## THE LARGEST FERRYBOAT IN THE WORLD.

BY H. E. WRIGHT.

The steamer "Solano," the largest ferryboat in the world, crosses the Straits of Carquinez, carrying the trains of the Southern Pacific between Port Costa, Contra Costa County, and Benicia, Solano County, California. She was built in 1879 and launched in November of the same year. Her construction resembles that of a huge scow, stiffened lengthwise by four wooden trusses, one under each of her four tracks. Her hull measures 64 feet 10 inches in beam and 116 feet 8 inches over the guards. She is a double-ender, with four balanced rudders at each end, controlled by hydraulic steering gear. The "Solano" is propelled by two simple walking-beam engines of low pressure. Each engine has a 60-inch cylinder with an 11-foot stroke, and its horsepower is 2,252. Each engine drives one wheel, and works independently of the other. The wheels are 30 feet in diameter, and each has twenty-four buckets.

The steamer has eight steel boilers, 24 feet 10 inches long and 84 inches in diameter, and carrying 40 pounds steam pressure. Six of these boilers are in use every day. Once in three weeks two are laid off, when the scale that has accumulated is removed with crude soda. Petroleum is used for fuel. Every twenty-four hours 3,200 gallons are consumed. The tanks hold 8,300 gallons. It takes 50 minutes to fire up.

The "Solano" has 424 feet of deck length and is 406 feet 7 inches on her keel. Her registered tonnage is 3,549 tons. Approximately, she has been handling 115,000 freight cars and 56,000 passenger cars a year. She is double-crewed, with seventeen men in each crew, and runs night and day, making from thirty-six to forty-six crossings in twenty-four hours.

The length of her trip is one mile. The average time of transfer including time required to cut trains, place them on the boat, cross the straits, unload, and couple on the other side, is about eleven minutes. Road engines handle one cut on and off the boat; a switch engine handles the other cut. The boat draws, light, 6 feet 4 inches. but draws 10 feet 7 inches when loaded.

The hinged steel aprons, weighing 190 tons, over which the cars are transferred from the dock to the boat, are four-track spans, 100 feet long. These are controlled by air-tight pontoons and counter-weights which are handled by hydraulic power from pressure pumps located on the boat itself, connection being made by means of pipes and ordinary air-hose coupling.

As the boat enters the slip, the counter-weights are raised by hydraulic power, leaving part of the apron unbalanced. This sinks the pontoon. The apron descends to the level of the deck, the end fits into a recess on the boat and is firmly latched down. The counter-weights are released, and the apron and the boat are free to rise and fall with the tide.

## THE CAPITAINE MARINE PRODUCER-GAS ENGINE.

An interesting type of marine internal-combustion motor has been introduced upon the European market. The plant comprises the engine itself, together with a producer-gas installation providing the necessary fuel for the motor. The application of this type of engine is a new development in power craft; and though its utilization is to a certain degree limited, owing to restrictions in space and weight, yet for purposes where weight is not an all-important problem, such as in tugs, barges, and large sailing vessels, it is admirably suited, owing to the low cost of maintenance. This latter fact is the most salient feature of the Capitaine plant, herewith illustrated, it being possible to operate a 10-horse-power engine at a running cost of two cents per hour.

The plant primarily consists of a generator for the supply of the fuel, cooling and scrubbing apparatus, and the motor. It is due to the inclusion of the scrubber and cooler that the space requisite for the accommodation of the plant as well as the weight are somewhat increased, but their presence is absolutely essential to the satisfactory and efficient operation of the engine. In the first place, the gas supplied from the generator is of such a high temperature that it must be passed through the cooler to condense it sufficiently for complete and proper combustion in the engine, while at the same time, in order to prevent clogging of the latter, it must be submitted to the scrubber, to cleanse the explosive vapor from the particles of dirt and other foreign substances suspended therein.

The plant shown in the accompanying illustration is one that is now being subjected to exhaustive experiments by Sir John Thornycroft & Co. It comprises a two-cylinder engine, developing 30 horsepower, and the gas generator, and is designed for installation upon a heavy type of commercial craft. The floor space occupied by the installation is 7 feet 6 inches in length by 3 feet 6 inches in width, while it weighs 2 tons 15 hundredweight. The cylinders are 8.27 inches diameter and the stroke is 11.02 inches. The normal speed of the engine is 200 revolutions per minute. The pressure of the compression is 175 pounds per square inch; the explosion pressure ranges from 400 pounds to 500 pounds per square inch; while the M. E. P. is about 100 pounds per square inch.

The gas-generating portion of the plant comprises a large drum, and consists of a shell lined with firebrick for a depth of about 4 feet. The space above this section contains a water reservoir. Small coal is placed in the generator from the top, and the coal space is entirely filled. The gas generated is a combination of producer and water gas, which are produced simultaneously. When the fire is started and the steam raised, the latter is directed through the blowpipe on to the grate at the same time as a current of air is injected. The grate is a dished plate somewhat larger in diameter than the brick-lined coal area, and is placed slightly below it, so that a ring of red-hot coal is formed round the edge of the plate and exposed to the jets of steam and air that are injected. The height of this plate can be regulated as desired by means of a rack and pinion actuated by a large lever working on a quadrant. The water reservoir is a conical bell-shaped casting, which is suspended from the cover and is sunk in the coal bed. The gases flow through the center, the water being so arranged as to surround the reservoir.

The grate is provided with two small doors, one on either side of the drum, through which the ashes are withdrawn. To the back of the generating tank are attached two cocks, one serving the functions of an overflow and the other a drain cock to the water receptacle. When the fire is first lighted, more air is required than can be admitted through the orifices provided for this purpose. When the motor is running, this increased supply is in-

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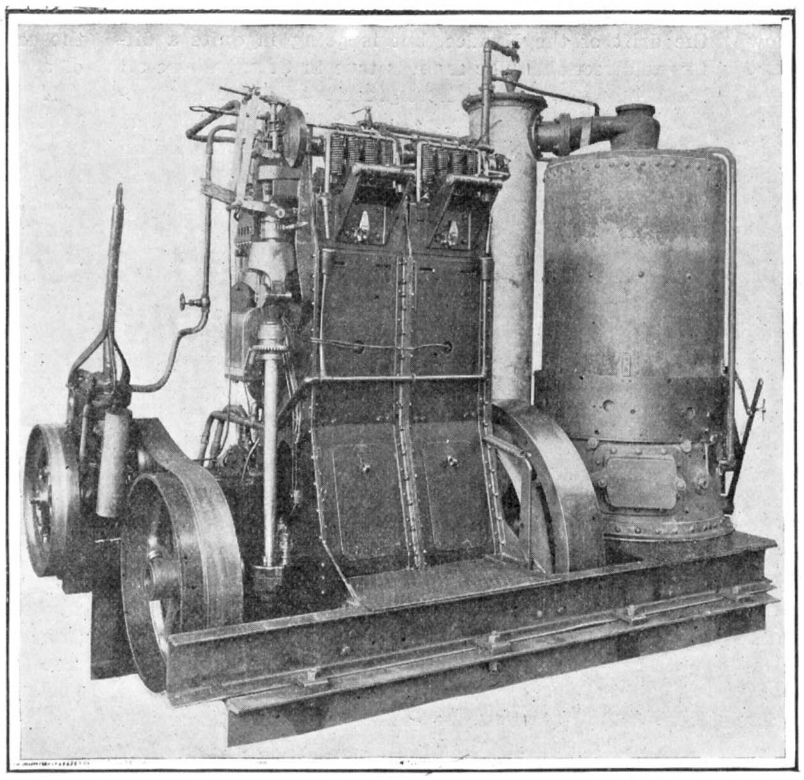
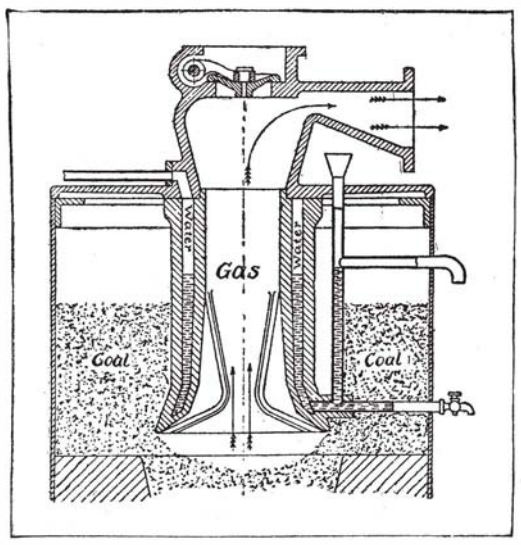
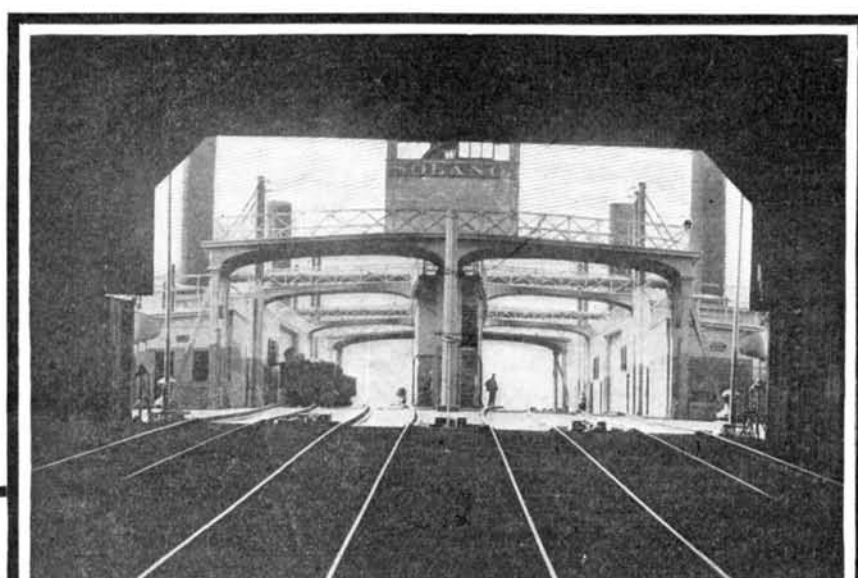


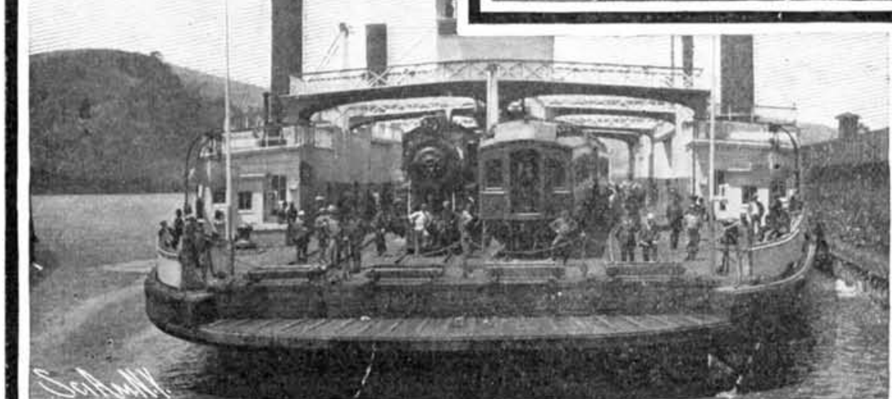
**Floor Space,** 3½ by 7½ feet. **Weight,** 2¾ tons. **Horse-Power,** 30.

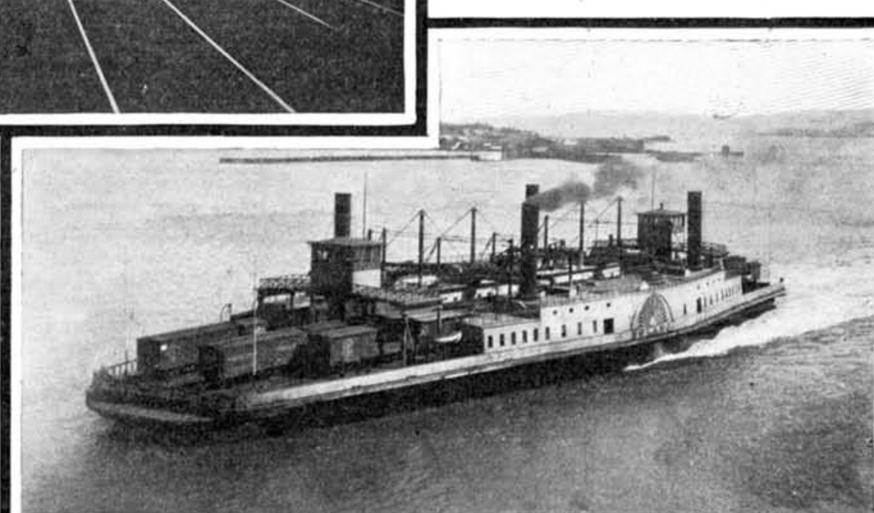
A COMPACT MARINE PRODUCER-GAS ENGINE.




**Section of Top of Capitaine Gas-Generator.**







**The "Solano" Entering Her Slip.** **"Solano," Loaded, in Mid-Stream.**

**View Looking Along the Deck, Showing the Four Tracks.**

A GREAT CALIFORNIA RAILWAY FERRYBOAT.

000 ounces of gold. Consequently, the yield from the gold mines has increased 60 per cent in less than a decade.

In seeking the reasons for this truly remarkable development, one is especially prominent—the great advance which has been made in the methods followed by the modern gold seeker. The prospectors have taken advantage of progress in geology, chemistry, and other sciences, and have provided themselves with mechanical aids which are far superior to the crude implements employed by the metal hunters of the past. Their examination has not been confined to merely the bed of a creek or the side of a mountain, but often is so extensive that it embraces miles of area. Many a prospecting tour rises to the dignity of an expedition, and embraces a variety of apparatus, to say nothing of a staff of geologists and other experts.

In the old-fashioned system, as it might be termed, of seeking precious metal, the prospectors can be divided into two classes—those who are satisfied to obtain the metal in any form, and the "pocket hunters." The latter individual considers himself above the other type of prospector, terming his calling professional. Many a one has spent the better part of his life in exploring beds of streams and dry valleys in search of pockets. In southern Oregon the pocket hunters have been perhaps more numerous than elsewhere in the United States proper, as this section of the State has yielded a large amount of gold in this form. Pocket prospectors depend upon the pick, shovel, and pan as do their fellows, but they seldom dig further into the side of the bank or hill than their shovel will reach.

The ordinary prospector wades through the bed of the stream or tramps through its sand if it is "dry," here and there filling his pan with the material. Then immersing the pan in water, he thus separates the sand from the other matter, and gradually spilling out the sand, eagerly gazes at the bottom of the pan to note any glittering streak which may betoken the presence of gold. If he is working along the side of a hill where he believes the ledge of rock may contain a vein of gold-bearing ore, he breaks off likely portions with his pick, crushes them as best he can, and dumping the dust and fragments into his pan, repeats the separation process. In the examination of rock for metal-bearing ore the *arrastra* of the Mexicans and Spaniards has been used extensively, especially in California and Oregon. This contrivance consists of a vertical shaft or axis, which supports several wooden bars fastened at right angles to it. To the ends of the bars are attached heavy flat stones, which by the movement of the axis revolve in a circular pit. The specimens of ore are placed in the pit, a stream of water turned upon them, and the *arrastra* placed in motion by animal or water power. The ore is resolved into a slimy sediment by being ground in the water, and passes off through the sluiceway, which is provided with riffles for catching the gold.

The modern methods for searching for deposits of precious metal are so radically different from those described, that it may be said a revolution has taken place in prospecting in the United States. In the Rocky Mountain region the formation has been pierced as far as 2,000 feet in the effort to ascertain the existence of a vein, or the dimensions of one already discovered. Some of the projects which have been carried out preliminary to the opening of mines, represent an outlay of over a million dollars in the purchase of apparatus, the employment of noted experts, and in the general magnitude of the operations.

Among the mechanical appliances which have been of great assistance to the modern prospector is the drill. With it he can make borings in a week where if a shaft were sunk a year would be needed. If the formation is to be examined by a shaft, however, the cost of sinking it is reduced to a minimum by means of explosive cartridges, which are now manufactured especially for such service. They are ignited by means of the electric current, and it should be said that an essential part of the modern prospecting outfit is the chemical battery, which is not only of value for this purpose, but in the application of electrolytic methods to separating the precious metal from the dross.

Few expeditions of any size are sent out without an experienced geologist, who is usually provided with maps and other data giving the best information available regarding the region to be explored. Maps giving the extent of the claims, the direction of the veins, and the general topography of the region where the mine is to be opened are obviously of much value, and a draftsman is frequently included in the staff, with material for preparing the maps on the spot from the data obtained by the investigators.

Besides the geologist, the services of an expert chemist are also of great importance, and a laboratory in miniature is contained in the packs carried by the animals. So complete is this portion of the equipment, that a fairly correct field analysis can be made of the specimens secured by the use of the drill or by the other prospecting tools. If the outcropping of a quartz vein is discovered, enough is broken off to allow its character to be studied both from a geological and chemical standpoint. After examining it in connection with the formation in the vicinity, the geologist is often able to indicate where the surface can be bored with the possibility of reaching the ore-bearing strata at once. The value of the ore from the outcropping and that from the interior can be approximately determined by the chemist. To crush the ore is a slight undertaking, and with the lead which he has brought along, the material can be readily fused in a portable furnace. In fact, he has the essentials for making a "dry assay" on a limited scale, for cupels are now made of such light weight that they can readily be carried on muleback. Taking the ingot of lead and of precious metal, he can easily oxidize the lead by placing it in his cupel, and heating the latter to the required temperature in an oven constructed of material which he can obtain in the vicinity. With his nitric acid he separates the silver which may remain, leaving the gold only to be tested for its value. The proportion of the gold to a given quantity of ore can be determined by his scales, but by using his touchstone or black basalt, he can detect the quality of the gold by the color which this substance makes when drawn over the surface of the metal.

In the outfit of the modern prospector quicksilver has become practically indispensable. Its affinity for gold makes it a most valuable agent. Where the existence of placer gold is imagined, the introduction of mercury into the test washer soon solves the problem, and avoids the use of riffles and other crude appliances which were formerly depended upon almost entirely. After crushing the specimens of test ore, the quicksilver can also be used to ascertain the quantity of free gold among the particles. As the mercury can be eliminated by heating the composition to a sufficiently high temperature, it is now utilized in large quantities by the modern prospector.

## THE CAPITAINE MARINE PRODUCER-GAS ENGINE.

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jected by means of an air blower driven by a gasoline motor. For some minutes the coal burns in precisely the same manner as it would in an ordinary furnace, and the combustion gases are allowed to escape through a chimney, though in their passage, by being directed through the center of the ring where the water is retained, they serve to gradually heat the water and prepare the steam ready for starting.

As the gas is produced and escapes from the fire of the generator at an excessively high temperature, it passes into the cooler. This part of the apparatus is shown at the left of the large generator, and consists of another drum of small diameter. The gas is first cooled at the top of the drum, by passing round a flat cooling coil through which a spray of water is passed, and it finally settles to the bottom of the scrubber, from which it is withdrawn by a pump. A fine spray of water is also forced upward from the bottom of this drum and strikes the wall about half way up. The result is that no gas can possibly emerge at the bottom without first having come into contact with the water jet, which arrests and carries off any impurities suspended in the gas. This process completed, the gas, comparatively cool and clean, is then deprived of the moisture with which it has become impregnated before it enters the engine. It escapes through a baffle at the bottom of the drum, and in so doing is partially dried, though to complete this operation it is conveyed to a centrifugal drier, consisting of a number of plates fixed on rings one behind the other in a small cylinder; this drier churns and agitates it until every trace of moisture has been completely removed. The gas is then ready for combustion in the engine.

In the gas produced by this process there is a larger percentage of carbon monoxide than carbon dioxide. The gas is consequently not very rich, but the resultant issue of this defect is that a larger cylinder capacity horse-power is required. The calorific value of the gas is 137 British thermal units per cubic foot. The formation of a larger percentage of carbon monoxide than carbon dioxide is preferable, inasmuch as less water is formed in the motor by the explosion of the gases than would otherwise be the case if there were a predominance of carbon dioxide. The formation of the greater quantity of carbon monoxide is attributable to the insufficiency of air, and consequently oxygen, injected into the generator during production.

The gas enters the engine through a double-seat valve, while an adjustable quantity of air can be admitted through the upper seating. In the arrangement of this motor, the cylinder valves are placed in the head of the cylinder, which can be removed by sliding forward after the release of the retaining nuts. The governing arrangement is ingenious. There is a quick-action governor, which when the maximum speed is exceeded grips a brass-ended fiber ring between two collars on the governor shaft. The governor also acts upon the low-tension magneto which is employed for ignition purposes. This magneto is driven off the governor shaft, and is completely under the control of the governor so far as the time of firing is concerned. In the hand control of the governor the time of ignition is also automatically controlled. This arrangement is exceedingly sensitive, an alteration of ⅜ inch of the collar varying the revolutions between 40 and 60 per minute.

The cylinders are water-cooled, the jacket for the same being shrunk on to the walls of the cylinder, and forced lubrication is employed. The exhaust is muffled in a water-jacket silencer, the water employed for this purpose being afterward used in the gas generator.

It is expected that some highly efficient results will be obtained by the application of this plant, particularly for certain types of commercial craft. It constitutes a cheap and efficient source of propelling power, and its development is being followed with great interest. Such a plant has extended possibilities upon tugboats and barges, where weight and space do not form such important considerations.

### Engineering Notes.

Stone sawing by wire is done successfully in France, according to a paper by Mr. E. Bourdon in the Bulletin of the Society for the Encouragement of National Industry. A complete plant comprises an endless wire passing round a series of pulleys, one of which is a driving-pulley. The necessary tension is obtained by a straining trolley working on an inclined plane, and between the driving shaft and this trolley is situated the saw frame, which carries the guide-pulleys for the wire saw. This wire, which is driven at a given speed, is caused to press lightly on the stone, and the cutting is done by sand mixed with water, which is conveyed into the saw-cut as the work proceeds. Though the mode of operation appears simple, it entails various difficulties in practical application. Three twisted steel wires are used, each wire having a diameter of 0.098 inch. The strands must be twisted fairly tight and should make one turn in 1.18 inch. The wire may be driven in the workshop at a speed of 23 feet per second, but in quarries or adits the speed should not exceed 13 feet per second. The force exerted by the wire to produce the cut must be uniform and must be capable of being readily varied; moreover, it must be proportionate to the length of the cut.

In the notable passage of the turbine-propelled steamer "Loongana" from Glasgow to Australia, the marine steam turbine once again demonstrated its possibilities and suitability for the same class of work as that which has hitherto been fulfilled by the ordinary reciprocating engines. The journey was covered in 30½ days. The vessel experienced some of the roughest possible weather during the voyage, but even under these most adverse conditions it was found that with four boilers at work a speed of 18 knots per hour could be easily maintained. The average speed, however, throughout was 15 knots, and it was attained on a daily consumption of 63 tons of coal. Some interesting tests were carried out during the voyage to ascertain the relative economies of the turbine and the ordinary reciprocating engines, and conclusive data were obtained showing at what speeds the turbine is the less expensive. These experiments proved that for vessels where a speed of 16 knots is required the turbine is much more economical than the cylindrical engines, but it becomes more expensive if the speed is decreased below 15 knots. Special observations were made of the behavior of the turbines and vessel under fluctuating conditions. On no single occasion was there any sign of propeller racing and it was only when traveling at the highest possible speed that any vibration over the screws was experienced and then it was very slight. Far steadier running was obtained, and even in the roughest weather not a single sea was shipped by the steamer. Not the slightest trouble was experienced with the machinery, and the turbines did not have to be stopped for any purpose throughout the voyage except when coaling at ports. Nor did the necessity arise for repairing or renewing any part of the machinery. This is the longest journey that has ever been covered by a turbine-propelled steamer, and the steady running of the vessel under all conditions of weather constituted one of the most prominent features of the journey. Anticipations have been entertained that although this machinery has proved far more economical in regard to fuel consumption than reciprocating engines for vessels engaged in coast and short-distance traffic, it would prove more expensive for ordinary long-distance voyages. This trip, however, has proved the opposite to be the case and established the superiority of the turbine for long-distance traffic under all conditions.

Occasionally a mine-shaft is "sunk upward," to use a paradoxical expression, for some special reason. The shaft is divided temporarily by brattice-work, the space on one side being filled with excavated rock, and forming a platform for the men.—Engineering and Mining Journal.