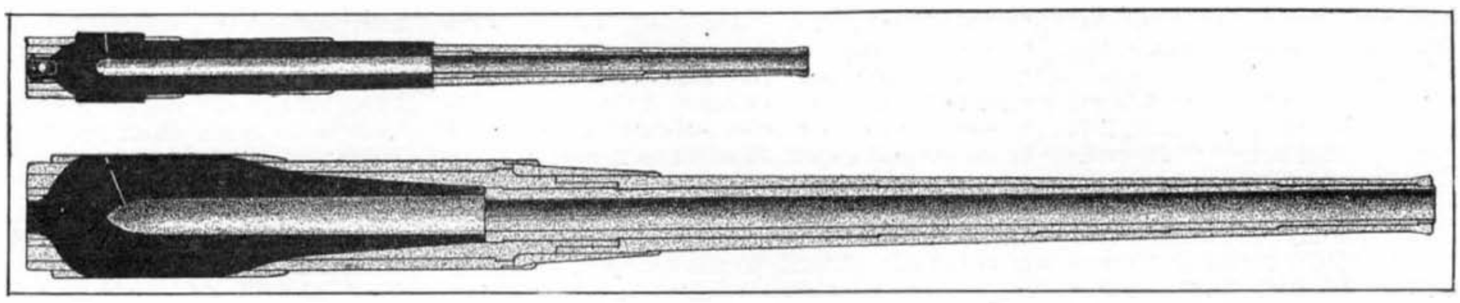
OUR NAVAL GUNS IN THE CIVIL WAR AND TO-DAY.

Naval ordnance has made greater strides in the forty years that have intervened since the civil war than in several centuries preceding. As proof of this it is enough to look at the striking comparison shown in the accompanying cut. The smaller illustration represents a Parrott 100-pounder of 1862, superimposed upon a modern 100-pounder, or to be correct, a 6-inch 50-caliber, rapid-fire rifle, of the year 1902; the lower diagram represents a 15-inch smooth bore of the civil war superimposed upon a 12-inch breech-loading 45-caliber rifle of to-day. The comparison might be carried out at greater length throughout all the various calibers that constitute the batteries of naval ships, but it is sufficient to compare the main battery of the "Monitor" with the main battery of the modern battleship, and what might be called the secondary battery of the frigates of 1862 with the standard secondary battery gun of the battleship of to-day.



The Parrott 100-Pound Rifle and the 15-Inch Smooth-bore (Period of Civil War) Compared with the 50-Caliber 6-Inch and the 45-Caliber 12-Inch Rifles of 1902. Civil War Guns in Black.

OUR NAVAL GUNS IN THE CIVIL WAR AND TO-DAY.

The heaviest piece carried in the civil war was the 15-inch smooth bore. This gun weighed 42,000 pounds; its length over all was 15 feet 1 inch; its maximum diameter at the breech was 4 feet, and with an ordinary charge of 35 pounds of black cannon powder, it fired a spherical shell weighing 350 pounds. According to the ordnance regulations, under extraordinary conditions, these guns might be fired 20 rounds "at ironclads at close quarters," using 100 pounds of hexagonal or cubical powder and a solid shot weighing 450 pounds. Under these conditions the respectable muzzle velocity of 1,600 foot-seconds was obtained, with a corresponding muzzle energy of 7,997 foot-tons. It would be interesting to know what the powder pressure was under these conditions, for the velocity and energy are something truly remarkable for a cast-iron gun. It is little wonder that only 20 rounds were allowed under the severe stresses imposed by these ballistics.

Now, compare these results with the most powerful gun in our navy to-day, namely, the 12-inch, 45-caliber rifle, which weighs 53.4 tons, has a total length of 45 feet, and with a charge of 360 pounds of smokeless powder fires an 850-pound shell with a muzzle velocity of 2,800 foot-seconds, and a muzzle energy of 46,246 foot tons. The true basis of comparison of the relative efficiencies of the two guns is the amount of energy developed per ton of the weight of the gun, and on this basis we find that the old 15-inch, smooth-bore gun when fired with 100 pounds of powder, developed 427 foot-tons of energy per ton of gun, as against 872 foot-tons of energy per ton developed by the modern 12-inch gun.

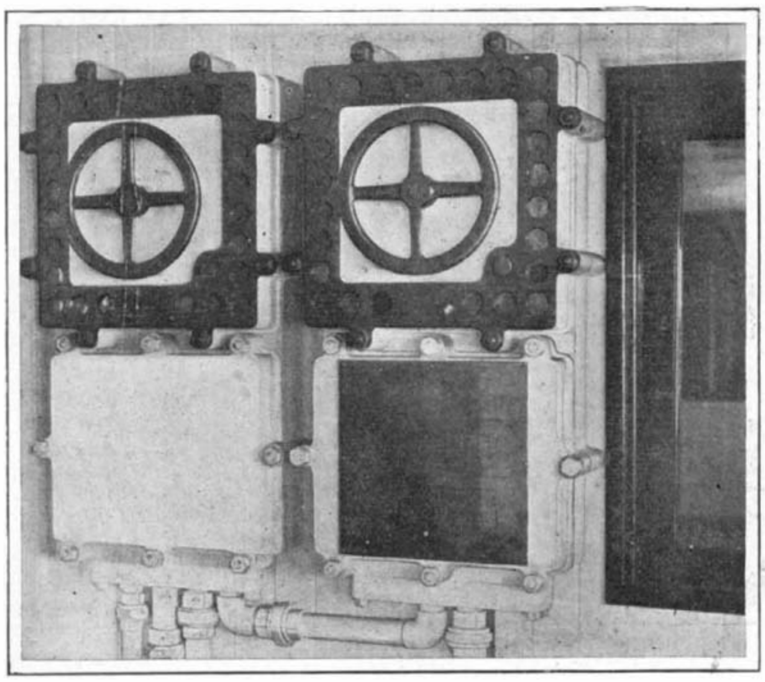
If we take account of the durability of a gun the advantage will be strongly on the side of the modern piece, for whereas the 15-inch smooth-bore was limited to twenty rounds under the given conditions, the modern 12-inch rifles, judging from the small amount of erosion developed with nitro-cellulose powders, should have a useful life of at least half a thousand rounds. Moreover, it must be remembered that the modern elongated shell will hold its velocity much longer than the old spherical shell of the smooth-bore, and, consequently, the respective muzzle velocities and energies are not an exact criterion of efficiency.

The gun of 1862 that answers to the modern secondary battery, 6-inch rifle, is the Parrott muzzle-loading rifle, a cast-iron gun which was strengthened at the breech over the powder chamber by shrinking thereon an iron hoop. The bore of the gun was 6.4 inches. It weighed 4.35 tons, was 12 feet 4 inches in length and with a charge of 10 pounds of powder it fired a 100-pound shell with an initial velocity of 1,080 foot-seconds and a muzzle energy of 810 foot-tons. Compare this with the modern 6-inch rifle, which weighs 8.5 tons, is 25 feet in length, and with a charge of 40 pounds of smokeless powder fires a 100-pound shell with an initial velocity of 2,900 feet per second and an initial energy of 5,838 foot-tons. Compared on the basis of energy per ton of gun, we find that the 100-pounder Parrott muzzle loader developed 186 foot-tons of energy per ton of gun, whereas the modern 6-inch breech-loading rifle develops 784½ foot-tons of energy per ton of gun.

ELECTRICAL CONTROL OF BULKHEAD DOORS ON WARSHIPS.

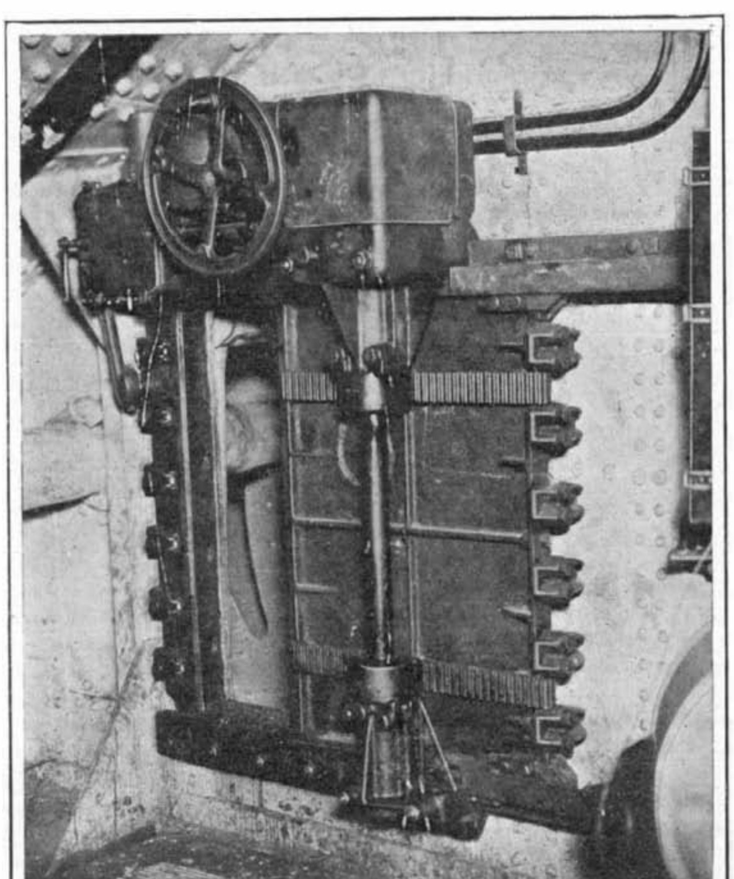
Electricity has now finally supplanted hydraulic and pneumatic pressure in the control of bulkhead doors and armored hatches on the ships of the American navy. The armored cruiser "Colorado" just completed, is the first vessel in any navy to be equipped with a full complement of water-tight doors, electrically controlled. The new system is entirely an American development, although it is understood that the admiralty offices of several foreign nations are interesting themselves in it.

The installation on the "Colorado" was in accordance with Navy Department specifications stipulating that "each such door or hatch must be capable of permitting operation on the spot by power or by hand from either side of the bulkhead or deck, and all such doors are to be capable of being closed by power, simultaneously, from the emergency station. During any period of simultaneous or emergency closing full control must be maintained for opening any individual door on the spot, either by power or by hand, from either side of the bulkhead, and after any individual opening the emergency closing must repeat itself automatically. Approved means must be adopted to indicate continuously at the emergency station, during every emergency period when each door is shut and locked."

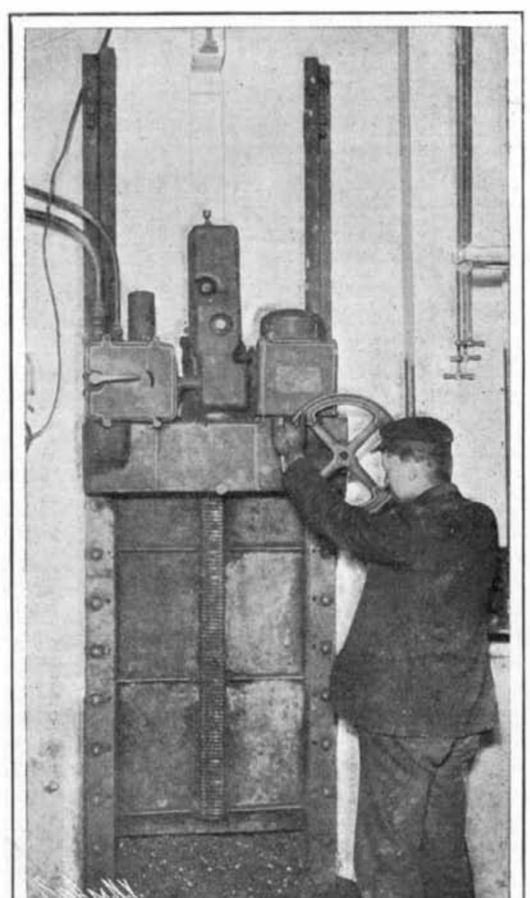


Emergency Station in the Pilot Honse.

These requirements were based on a long series of experiments with hydraulically-controlled doors on the cruiser "Chicago" and pneumatically-controlled doors on the battleships "Maine" and "Missouri," as well as several other cruisers. It was found that the older methods of control were vitally deficient in their failure adequately to provide for local control or to prevent doors from closing suddenly and without warning. This defect tended to create hostility toward the apparatus on the part of the man whose duties might require him to pass through the door or who might become imprisoned in a compartment in case of accident. The pneumatic and hydraulic doors also leaked and were an unending source of annoyance aboard the ship. Having ever in mind, however, the lessons taught by the sinking of the British man-of-war "Victoria" (whose doors were open at the critical moment), the Navy Department has encouraged the development of a door which would effectually safeguard the man and equally effectually insure the safety of the ship.



A Horizontally Closing Door, Showing the Motor, Rack, Hand Controller and Hand Gear.

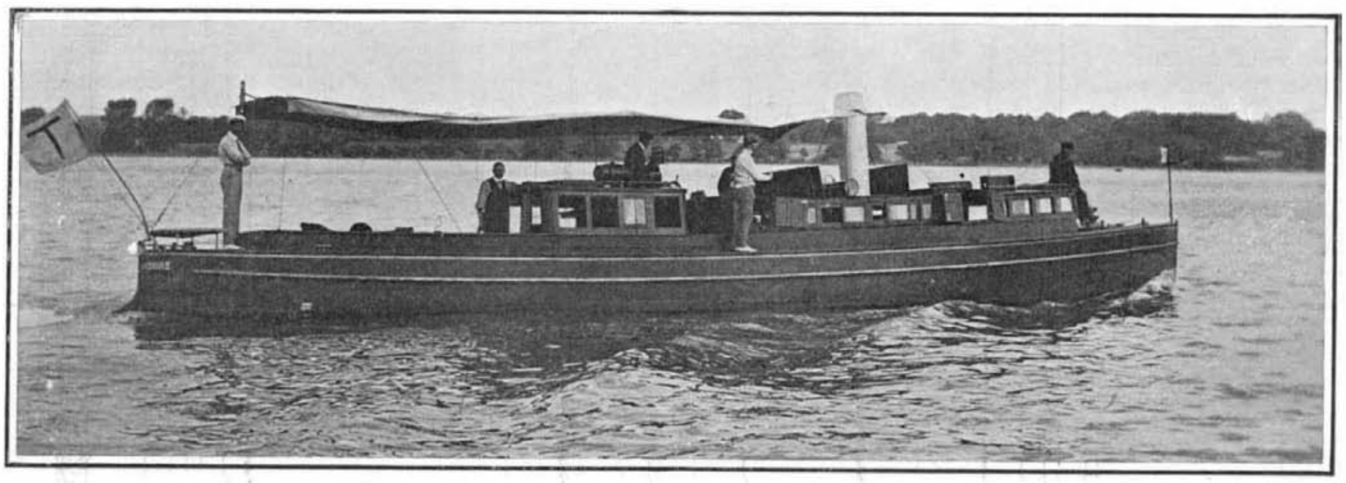


Closing a Vertically-Operating Bunker Door by Hand Gear.

ELECTRICAL CONTROL OF BULKHEAD DOORS ON WARSHIPS.

The present system consists of a central emergency station connected with the controller on each door and hatch gear by one twin conductor. The working parts of the emergency station are located in a water-tight brass case which is installed on the wall of the pilot house, the bridge, or in some other place convenient to the officer of the deck. The essential parts of the station are: (1) the mechanism for controlling the circuits running to each door or hatch gear for closing the same; (2) the lamps to indicate the closure of each door or hatch; and (3) a fuse box in which each wire is provided with the proper fuse. On each door or hatch-plate there is a direct-current motor, reversible, compound-wound, bipolar, constructed for intermittent service and entirely inclosed in a water-tight case. This motor is capable of one horse-power under normal conditions, but will carry without injury an overload of 50 per cent for five minutes and 400 per cent for 10 seconds. Each door is also provided with a hand controller for opening the door when the current from the emergency station is on and with a hand gear for opening and closing the door without the aid of the motor.

The operation of the system is briefly as follows: If the ship is in danger of collision or ramming, it is the duty of the officer or seaman nearest to the emergency station to pull a latch similar to that of a fire alarm box, which releases the gearing within the station. This gearing automatically closes the circuits operating the emergency switches located in the controller in each door. It does not start all of the motors at the same time, thus avoiding the necessity for the enormous supply of current which would arise if all were started at once; but so nicely is the operation of the emergency station adapted that twenty-five doors and hatch gears can be closed in 1 minute and 15 seconds without more than four motors being in operation at any one time. As each door shuts it closes automatically a circuit running to the emergency station and connected with an incandescent electric light therein located. These lamps show in the photograph of the station in the form of a border of transparent disks each numbered to correspond with one of twenty-five doors or hatches. If there is an obstruction at any door such as to prevent its closure, the fact will be indicated by the failure of the lamp back of the corresponding disk to light. During the time the emergency current is turned on a red indicator lamp burns continuously so that a mere glance at the station shows whether the emergency is on or off.



THE "EMIL CAPITAINE," A 75-HORSE-POWER YACHT DRIVEN BY PRODUCER GAS.—THE FIRST OF HER KIND.

The door controllers contain three independent switch mechanisms, the most important of which is the one used to open the door while the emergency current is on. This is to avoid the possibility of members of the crew being imprisoned and suffocated in compartments closed from the emergency station. By simply raising the hand lever the door is made to move backward, allow time for passage and then close again. The second switch is operated from the emergency station, and is the one by which the doors are closed. Its operation can only be suspended temporarily in the manner just described, and the door will always close as soon as the controller lever is released. The third switch is made necessary by the fact that blowouts of fuses would otherwise occur if the door in closing should encounter an obstacle such as a bag of coal or piece of timber left in the opening. This switch is operated by mechanical connection with the door or hatchway, and after an obstruction is removed the switch will again close the circuit to the motor and the door will go on its way toward its grooves without further attention. This switch is an essential part of the system, for without it an obstruction would result in a blowout of the fuses protecting the motor and prevent subsequent operation until these fuses had been replaced.

Another important part of the new device is the tightening gear. This was a feature of the power door which involved some difficulty for the reason that the door must be allowed room for free action between the guides and must at the same time fit so well as to prevent escape of water under pressure equivalent to a head of 35 feet. The tightening gear in the door is a great improvement over the old method of using two wedge surfaces. It substitutes an arrangement consisting of a wedge acting against a curved surface, thus securing more water-tight closure while avoiding the possibility of jamming. It also makes it impossible for coal and other material to find lodgment between the wedges—something that was very likely to occur in the power doors between coal bunkers and the fire rooms.

Reference to the illustrations will clear up any doubt the reader may have as to the details of the operation of the system so far as the doors are concerned. In the picture of a vertical coal-bunker door the controller is shown on the left, the motor on the right. At the time the picture was taken the door was being closed by the auxiliary hand wheel. In the photograph of the horizontal door the controller box is also on the left and the motor in the center. In this picture will also be noticed the double rack in which operate cog wheels attached to the vertical shaft turned from above by the motor. In the case of hatch-plates a lifting mechanism is substituted for the rack and cog wheels.

The "long arm" system, just described, is now installed on the armored cruisers "Colorado," "Pennsylvania," "Tennessee," "California," "South Dakota," "West Virginia," and "Maryland," the battleships "Louisiana," "Minnesota," "Connecticut," "New Jersey," "Rhode Island," and "Vermont." Besides its direct value in increasing the efficiency of the cellular structure—providing, as it does, absolute assurance that bulkhead openings will be closed in time of danger—the adoption of the system results in a standardization of doors, openings, and parts of the operating mechanism. To put an end to the present endless variation in types and sizes of bulkhead doors and fittings is in itself a great advantage, and in time it is believed that these parts of a ship will be as thoroughly standardized as railway equipment is now. The cost of the electrical system is less than one per cent of that of the hull.

THE FIRST PRODUCER-GAS BOAT.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

A short time ago we drew attention in the pages of the Scientific American to the development of the gas producer engine for marine purposes. The system described therein was that recently devised by Herr Emil Captaine, of Frankfort (Germany), which the inventor has applied to small vessels engaged in sheltered and still-water traffic on the European Continent with conspicuous success. As we mentioned at the time, Messrs. Thornycroft & Co., the well-known shipbuilders of London, have adopted the idea for more extensive application, and were at that time conducting several experiments with the system with a view to its installation upon a commercial or pleasure vessel. These efforts have now been brought to a successful issue, and at the recent reliability trials carried out in the Solent great interest was manifested in the vessel entered by Messrs. Thornycroft & Co., the engines of which depend upon fuel generated on the Capitaine suction gas producer principle.

This is the first practical attempt to prove the commercial possibilities of the system for open-sea work. The first recorded instance of a vessel being propelled by an internal combustion motor is that which was made as far back as the sixties, when the Marquis d'Nare d'Aubaie's auxiliary yacht "Djesirèly" was fitted with a Lenoir motor. In this instance, however, the gas was not produced on board, but generated in a stationary apparatus on shore and stored on the vessel under pressure in cylinders.

The Thornycroft vessel, named "Emil Capitaine," in honor of the inventor, is a small yacht 60 feet in length by 10 feet beam, and with a draft of 2 feet 6 inches. The boat is designed upon the well-known Thornycroft lines which have been adopted in many of their boats with conspicuous success. The stern is broad and flat, and the single propeller works in a tunnel, thereby insuring great steadiness in running without causing the stern to settle down unduly, and further causing a clear and unobstructed flow of water to be maintained to the propeller. The hull is constructed of galvanized steel plates. Roomy accommodation is provided, there being two saloons, one forward and one aft, respectively. The machinery is installed just forward of the aft cabin, between watertight bulkheads.

The suction gas producer plant, together with the specially designed engine for working with the same, have been built by the Thornycroft Company from the designs of Herr Emil Capitaine. The motor is of the inclosed vertical type, having four single-acting cylinders, each having a bore of 8½ inches with a stroke of 11 inches running at a normal speed of 300 revolutions per minute.

The special designs involved in the construction of this engine may be gathered from the following description of the plant. The engine frame is comprised of mild steel plates connected by angle bars, so that a box-like structure is provided, of great rigidity. The crank pit is formed by carrying the steel plates right around. The cylinder trunks are each cast separately and are contained in the framing. The cylinder heads are also cast separately and are supported between plates riveted to the transverse members of the frame. The result of this design is that the latter plates serve to absorb all the shock of the explosion which is transmitted directly to the crank-shaft bearings, which are also bolted to the frame plates. Heavy bolts for the purpose of connecting the cylinder heads to the trunk, which practice is usually adopted in this type of combustion motor, are thereby dispensed with, while possibility of leakage is reduced to the minimum. This principle also renders the engines more accessible, it being possible to remove all the mechanism concerning the ignition and valves with facility and celerity when it is requisite to carry out cleaning, inspection, or other operations. In fact, the gearing can be disconnected and replaced within the short space of six minutes.

All valves are mechanically operated by cams, the latter being actuated from the crank shaft by means of suitable gears. The cam shaft is placed above the top of the cylinders and slightly out of the center line, the motion being imparted to the valves through rocking levers. The cam shaft is hollow and carries in it a sliding shaft which, by means of radial arms projecting through slots in the cam shaft, operates the strikers of the low-tension magneto igniters. The longitudinal motion of this internal shaft, which is controlled by the governor of the engine, varies the time of ignition, advancing or retarding it as the speed of the engine increases or decreases. There is also an arrangement introduced whereby the timing of the magneto machine is simultaneously varied to correspond with the point of ignition. The engine itself is controlled by means of a throttle valve in the induction pipe connected by a special device to the governor. There is furthermore provision for completely cutting out the electrical circuit when the speed of the engine exceeds a certain limit.

The engine is fitted with half compression gear for starting purposes. The latter function is carried out by means of a separate single-cylinder Thornycroft motor of 6 horse-power through a belt drive. The half-compression cams are automatically thrown out of action by means of an attachment fitted to the governor when the motor reaches its normal running speed. The cylinder heads are water-cooled, the circulation being carried out with a centrifugal pump driven off the engine. The exhaust is also water-jacketed, and the gases escape into the outer atmosphere through a funnel, thereby dispensing with a silencer. Forced lubrication is adapted to all bearings by a specially designed reciprocating oil pump. Access to the bearings of the crank shaft and connecting rods of the pistons is obtained through doors fitted in the lower part of the engine. At the forward end of the crank shaft is a pulley for driving a gas drier and a centrifugal pump for pumping the heated and dirty water from the gas purifier. Reversing is carried out by means of epicyclic gear and a cone clutch placed in the line of shafting forward of the thrust block. The engine is freed and reversed in either direction by a single hand wheel.

The suction gas producer is of the ordinary cylindrical shape, comprising a steel shell with a firebrick lining surrounding the hot zone. The fire bars are of channel section to enable them to withstand better the intense heat and also to hold the ash. They are carried on cams and can be lowered toward either side to facilitate clinkering. There are three charging doors in the top which deliver into a conical annular hopper, while in the lower part are provided the usual air and steam inlets. The steam generator is placed in the upper part of the producer and comprises a shell with field tubes. This serves the dual function of cooling the gases and generating steam which is decomposed in the fire in order to supply the necessary gases for the explosive mixture. An ingenious alternative arrangement is fitted whereby the steam may be generated by the exhaust gases from the engine. After production the gas passes into a cooling tower in which