{v^2}{10}$.	Remarks.
1.	1.4	20.87	6,525	430	18,500	
2.	1.3	20.44	6,525	430	18,500	
3.	1.23	19.12	6,035	395	15,600	Thin rim.
4.	1.04	16.62	5,872	380	14,400	Thin rim.
5.	....	20.87	2,925	192	3,700	Joint.
6.	1.38	19.25	5,600*	368	13,600	Three arms.
7.	1.25	16.56	6,198	406	16,500	Three arms.
8.	.95	13.68	5,709	368	13,600	Three arms.
9.	.75	12.68	5,709	365	13,300	Thin rim.
10.	.65	13.00	5,709	361	13,000	Thin rim.

*Doubtful.

Note.—The diameter of the wheels ranged from 14½ to 15⅛ ins. The breadth of rim was 2 ins., except Nos. 9 and 10, 1⅞ ins. The area of the arms was 0.46-sq. in. Nos. 6, 7 and 8 had three arms, the others six arms.

To determine to what extent the strength is affected by bending, values of $\frac{v^2}{10}$ have been calculated. As has been shown by Mr. Stanwood in the paper before referred to, this expression represents approximately the tensile stress on the square inch of section of rim due to the centrifugal force, for cast iron. By comparing these values with the tensile strength of the iron, viz., 19,000 lbs. per sq. in., the amount of stress due to bending may be estimated. This difference varies from 500 lbs. per sq. in. in Nos. 1 and 2 to nearly 6,000 lbs. per sq. in. in Nos. 9 and 10—being greatest in the wheels with thin rims or few arms. None of these wheels, however, except No. 5, would have been unsafe at the usual limit for fly-wheel rims of 100 ft. per second. Wheel No. 10 would have had a factor of safety of over 12 at that speed.

Twenty-four-Inch Wheels.

No. 11 was a special wheel which had been in actual use. This wheel burst at 3,670 revolutions per minute, or a peripheral speed of 385 ft. per second, which corresponds well with the average speed of the 15-in. wheels. The explosion was very violent, and completely wrecked the shield. The quality of the iron was unknown, save that it appeared clean and close-grained.

Flanged Joints.

The wheels numbered 12 to 15 were of the same model as the 15-in. wheels on a larger scale, but each wheel had two internal flange joints in the rim, midway between the arms. The joints were all carefully planed and the holes drilled to match. The wheels were not turned on the face, but were balanced the same as the others.

The bolts used were of steel, and samples of each broken in the testing machine gave the results shown in the table.

Wheel No. 12 burst at a speed of less than 1,800 revolutions per minute, but the exact speed was not recorded. The flanges broke, but the bolts were uninjured, except for a slight stretching.

No. 13 was a duplicate of No. 12 in every way. The bolts were uninjured but the flanges broken through the bolt holes. The flanges of the pattern were then strengthened by adding ¼-in. to the thickness, the bolts remaining the same.

In wheel No. 14 the bolts failed.

In No. 15, bolts ⅝-in. in diameter were used. The flanges of one joint were badly broken, the bolts remaining whole. The second joint was uninjured.

The results are summarized in Table II. It will be noticed that the rim speed is about one-half that of a solid wheel, and therefore the centrifugal tension about one-fourth. The joints in all the wheels were carefully made, and were relatively stronger than many joints in fly-wheels which are running to-day in our mills and shops. The centrifugal tension at the joint would be greater than that given in Table II., on account of the weight of finages and bolts. At a rim speed of 100 ft. per second these wheels would have a factor of safety of about 3 6-10, which is altogether too small.

TABLE II.—Particulars of 24-in. Wheels Tested.

No.	Shape and size of rim: Bre'dth, ins.	Depth, ins.	Area, sq. ins.	Weight of wheel, lbs.	Flanges: Effective breadth, ins.	Efctive area, ins.
11.	2⅛	1.5	3.18	75.25	....	....
12.	4 1/16	.75	3.85	93.0	2.8	1.92
13.	4	.75	3.85	91.75	2.75	1.89
14.	4	.75	3.85	95.0	2.75	2.58
15.	4 1/16	.75	3.85	94.75	2.5	2.34
16.	1.2	2.1	2.45	65.1	...	....
17.	1.2	2.1	2.45	65.0	...	....

Notes.—No. 11 was a solid rim wheel. Nos. 12 to 15 had internal flanges bolted. Nos. 16 and 17 had linked joints—No. 16 with three links, and No. 17 with two. The flanges of Nos. 12 and 13 were 11-16-in. thick; Nos. 14 and 15, 15-16-in. Each joint was bolted with four bolts, 15-16-in. diameter, except No. 15, which had ⅝-in. bolts.

By testing machine:

Tensile strength of cast iron = 19,600 lbs. per sq. in.
Transverse strength of cast iron = 46,600 lbs. per sq. in.
Tensile strength of 5-16 bolts = 4,000 lbs. each.
Tensile strength of ⅝ bolts = 5,000 lbs. each.

*Condensed from a paper presented at the New York meeting of the American Society of Mechanical Engineers.

†Professor of Mechanical Engineering, Case School of Applied Science, Cleveland, O.

TABLE III.—Failure of Flanged Joints.

No.	Area of rim, sq. ins.	Effect. area flanges, sq. ins.	Total strength bolts, lbs.	Bursting speed. Revs. per min.	Bursting speed. Feet pr sec. = v.	Centrifugal tension. Per sq in. $= \frac{v^2}{10}$	Centrifugal tension. Total, lbs.
11.	3.18	.....	......	3,672	385	14,800	47,000*
12.	3.85	1.92	16,000	.....	...	......	......†
13.	3.85	1.89	16,000	1.760	184	3,400	13,100†
14.	3.85	2.58	16,000	1,875	196	3,850	14,800§
15.	3.85	2.34	20,000	1,810	190	3,610	13,900†

*Solid rim. †Flange broke. §Bolts broke.

Linked Joints.

Wheels numbered 16 and 17 were of the familiar rolling-mill type, with the joints connected by steel links over cast-iron lugs, the links being heated and shrunk on. The dimensions of the lugs and links are given in Table III.

Wheel No. 16 had three links to each joint, one on each face and one inside. Each joint broke on one side, through the rim, without shearing the lugs or breaking the links.

In No. 17 the link was omitted from the inner lug, leaving but two links to each joint. On one side the rim broke as in No. 16; on the other side the lugs failed by breaking off. It is impossible to say which joint failed first. No. 16, with three links, broke at a speed 66% in excess, and No. 17, with two links, at a speed over 50% in excess of that of the wheels with flanged joints.

The strength of the rim at the weakest section is apparently in excess of the strength of the links, whereas it was the rim that failed in each case. It must, however, be remembered that the links were under direct tension, while the rim was subjected to bending in addition.

At 100 ft. per second the factors of safety for Nos. 16 and 17 would be 10¼ and 8 4-10 respectively.

Conclusions.

1. Fly-wheels with solid rims, of the proportions usual among engine builders and having the usual number of arms, have a sufficient factor of safety at a rim speed of 100 ft. per second if the iron is of good quality and there are no serious cooling strains.

In such wheels the bending due to centrifugal force is slight, and may safely be disregarded.

2. Rim joints midway between the arms are a serious defect and reduce the factor of safety very materially. Such joints are as serious mistakes in design as would be a joint in the middle of a girder under a heavy load.

3. Joints made in the ordinary manner, with internal flanges and bolts, are probably the worst that could be devised for this purpose. Under the most favorable circumstances they have only about one-fourth the strength of the solid rim and are particularly weak against bending.

In several joints of this character, on large fly-wheels, calculation has shown a strength less than one-fifth that of the rim.

4. The type of joint exemplified in Nos. 16 and 17 is probably the best that could be devised for narrow-rimmed wheels not intended to carry belts, and possesses when properly designed a strength about two-thirds that of the solid rim.

It is gratifying to notice the fact that since the subject of joints in fly-wheel rims has been so thoroughly venti-

TABLE IV.—Failure of Linked Joints.

		No. 16	No. 17
Lugs.	Breadth, ins.	0.45	0.44
	Length, ins.	1.0	.98
	Area, sq. ins.	.45	.43
Links	Effect. breadth, ins.	.57	.54
	Thickness, ins.	.327	.380
	Effective area, sq. ins.	.186	.205
Maximum rim area, sq. ins.		2.45	2.45
Net rim area, sq. ins.		1.98	1.98
Strength of links, lbs.		30,540	20,360
Strength of rim, lbs.		38,800	38,800
Bursting speed, revs. per min.		3,060	2,750
Bursting speed, ft. per sec = v.		320	290
Centrifugal tension.	Per sq. in. $= \frac{v^2}{10}$	10,240	8,410
	Total	25,100	20,600
Remarks		Rim broke.	Lugs and rim broke.

By Testing Machine: Tensile strength of cast iron = 19,600; transverse strength of cast iron = 40,400; average tensile strength of each link = 10,180.

lated during the discussions before this Society, several of our prominent engine builders have changed the designs of their wheels by bringing the rim joints opposite the ends of the arms.

The experiments which have just been described, although at times a trifle too exciting, were interesting from first to last. The writer hopes to supplement them by others on models of the more recent rim-joints, and would be glad to receive any suggestions.

The more this subject is agitated, the less shall we have occasion to mourn the destruction of life and property on account of faults in the design of this most necessary element of the steam engine.

A NOTE ON THE STRENGTH OF WHEEL RIMS.*

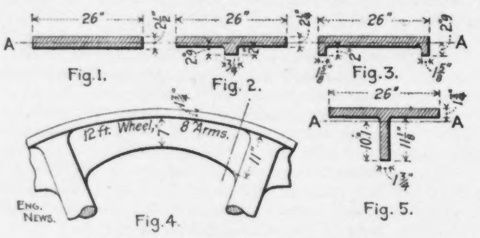
By Albert K. Mansfield, M. Am. Soc. C. E.†

On p. 5 of Mr. Suppiee's translation of Releaux's "Constructeur" occur these words: "It is upon this point that the peculiar strengthening effect of ribs depends, and which makes their use so advantageous in cast-iron construction."

Then illustrations follow to support the fact that ribbed construction increases strength, that is, is economical of material; but it is not shown there, nor elsewhere to the present writer's knowledge, that this is not universally the case, but that the exact contrary may be the fact.

This may best be pointed out by a practical illustration: The moment of resistance* of the rectangular section of Fig. 1 is $\frac{hb^2}{6}$ or $\frac{26 \times 2\frac{1}{2}^2}{6} = 27.07$, AA being the neutral axis.

Now let ¼-in. of the thickness of this section be formed into a rib 3¼ ins. thick, as shown by Fig. 2. Preserving the same total area as before, this rib becomes 2 ins. deep, making the total depth of the section 4½ ins. The neutral axis will be found to be located as shown in the



Fly-Wheel Rims of Various Section.

figure, and from a well-known formula the moment of resistance is found to be 18.64; that is, the least moment of resistance, or the moment of inertia divided by the greatest distance of fiber from the neutral axis.

The section has therefore been weakened by the ribs; in fact, unless it represents the special case of a cast-iron beam loaded so that the extreme fiber is subjected to compression, it is only about two-thirds as strong as before. It is seen, therefore, that under some conditions ribbing does not have a strengthening effect. It would clearly be useful to generalize this matter in such a way as to make it easy for the designer to determine when and to what extent ribbing may or may not be resorted to with advantage, but that is beyond the purpose of the present writing.

If we separate the rib of Fig. 2 into two ribs and place them at the ends of the section as in Fig. 3, we have, without change of strength, a section similar to that often used in the construction of wheel rims. The bending moment of such rims, due to centrifugal force, acts with maximum effect near the wheel arms, in such way as to cause tension at the extreme fiber. It will be clear, therefore, that such ribs in such place may make the wheel weaker than it would be if they were not employed. It is not meant that wheels cannot be ribbed in this manner to their advantage, but rather that it is necessary to take care that they are not thus ribbed to their disadvantage. There are many wheels in service which have been strengthened in this negative way.

The destructive accidents which have occurred to large wheels have led to bringing cast iron into disrepute as a material from which to construct such wheels. This fact, coupled with that pointed out above relative to rim-flanges, has led the present writer to the use of the method of ribbing wheels illustrated in Fig. 4, which seems to fill all requirements, enabling cast-iron rims to be made as strong as may be practically desired.

Maintaining the same face of wheel and total area of section as before, let us employ ¾-in. of the thickness of rim in forming a rib 1¾ ins. thick at center of rim; the section then becomes as shown by Fig. 5. The neutral axis of this section is at line AA, and the moment of resistance becomes 77.5, which is nearly three times as strong as the section of Fig. 1, and is more than four times as strong as the flanged section of Fig. 3. Of course, a further increase of strength may be obtained by adding to depth of flange.

Now the section of Fig. 5 is taken to represent that next the arms, in which (the case being that of a built-in beam uniformly loaded) the extreme fiber is under tension. The mid-section between arms, however, while acted upon by an equal moment (when the cross-section is uniform), is bent in an opposite direction; therefore the extreme fiber is compressed, which, for equal strength, enables the flange at this point to be reduced, because cast iron is twice as able to resist compression as extension. The modulus of resistance at this point may therefore be one-half as great as at the arms, which will be found to correspond with a flange depth of about five-eighths of that at arms, or in this case about 7 ins.

The proportions are shown in Fig. 4. Almost any desired strength may be attained by this method. It has several other advantages over uniform flanges at edges which will readily occur to designers or wheels.

*A paper presented at the New York meeting of the American Society of Mechanical Engineers.

*[This is more correctly the "section modulus." The moment of resistance is the section modulus multiplied by the resistance per square inch at the extreme fiber.—Ed. Eng. News.]

†Mechanical Manager, Buckeye Engine Co., Salem, O.

FORM FOR REPORTING THE RESULTS OF BOILER TESTS.

The Committee of the American Society of Mechanical Engineers, appointed in 1895 to revise the standard code of 1885 for trials of steam boilers, has presented in pamphlet form its report at the meeting held in this city this week. A year ago it presented what was called a "Preliminary Draft of Report," prepared by a sub-committee of four out of the nine members of the committee, requesting full discussion and criticism. In our issue of Dec. 9, 1897, we printed from this "preliminary draft" those sections which differed materially from the code of 1885. In the final report now presented, which, however, is still "subject to revision" before being printed in the volume of Transactions, the amendments to the 1885 code which were in the "preliminary draft" are retained, with a few corrections of more or less importance. The principal new feature of the report in its present shape is the insertion of a "Short Form of Report" of the results of a boiler test, containing only 31 items, as an alternative to the longer form presented last year, which contains 74 items. The short form is recommended for commercial tests and as a convenient form of abridging the longer form for publication when saving of space is desirable. We reprint this "Short Form" below:

Data and Results of Evaporative Test,

Arranged in accordance with the Short Form advised by the Boiler Test Committee of the American Society of Mechanical Engineers.

Made by................on...........boiler, at.........
to determine ....

Grate surface	sq. ft.
Water-heating surface	"
Superheating surface	"
Kind of fuel	
Kind of furnace	

Total Quantities.

1. Date of trial	
2. Duration of trial.	hours.
3. Weight of coal as fired	lbs.
4. Percentage of moisture in coal.........	per cent.
5. Total weight of dry coal consumed.....	lbs.
6. Total ash and refuse	"
7. Percentage of ash and refuse in dry coal	per cent.
8. Total weight of water fed to the boiler.	lbs.
9. Water actually evaporated, corrected for moisture or superheat in steam.......	lbs.

Hourly Quantities.

10. Dry coal consumed per hour.	lbs.
11. Dry coal per hour per square foot of grate surface	"
12. Water fed per hour....................	"
13. Equivalent water evaporated per hour from and at 212° corrected for quality of steam	"
14. Equivalent water evaporated per square foot of water-heating surface per hour	"

Average Pressures, Temperatures, Etc.

15. Average boiler pressure	lbs. per sq.in.
16. Average temperature of feed water.....	deg.
17. Average temperature of escaping gases..	"
18. Average force of draft between damper and boiler............	ins. of water.
19. Percentage of moisture in steam, or number of degrees of superheating...	

Horse-power.

20. Horse-power developed (Item 13 ÷ 34½)	HP.
21. Builders' rated horse-power............	"
22. Percentage of builders' rated horse-power	per cent.

Economic Results.

23. Water apparently evaporated per pound of coal under actual conditions. (Item 8 ÷ Item 3).........................	lbs.
24. Equivalent water actually evaporated from and at 212° per pound of coal as fired. (Item 9 ÷ Item 3)..........	"
25. Equivalent evaporation from and at 212° per pound of dry coal. (Item 9 ÷ Item 5)	"
26. Equivalent evaporation from and at 212° per pound of combustible. [Item 9 ÷ (Item 5 — Item 6)]................. (If Items 23, 24 and 25 are not corrected for quality of steam, the fact should be stated.)	"

Efficiency.

27. Heating value of the coal per pound...	B.T.U.
28. Efficiency of boiler (based on combustible)	per cent.
29. Efficiency of boiler, including grate (based on coal)	per cent.

Cost of Evaporation.

30. Cost of coal per ton of 2,240 lbs. delivered in boiler-room	$
31. Cost of coal required for evaporation of 1,000 lbs. of water from and at 212°..	$

MEDICAL OUTFIT AND INSTRUCTIONS FOR AN ENGINEER IN THE TROPICS.

In the "Medical Fortnightly" of Nov. 15, we find an interesting letter by Albert L. Ashmead, M.D., of New York city, describing a medical outfit which he prepared for his brother, Mr. Percy H. Ashmead, C. E., who has recently sailed to Ecuador to fulfil an engagement as topographical engineer on the line of the Guayaquil & Quito R. R. As many of our readers are likely to see service in tropical countries during the next few years, we reprint in full Dr. Ashmead's description of this outfit, which, it is of especial interest to note, can all be carried in a box only 9 × 12 × 6 ins. in size:

Two porte caustics; to stop a bleeding point; to stimulate a sore that heals too slowly, etc.

Iodoform gauze 10 per cent; as a dressing for wounds, cut off as much as may be required.

Sun cholera mixture tablets; for diarrhea, one every two hours until the diarrhea is checked.

Triplex pills (blue mass, aloes and podophyllin); for torpidity of the liver in the tropics; when there is constipation take one of the pills at bedtime.

Permanganate of potash pills (2-grain); in case of snake bite, take one, and follow at once with a tumbler of water. Repeat every hour. In gonorrhea, dissolve one in a tumbler of water, and use as an injection. As a surgical wash in the same dilution, apply on cotton to the part affected.

Chronic acid solution (1 to 100 parts of water). This is the Orfila prize remedy for viper bites. Use as a wash with absorbent cotton, to the snake bite wound, at once after the biting.

Solution of chloride of gold (1 in 60 parts of water). This is Calmette's remedy for snake bites. On being bitten, after washing the wound with the above acid solution, inject 10 minims (or drops) with the hypodermic syringe, in the sound skin, near the wound; repeat the injection after one hour.

Solution of chloride of lime (Merck's pure 1 in 60 parts of water). This is another of Calmette's remedies. In snake bites, after washing the wound with the chromic acid solution, and injecting in the neighborhood of the wound, the chloride of gold solution (10 minims), inject with the hypodermic syringe, 10 minims of this solution, beneath the sound skin, near the wound. Repeat after an hour's interval.

These three local remedies, the chromic acid wash, the hypodermic chloride of gold, the hypodermic chloride of lime, must be fortified in case of snake bite, by the internal administration through the mouth, of a permanganate of potash tablet (followed by a glass of water) every hour.

Callodion with 2½% salicylic acid. In insect stings paint over the skin, and also in certain skin eruptions, with a piece of cotton wrapt around the end of a stick.

Callodion with 10% idioform; use as a dressing for wounds, painted on the wound, with cotton on the end of a stick, or with camel's hair pencil.

Calomel and soda tablets (each one grain); to stimulate liver, correct disordered stomach, relieve colic, correct torpidity of liver when stools are clay or gray colored, to cause a flow of bile, and when diarrhea refuses to yield to sun cholera mixture treatment, take three of these tablets at a dose. If diarrhea is present, continue taking sun cholera mixture tablets, one at a dose, as before ordered in diarrhea.

Mercury with chalk (12 sample powders, 5 grains each, and one-half ounce in bulk in bottle). In tropical dysentery, with bloody mucus, with straining at stool, with abdominal pain, before bloody mucus stooling, take a five-grain powder, with a five-grain Dover's tablet, every two hours. Continue until the character of the stools change; that is, becomes natural, either brown or green. Watch the gums, if taken more than a day, so as not to salivate. Should blood and mucus appear again in the stools, after having been once checked, or should the straining and the pain return, go through the same course of treatment again. It may be noted here that no case of tropical dysentery can be cured without this course of mercury.

Muriate of pilocarpine, 1-20th grain tablets. One tablet is to be taken by the mouth, and then again after four hours, unless the prostration and the sweating should be excessive. In case of pleurisy, in pernicious congestive malarial fevers, a tablet of pilocarpine.

Dover's tablets, 5 grains each. In dysentery, a tablet with a mercury and chalk 5-grain powder, to be taken every two or three hours. In coughs or colds of every kind, give a tablet every two or three hours (without mercury and chalk), or on going to bed, two tablets at a dose. For fever, malarial or any other, give a tablet every three hours, with a quinine pill.

Quinia Sulph. tablets, 5 grains each. While in the tropica take one every night, even when you are well. In case of chills and fever, take two at night, and one every three hours. In case of congestive malarial fever, or a fever which does not yield at once to this treatment, give two pills every four hours (supplemented by the hot pack, the patient to be wrapped in a sheet wrung out of hot water), until 100 grains of quinine have been taken. While administering quinine, add morning and night five tablets of calomel and soda. If the fever does not yield in two or three days of this treatment, give one calomel and soda tablet every two hours until the mouth is sore from the mercury, and at night time, a purge of one triplex pill. If the purging appears too severe, check it with a sun cholera mixture tablet after each purging.

Carbolized vaseline (1 in 8) for dressing wounds, and for piles.

Surgical needles (half round, 6, assorted) and thread.

Styptic cotton (one bottle) for nose bleed of the Andes, etc.

Ointment oleate of bismuth, as a mild dressing for inflamed skin or burns.

One hypodermic syringe, with instruction how to use it.

One can of mustard leaves, for counter-irritation.

Three two-inch roller gauze bandages.

Three three-inch roller gauze bandages.

One pair dressing scissors.

All to be packed in a wooden box with absorbent cotton (one-half pound) 9x12x6 inches. A copy of Dr. Paul Gibier's pamphlet (Bulletin Pasteur Institute, January, February, March, 1897), serum-therapy in snake poisoning, etc., was added to the package.

THE NEW YORK MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The annual meeting of the Society, which is being held this week at its house in New York city promises to be as largely attended as was the meeting a year ago, which was the largest in the history of the Society. The meeting was informally opened on Tuesday afternoon, Nov. 29, by the gathering of many members in the spacious parlor, which was for the time being a smoking room, and was formally opened at 9 p. m. in the auditorium, when the retiring president, Mr. Charles Wallace Hunt, delivered his annual address, a portion of which will be found elsewhere in this issue.

On Wednesday morning a business session was held, at which were presented the annual reports of the council, tellers and committees. The tellers reported the election of 22 new members, including 2 promoted from the associate grade, 4 associates, and 13 junior members.

The new officers elected were announced as follows: President, George W. Melville, Chief Engineer, U. S. N., Washington, D. C.; Vice-Presidents, E. D. Meier, St. Louis, Mo., George R. Stetson, New Bedford, Mass., and B. H. Warren, Pittsburg, Pa.; Treasurer, Wm. H. Wiley, New York; Managers, E. C. Felton, Steelton, Pa., R. H. Soule, Philadelphia, Pa., and A. M. Goodale, Boston, Mass.

The Annual Report of the Council contains many matters of interest. Among them are the appointment of a new committee to consider the subject of Standard Pipe Unions, to confer with similar committees of the Railway Master Mechanics and Car Builders' Associations; and the appointment of a committee to report on Standardization or Unification of the Methods of Testing Steam Engines. A letter has been received from the British Institution of Civil Engineers, expressing its desire to welcome the members of the Society in England in 1900 on the occasion of their visit to the Paris Exposition. The membership of the Society now consists of: honorary members, 14; members, 1,395; associates, 123; junior members, 349; total, 1,881. The financial report shows receipts during the year, $32,406; disbursements, $31,755; cash balance, $698; uncollected accounts, $4,486; unpaid bills, $185. Assets over liabilities, $51,285, of which $23,600 is invested in 5% bonds on the building of the Mechanical Engineers' Library Association, and $24,107 is in the volumes of printed proceedings of the Society. The outstanding indebtedness of last year, $3,200, has been wiped out. The Library Association reports net assets of $1,194 in cash and $10,700 in books and manuscripts.

The report of the committee on a standard code for steam boiler trials was presented in pamphlet form. We give an extract from the new code in another column.

After the business session, professional papers were presented for discussion as follows: "Note on Strength of Wheel Rims," by A. K. Mansfield. "The Bursting of Small Cast-Iron Fly-Wheels," by Prof. C. H. Benjamin. A brisk discussion followed this paper, which was participated in by many members, including John Fritz.

A luncheon was served in the building at the close of the session, and the afternoon was left free to members to visit places of interest, to meet socially in the parlors or to attend to other business. In the evening the annual reception and conversazione of members and ladies was held at Sherry's, 44th St. and 5th Ave.

A THIRD BRIDGE OVER THE EAST RIVER, possibly at Blackwell's Island, is advocated by Mayor Van Wyck, and he requests the Board of Public Improvements to take such action, as to location, plans and construction, as may be necessary before the project is submitted to the Municipal Assembly. He recommends crossing over Blackwell's Island. Some complications may arise, as the New York & Long Island Bridge Co. already has a franchise for a bridge at Blackwell's Island. It has built piers on Long Island and Blackwell's Island; but the company is somewhat entangled in the settling up of the Corbin estate, which controls the enterprise. The new assessed valuation of real estate in Greater New York, raising the aggregate by about $400,000,000, seems to have removed the debt limit obstruction, which for a time interfered with raising funds for the East River bridge now under construction.

AN ARC AT THE EQUATOR is to be measured as a result of the Stuttgart conference of the International Geodetic Association, in October. Mr. E. D. Preston, of the U. S. Coast and Geodetic Survey, represented this government at the conference and he will soon make his official report. This arc at the equator, when measured, will be compared with one near the pole, now being measured by the Swedes and Russians; and the comparison will make it possible to determine the difference in length between the polar and equatorial diameters of the earth. Continuous latitude observations, at six stations encircling the earth near the 39th parallel, north latitude, are to be made by six separate nations. The purpose of this observation is to investigate the small periodic changes in the latitude of all places first reported about ten years ago, and to determine the secular motion of the pole. The International Bureau of Weights and Measures, at Paris, reported that a bar made of 36% nickel and 64% steel, was expanded by heat only 1-50th of what would be expected from the separate metals. This is of great importance in the manufacture of astronomical clocks, as it practically eliminates the temperature question.

THE TOTAL IMPORTS OF GOLD INTO THE UNITED States, in the ten months ending Oct. 31, 1898, says the U. S. Bureau of Statistics was $143,658,095; this is more than 50% in excess of any previous importation in the same period. The exports of gold in this ten months were but $14,061,849, or less than for any similar previous period. This unprecedented flow of gold to the United States is explained by the enormous balance of trade in our favor; the total imports of merchandise, in these ten months, being valued at $527,757,554; while the total export was worth $987,964,356. Out of $1,866,757,783 in circulation in the United States, on Nov. 1, 1898, the sum of $649,846,727 was gold; on Nov. 1, 1895, the gold in circulation amounted to $475,181,593, out of $1,598,859,316 as a total.

EXPORTS OF MANUFACTURED GOODS from the United States, and their phenomenal growth in the past ten years, as compared with the two preceding decades, are well shown by a table just issued by the Bureau of Statistics of the Treasury Department, which we reproduce as follows:

Manufactures.	Total value of exports for fiscal year ending June 30. (1 = 1,000) 1868.	1878.	1888.	1898.
Iron and steel.......	$8,352	$16,052	$17,763	$70,367
Refined mineral oils..	20,020	43,564	41,260	51,782
Copper and mfrs. of.	479	2,329	3,812	32,180
Leather	1,414	8,080	9,583	21,113
Cotton manufactures.	2,971	11,438	13,013	17,024
Chemicals	2,757	3,414	5,633	9,441
Wood manufactures..	2,088	3,963	4,733	9,098
Cycles	.....	.....	.....	6,866
Agricultural implmts.	673	2,575	2,645	7,609
Paraffin	47	155	2,168	6,030
Paper and mfrs. of..	524	1,086	1,078	5,494
Tobacco manufact'rs.	3,100	3,681	3,776	4,818
Fertilizers	35	1,208	1,255	4,359
Scientific instrum'ts..	.....	27	714	2,770
Books, maps, etc.....	349	586	1,734	2,434
Flax, etc., mfrs......	592	1,202	1,391	2,557
Sugar and molasses..	348	4,920	3,255	2,111
Carriages & horse crs	404	979	1,381	1,946
Spirits.	1,416	1,149	871	1,850
Oils, vegetable	186	323	381	1,843
India rubber mfrs....	170	305	866	1,723
Clocks and watches...	536	936	1,529	1,727
Zinc manufactures ..	68	216	18	1,339
Marble & stone mfrs..	.....	597	644	1,792
Gunpowder, etc.	546	3,459	648	1,395
Stationery	.....	.....	425	1,005
Musical instruments..	173	756	908	1,383
Glass, etc.	609	869	881	1,211
Brass manufactures..	16	589	308	1,320
Starch	205	605	202	1,371
Soap	626	658	815	1,390
Railway cars	.....	532	826	1,478
Paints, etc.	131	239	492	1,079
Wool manufactures...	206	449	471	1,089

It should be especially noted that the growth in volume of exports is really much larger than the above table shows, for prices have gone steadily downward during the past thirty years. This is especially true of the decade from 1888 to 1898, in which the greatest growth in the value of exports is shown. Besides this, it must be remembered that the value of the exports of 1868 was measured in the paper currency of that date, the value of which was only 71.5% of the value of gold. Hence the growth in volume of exports from 1868 to 1878 was at least 30% more than the above table shows.

THE REPORT OF SECRETARY OF THE INTERIOR Bliss deals with public lands, Indians, pensions, territorial and educational affairs, etc. Mr. Bliss says that of 301,000,000 acres of desert land requiring irrigation, the available water supply is only sufficient for 71,500,000 acres; the remainder is only valuable for grazing purposes. The 30 forest reservations contain an estimated area of 40,719,474 acres. During the year the U. S. Geological Survey made a topographical survey of 30,057 sq. miles; the aggregate now surveyed being equal to about one-fourth of the entire territory of the country, exclusive of Alaska.

THE PROGRESS IN ELECTRICAL SCIENCE was the subject of the late address of William Henry Preece, C. B., F. R. S., on assuming the Presidency of the Institution of Civil Engineers. Mr. Preece was a pupil of Faraday, and for nearly 50 years has been actively engaged in electrical work, and especially in telegraphy. He said that the original line of Cook and Wheatstone, constructed in 1837, and connecting Camden Town and Euston Grove Station, and 1¼ miles long, had grown to 1,111,366 miles of wire under British control alone. This aggregate covered 435,000 miles for the General Post office; 105,000 miles for railway companies; 387,966 for India and the Colonies, and 183,400 miles of submarine cables. In the United Kingdom alone there are now in use 152,019 telephones, 133,498 of these belong to the National Telephone Co. Mr. Preece recommends the control of the telephone business by the state as in the case of the postal and telegraph service in England. He combats the popular idea that the purchase of the telegraph business in 1869 was a bad bargain for the state. He says the sum paid for it was $24,945,240; the number of messages then sent was about 5,000,000 per year, and the gross annual income was about $2,500,000. This income is now $15,358,615, and over 83,000,000 messages are sent per year; the capital account, closed in 1891, and including Post Office extensions, was $50,656,645; and he says a syndicate now wanting to buy the plant would have to raise a capital of over $150,000,000. In referring to electric lighting, Mr. Preece said that the electrical energy used in a first-class battleship was expended as follows:

	E. HP.
Internal lighting	60
Searchlights	65
Ventilation	30
Capstans, hoists, etc.	60
Reserve	45
Total	260

This quantity supplied 1,000 glow-lamps, 6 searchlights, 16 ventilating fans, and required from 2 to 8 motors. Searchlights were first introduced on warships in 1875, by Mr. Henry Wilde; the first ship fitted with internal electric lighting was the "Inflexible," in 1882. In 1884 the British Admiralty ordered it to be applied to all warships. Electric power was first used on the "Barfleur" for working guns and ammunition hoists. Its use has been partially extended to working gun-turrets, capstans, ventilating fans, boat hoists, etc., but hydraulic power, for these purposes, is still preferred in the British Navy.

A PUBLIC MEMORIAL MEETING, in commemoration of the late Col. George E. Waring was held at the Cooper Union, New York city, on Nov. 23. The City Club, Authors' Club, Century Association and Chamber of Commerce united in arranging for the meeting. Letters were read from prominent citizens and speeches were made by President Low, of Columbia University; Bishop Potter, Reuben Simons, Carl Schurz and Jacob A. Riis. Resolutions were adopted setting forth the services of Colonel Waring as a soldier, citizen and sanitary engineer. The Chamber of Commerce has appointed a committee to raise a fund of $100,000, the income from which is to be paid semi-annually to the widow and daughter of Colonel Waring; and after their death the principal is to go to Columbia University and is to be known as "The Waring Municipal Fund." Thus far about $37,000 has been subscribed.

AN ELEVATOR TRUST, to be called the Otis Elevator Co., says the "New York Commercial," has been formed by consolidating into one company about 90% of the elevator business of the country. The capital of the company will be $10,000,000; $4,000,000 in non-cumulative preferred stock, and $6,000,000 in common stock. Mr. Wm. H. Baldwin, of the Otis Elevator Co., is the chief mover in the enterprise, and will probably be the president of the new company.

BOOK REVIEWS.

BUILDING, CONSTRUCTION AND SUPERINTENDENCE. Part II.. Carpenter's Work.—By F. E. Kidder, C. E., Ph. D., Fellow American Institute of Architects, New York, 1898: William T. Comstock, 23 Warren St. Cloth: 6¾ × 9¾ ins.; pp. 544; 524 illustrations. $4.

The first volume of this work appeared in 1896 (Eng. News, Nov. 26, 1896), and was devoted to the treatment of those details of building construction generally coming within the province of the mason. Part II., which is now before us, is of the same size and general make-up, but it has 100 more pages and nearly twice as many illustrations. As indicated in the title, it treats of the carpentry work of building construction, and it is essentially a book for the carpenter and builder rather than for the engineer.

Taking up the contents in somewhat more detail; Chapter I. describes the appearance, quality, ease of working, etc., of the different building and finishing woods of the United States. Among the particular features of this chapter which one notes with most interest are the illustrations and remarks showing the manner in which wood shrinks, and giving the methods of preventing shrinkage. Chapter I. is followed by chapters on wood framing; windows and outside frames; outside wood finish, such as cornices, gutters, gables, porches, etc., shingle roofs and the accompanying metal work; interior woodwork, including furring, interior finish, cabinet work, stairs, flooring, etc. Chapter VI. contains nearly 100 pages on the subject of builders' hardware, covering the construction of locks, hinges, butts, etc., etc. In Chapter VII. the subject of heavy framing in wood is discussed, and we note that the author gives the results of the most recent investigations upon the framing of compound beams which have been made by Prof. Kidwell (Eng. News, March 11, 1897, Feb. 3, March 17, 1898), and others. Chapter VIII. gives forms of specifications for carpenters' work, hardware, trimmings, slate and gravel roofing, tin work, etc.

The book is very profusely illustrated, many of the illustrations being detail drawings of parts of which drawings are not easily obtained. Taken as a whole we do not know of any book on the subject which contains the same amount of up-to-date information, and any young architect or ambitious carpenter would do well to place a copy in his library. The book has a very good index which enables references to be made easily to the different subjects treated.

RAILWAY CONSTRUCTION.—By William Hemingway Mills, M. Inst. C. E., Engineer in Chief of the Great Northern Ry. of Ireland. London, 1898: Longmans, Green & Co. Cloth, 6 × 10 ins.; pp. 364; illustrated; $5.

The American book which this volume most resembles in its character and scope is Mr. Geo. L. Vose's well-known "Manual for Railroad Engineers." It is a far less comprehensive treatise of the subject, however, than the American publication. The detailed information relating to the strength of materials and structures and the typical specifications and standard mathematical formulas given by Mr. Vose are almost entirely omitted by Mr. Mills. The book also describes English practice almost exclusively; the author's references to American practice being few in number and not always very accurate. For these reasons the chief value of the volume to the American engineer will be in the knowledge which it gives him in a broad general way of English practice in railway construction, leaving him to go elsewhere for such information as will qualify him actually to do the work. Keeping these limitations in mind, however, and considering the book as a series of notes upon English practice in railway construction rather than as a treatise upon railway construction in general, as its title indicates, it has considerable usefulness for the American engineer. Doubtless it would fill a much more useful field for the English engineer.

The chapters in detail are: (1) Location of a Line of Railway—Government Regulations—Questions for Consideration in Connection with Gage, Gradients and Curves: (2) Works of Construction; Earthworks, Culverts, Bridges, Foundations, Screw Piles, Cylinders, Caissons, Retaining Walls, and Tunnels; (3) Permanent Way, Rails, Sleepers, Fastenings, and Permanent Way Laying; (4) Station Buildings, Roofs, Lines and Sidings; (5) Sorting Sidings, Turntables, Traversers, Water Tanks and Water Columns; (6) Comparative Weights of Some Types of Modern Locomotives; (7) Signals, Interlocking, Block Telegraph and Electric Train Staff Instruments; (8) Railways of Different Ranks, Progressive Improvements, Growing Tendency for Increased Speeds, with Corresponding Increase in Weight of Permanent Way and Rolling Stock—Electricity as a Motive Power.

UP-TO-DATE AIR-BRAKE CATECHISM.—A complete study of the air-brake equipment, including the latest devices and inventions used. All troubles and peculiarities of the air brake and a practical way to find and remedy them are explained. By Robert H. Blackall, Air-Brake Instructor and Inspector, Delaware & Hudson Canal Co.'s R. R. New York: Norman W. Henly & Co. 12mo, cloth; pp. 230; 40 illustrations. $1.50.

This little book is designed especially for railway trainmen whose duties require a knowledge of the air brake and its methods of operation. The aim has been to make it so elementary and simple that the "green hand" can learn all he needs to know about air-brake work without other aid than this book gives. It is also a valuable textbook for use in the air-brake instruction schools which are carried on by most railway companies. Besides the air brake, the book also gives instructions on the use and care of the air signal. This is the first book for engineers' instruction we have seen which specifically cautions against reversing the engine at the same time the brakes are applied in making an emergency stop.

COMPRESSED AIR PRODUCTION, or the Theory and Practice of Air Compression. By W. L. Saunders. Published by "Compressed Air," 26 Cortlandt St., New York. 8vo. cloth; pp. 58; 27 illustrations.

This book consists chiefly of matter which was published serially in the little monthly journal called "Compressed Air." Mr. Saunders is well known as one of the leading authorities on the subject. His present book is of an elementary nature, entirely free from mathematics; but it presents the fundamental principles governing the production and use of compressed air in a way which can be readily understood, and will prove a useful handbook to those who undertake the installation or management of compressed air plants.

A HANDBOOK OF ENGINEERING LABORATORY PRACTICE. By Richard Addison Smart, M. E., Associate Professor of Experimental Engineering, Purdue University. New York: John Wiley & Sons. London: Chapman & Hall, Limited. Cloth, 12mo; pp. 290. $2.50.

The scope of this book is shown in the following extracts from the preface:

> This volume is intended primarily as a maual for the use of students in the routine of experimental work in Steam-engineering, Strength of Materials, and Hydraulics. It may also serve in a limited way as a guide to those engineers in active service whose familiarity with the ordinary methods of testing is limited. The chief object in view has been to provide in convenient form such directions for the conduct of the various tests and experiments comprising the course as the student will need to enable him to take charge of and conduct the particular work assigned to him in an intelligent manner and with little delay. The methods of testing described under the various general heads are not intended to cover the subject in an exhaustive way. Only such tests have been described as may be carried on in connection with the complement of apparatus to be found in the better equipped laboratories of experimental engineering, and the methods explained are those which the author has found to be most easily employed in every-day practice. Both the manner of arranging apparatus and the method of conducting the tests are capable of great variation to suit the needs of special investigations.

The author has condensed a great deal of useful information into small space. His style is clear and simple, and his treatment is entirely of a practical nature, avoiding theory almost entirely. The book should prove a useful one to students of mechanical engineering.

THE STORY OF THE RAILROADS.—By Cy. Warman, author of the "Tales of An Engineer," "The Express Messenger," "Snow on the Headlight," etc. New York: D. Appleton & Co. Cloth, 7¾ × 5 ins.; pp. 280; illustrated. $1.50.

This is not an engineering treatise, but a story of engineers, and a very interesting general history of the beginning and completion of the various trans-continental railways. The history of the Union Pacific road commences with the efforts of Asa Whitney, in 1835; but progress really begins with the surveys of the present Gen. Granville M. Dodge, made when in the employ of the Mississippi & Missouri Railway Co., in 1853. The story of the Union Pacific is carried to the completion of that road; and the Atchison, Topeka & Santa Fe, the Denver & Rio Grande, the Northern Pacific, and the Canadian Pacific are then taken up in sequence. Interspersed with the story are many incidents connected with the life and trials of the engineers and workmen engaged in building these roads, and character sketches of the rough social element that drifted West with the iron rails. The book is interesting reading for engineers and valuable for the historical matter which it contains.

PRACTICE AND THEORY OF THE INJECTOR. By Strickland Kneass, C. E., M. Am. Soc. M. E., etc. Second edition, revised and enlarged. New York: John Wiley & Sons; London: Chapman & Hall, Ltd. Cloth, 8vo; pp. 161. $1.50.

Mr. Kneass's book on the injector has been well known, since the issue of the first edition a few years ago, as the standard work on the subject. The new edition contains some new matter, and many changes have been made in the text of the original edition.

THEORY OF ELECTRICAL MEASUREMENTS.—Lecture Notes Prepared for the Third Year Classes of the Cooper Union Night School of Science. By William A. Anthony, Professor of Physics. First edition. New York: John Wiley & Sons. 5 × 7½ ins; cloth; pp. 90. $1.

This little book was prepared by the author for the use of the third year classes of the Cooper Union, New York, Night School of Science, in which he is Professor of Physics. It makes no pretension, of course, to be an elaborate and exhaustive treatise, but it presents the fundamental principles of electrical measurements to the student in a brief but clear manner.

Not the least valuable feature of the book is the series of problems given at the end of each chapter, the correct solution of which is proof that the student correctly understands the preceding text.

A TEXT-BOOK OF GEODETIC ASTRONOMY.—By John F. Hayford, C. E., Assoc. M. Am. Soc. C. E., Expert Computer and Geodesist U. S. Coast and Geodetic Survey. New York: John Wiley & Sons. Cloth; 9 × 5¾ ins.; uu. 351; illustrated.

This work is limited to the treatment of astronomy as applied to surveying, or to geodetic astronomy only. It is primarily a text-book for students, and is made sufficiently short and easy to be mastered by the student of civil engineering in the limited time usually devoted to this branch of study. The simpler and special means of deriving working formulas have been chosen, and considerable space is devoted to the discussion of the various sources of error in each kind of observation, and to the practical handling and adjustments of instruments used. In fact, the five principal chapters in the work separately treat of the sextant, astronomical transit, zenith telescopes and determination of latitude, the azimuth instrument and methods of observing longitude. The aim of the author has been to select formulas which have been found in practice to lead to the most rapid and accurate computations; and to this end he freely uses the larger and standard works of Chauvenet, Doolittle and Loomis, the various reports of the U. S. Coast and Geodetic, Lake, Boundary and other surveys and the practice of those making these reports. It is to be regretted that the illustrative figures used are bunched instead of being distributed through the text, where they belong.

EXPLOSIVE MATERIALS.—The Phenomena and Theories of Explosion, and Classification, Constitution and Preparation of Explosives. By Lieut. John P. Wisser, 1st Artillery, U. S. A. Instructor Department of Military Science, U. S. Artillery School, Editor "Journal U. S. Artillery." Van Nostrand Science Series, No. 70. New York: D. Van Nostrand Co. Boards; 6 × 3¾ ins.; pp. 145. 50 cents.

About fifteen years ago a first edition of this treatise appeared; but the development in this art has been so great in the interval, that the present edition has been entirely rewritten. The result is an entirely up-to-date study of the materials of explosives, the phenomena of explosion, chemical composition, the origin and rapidity of reactions and their propagation, and the products and force of explosion. The various types of explosives are then taken separately and minutely described. The composition and manufacture of smokeless powders is gone into at very considerable length, and forms an unusually interesting portion of the work.

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