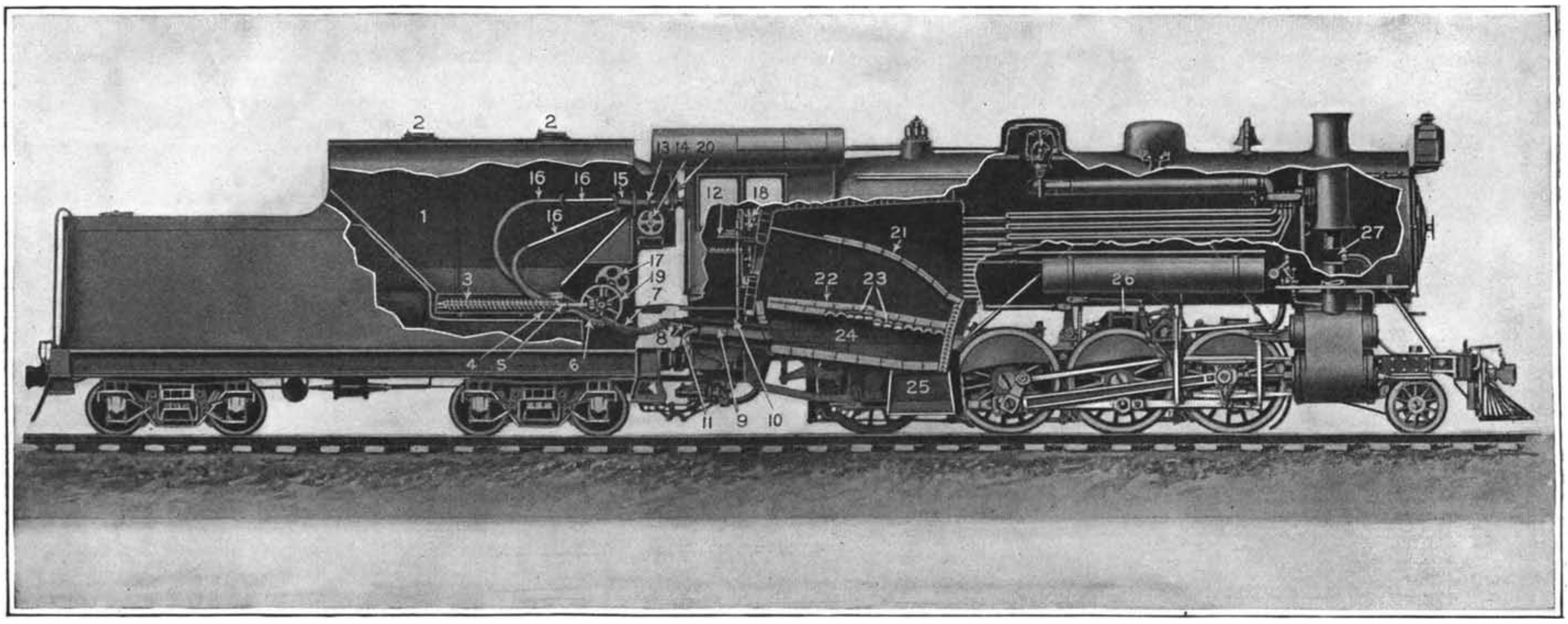


By courtesy of the New York Railroad Club

Locomotive that burns pulverized coal, thereby effecting a saving of 15 to 25 per cent of fuel

A Coal-Dust Locomotive

By Herbert T. Walker

THE expenditure for locomotive fuel on our steam railroads amounts to nearly 25 per cent of the total cost of conducting transportation. This enormous item of expense, coupled with the ever increasing cost of all material, due to the high price of labor, presents a problem which has engaged the attention of locomotive engineers for a number of years.

Experiments made in the way of burning solid fuel other than on grates in cement kilns and metallurgical furnaces have been successful, and pulverized coal is now extensively used for such purposes; but the difficulties inseparable from the conditions under which a locomotive has to be operated are great, and it is only recently that appliances for burning powdered fuel in locomotive fire-boxes have been practically developed.

A paper on the subject was presented at a meeting of the New York Railroad Club recently, and by the courtesy of the club we are now able to give some particulars of this important step in railroad fuel economy.

In the first place, it may be stated that any solid fuel which in a dry pulverized form has two thirds of its content combustible will be suitable for steam generating purposes. Therefore, the low value coal mine and strip-pit products, such as dust, sweepings, culm, slack and screenings, and even lignite and peat, are as suitable as the larger sizes and better grades of coal. As some of the products above named are now unsalable, the great saving effected by the use of the new form of fuel will be apparent; for the total cost to prepare pulverized coal in a properly equipped plant will be something less than 25 cents per ton. This item will be more than offset by the great difference in the cost of the grades of coal purchased for pulverizing as compared with those that would be required for burning satisfactorily on grates.

The preparation of the fuel is not complicated. It must be thoroughly dry; that is to say, the moisture should not exceed one per cent, and ground to a fineness so that it will pass through a screen from number 100 to number 200 mesh.

The first locomotive of any considerable size to be fitted up in the United States or Canada (and, so far as known, in the world) with successful apparatus for burning pulverized fuel in suspension was a 10-wheel type of engine on the New York Central Railroad. This engine has cylinders 22 inches diameter by 26 inches stroke. Driving wheels, 69 inches diameter. Boiler pressure, 200 lbs. Heating surface, 2,649 square feet. Grate area, 55 square feet. It is equipped with a Schmidt superheater and has a tractive effort of 31,000 pounds. It was converted into a pulverized fuel burner in the early part of 1914. Since then, other installations have been made to a Chicago and North-Western Railway "Atlantic" type of engine, and to a new "Consolidation" type of locomotive for the Delaware and Hudson Company, which latter is probably the largest of its type in the world, its tractive effort being about 63,000 pounds.

To give the reader an idea of the pulverized fuel burning equipment as applied to a locomotive engine, we present an illustration showing the general arrangement partly in section. The prepared fuel is passed into the fuel container, 1 (which is a part of the ordinary locomotive tender), through the openings 2, 2. These openings are then tightly closed to keep out moisture, as dryness of the fuel is the prime requisite. To start the fire, the first thing the fireman does is to turn on the steam blower, 27, in the smoke box; then he places a piece of lighted oily waste in the furnace, 24, after which he starts the motor, 17, driving the fuel conveyor, 3, and then the motor, 14, which drives the air blower, 13. The screw conveyor, 3, forces the fuel into the fuel and pressure air feeder, 4, where it meets the air driven by the blower, 13, through conduits 16. The fuel and air are thus driven through a commingler, 5, conduits 6 and 7, nozzle 8 and fuel and air mixer 9. This mixture then enters the combustion furnace 24, which is the ordinary locomotive fire-box provided with a fire-brick floor in place of grate bars, and is there ignited by the lighted cotton waste. The fire-box is fitted with brick arches, 21 and 22, and auxiliary air inlets, 23. There are also induced air inlets, 11, to secure perfect combustion and a slag pan, 25, in place of the usual ash pan.

The air and fuel control regulators, 12 and 18, are

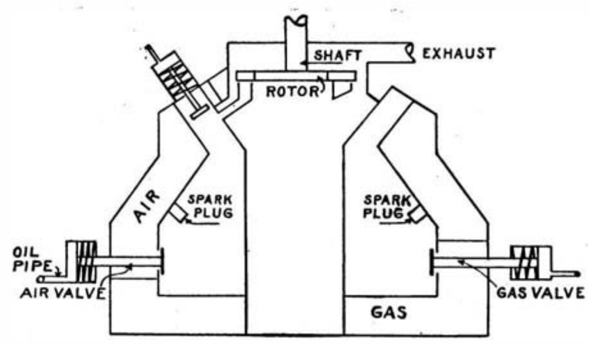
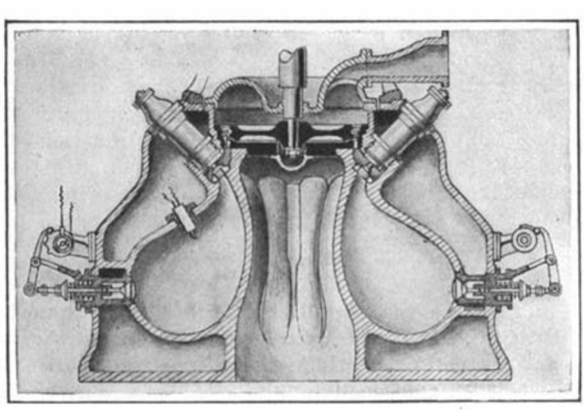


Diagram illustrating the operation of the gas turbine

There are several of the vessels shown in cross-section, together building up the base of the apparatus. Each has an air valve, a gas valve and an outlet valve



Cross-section through one of the explosion chambers of a German gas turbine

in the cab within reach of the fireman, who has no need to go into the tender, but can keep his place in the cab and assist the engine driver in looking ahead for signals. The fireman's duties will be very light compared with his work required in hand firing coarse coal on the ordinary grates. This is easily understood when we recall that the fireman of a heavy modern locomotive has to shovel coal into the fire-box at the rate of about 6,000 pounds an hour, or 100 pounds per minute. This laborious work cannot be done with the care necessary to secure good combustion, with the result that quantities of coal are dropped into the ash pan, the flues are rapidly choked with soot, and clouds of smoke, unburnt coal and sparks are ejected from the stack, to the annoyance of passengers and danger to property adjacent to the railway.

The improved system will change all this, for even when the fuel contains 15 per cent of non-combustible matter only about 2.5 per cent is deposited in the slag or ash pan, and this deposit is non-combustible. Whereas, when coal is burned on grates about 15 per cent goes into the ash pan, and this residuum always contains more or less combustible matter. The saving in ash pan waste alone is an important item.

When the proportion of powdered coal and air is properly regulated, the mixture bursts into a clear, intense flame in the fire-box, having a temperature of from 2,500 to 2,900 deg. Fahr., with no visible smoke at the stack (except when the fire is first started) and making but little soot deposit in the tubes. With this system of easy and rapid control of the fire it takes less than 60 minutes to get up 200 pounds of steam pressure from boiler water at 40 deg. Fahr. When the engine is standing the fire may be put out entirely, and within an hour can be reignited from the heat of the brick arches in the fire-box.

Only one set of fuel and pressure air feeders could be shown in our illustration, but as many as five units may be placed in the ordinary tender. As each unit has a capacity of from 500 to 4,000 pounds of pulverized fuel per hour, there will be no difficulty in meeting the requirements of the largest locomotives.

It is stated that the use of pulverized fuel effects a saving of from 15 to 25 per cent in coal of equivalent heat value delivered, as compared with the hand firing of coarse coal on grates.

In conclusion it must be noted that there is a certain element of danger in the handling of pulverized coal that does not obtain with the more ineffective coarse coal. But, with ordinary care and the observance of certain established rules, it is comparatively easy to avoid trouble, as is shown by the records of industrial plants using pulverized fuel.

An Ingenious Gas Turbine Developed in Germany

By Sydney F. Walker

WHAT appears to be a thoroughly practicable gas turbine was worked out in Germany just before the war. A turbine furnishing about 200 horse-power was built at Hanover a few years back, and was run for three years in order that its faults might be observed. Later on, a turbine furnishing 1,000 horse-power and driving an electric generator was built at another works in Germany. It was tested and an overall efficiency of 20 per cent was claimed between the energy delivered by the explosions and the electricity furnished by the generator. The special feature of the apparatus was that the explosions took place in one set of chambers, and the expansions partly in the explosion chambers and partly in the space in which the rotor of the turbine was revolving.

The rotor of the turbine ran in a horizontal plane; a number of explosion chambers, ten in the 1,000 horse-power apparatus, being arranged around its shaft. The explosion chambers were cast together with air and gas chambers, the whole forming approximately a truncated cone, the electric generator being placed at the apex of the cone. The gas and air chambers were kept full at definite pressures. Each explosion chamber was first filled with air up to the pressure in the air reservoir; the air supply was then cut off and gas forced in also under pressure, preferably by successive strokes of the gas pump, so that the gas would form layers in the explosion chamber.

(*Concluded on page 334*)

Scientific American War Game

What do you know of the science of war?

Knowledge of military strategy and tactics is obtained by a game of war played with pins and blocks and paper strips upon a contour map. The game is as scientific and absorbing as a game of chess. We invite our readers to participate in such a game.

Owing to the interest this series has aroused we have decided to run the articles weekly instead of every other week as announced last week.

WAR HAS BEGUN!

I.

In the SCIENTIFIC AMERICAN of March 11th we published the first paper of the war game series. Enemy patrols had been observed ten miles beyond "Lookout Hill." To gain information about the enemy, four cavalry patrols were sent out from the detachment stationed at "Norrisville."

II.

This week (page 328), the reports of the cavalry patrols are announced, the detachment which has moved forward, encamps for the night and takes measures to protect itself against surprise attacks. What measures should be taken?

III.

April 1st. The detachment now moves forward to a strategic position to engage the enemy in battle. What disposition should be made of the artillery, infantry, and cavalry?

IV.

April 8th. In this issue battle is joined, and our readers move over to the side of the enemy to learn of the measures taken by the enemy to defend itself.

In each installment problems are presented for the readers to ponder over. Military science is as exact as that of chess. These problems have definite answers, and the answers in each case will be found in the following installment.

This war game series is being conducted by Lieut. Guido von Horvath, formerly of the Austro-Hungarian Army, who is eminently fitted to teach military tactics by reason of his training at the Military Geographical Institute at Vienna.

In strict military parlance the first installment of the series are known as "map problems." A real war game will follow, when two military tacticians will be pitted against each other in military maneuvers. Announcement of this game will be given later.

The articles are written so that laymen can understand them.

Copies of the enlarged colored map covering the terrain of the war games, which appears on the cover of this number, may be had for 10 cents each.

MUNN & COMPANY, Inc.
Woolworth Building - - - New York

Our Vanishing Export Trade in the Products of American Forests

(Concluded from page 319)

lost importance on this side. The much-considered and anticipated impetus to American shipping may perhaps be an aid to it in any case. Such we will hope it may be. It is an interesting and an important trade, and we would like to hear again the clatter of American wooden shoes along Dutch streets, and see as formerly the railroad trains of other lands traveling across some rough-hewn ties that came from the forests of North America.

An Ingenious Gas Turbine Developed in Germany

(Concluded from page 322)

When a definite quantity of gas had been forced into the explosion chamber, the quantity being controlled by the governor, according to the load, the charge was fired by a number of electric sparks passing between pairs of platinum points arranged in different parts of the explosion chamber. The idea was to fire the charge simultaneously at different points, and, if possible, to fire the different layers mentioned above. When the charge was fired, the products of combustion were expanded by the heat liberated in the usual way; and when the pressure due to their expansion reached a certain figure, an outlet valve was opened. The outlet valve was practically a gate, swinging on hinges, that could be opened outwards by the pressure of the hot gases, and that was arranged to be closed mechanically. The hot gases passed through the outlet valve and thence through a channel leading to a nozzle.

The rotor was arranged upon the same lines as the De Laval and Curtis steam turbines. It consisted of a disk carrying a number of buckets upon its periphery. The hot gases formed in the explosion chamber were expanded down during their passage to the rotor, by the aid of the conical-shaped nozzle, to several pounds below atmospheric pressure. The large volume of hot gases thus formed swept through the buckets of the rotor in a similar manner to that in which the large volume of low pressure steam flows through the buckets of the De Laval and Curtis turbines. A fan was placed in the exhaust, which enabled the pressure of the gases to be reduced to the low figure mentioned. After the hot gases had performed their work in causing the motor to revolve, cold air was again forced into the explosion chamber, and through the passages leading to the rotor, but not through the rotor itself. The cold air performed the offices of scavenging and of cooling the explosion chamber. After the cold air had been flowing through the explosion chamber for a certain time, the outlet valve was closed mechanically, and the air then proceeded to fill the explosion chamber, ready for another explosion. The 200 horse-power experimental turbine that was made at Hanover had its valves worked mechanically by rods and cams taking their power from the axle of the turbine rotor. In the 1,000 horse-power turbine, however, the valves were worked by oil pressure, a servo motor being employed. The arrangement of the servo motor was very ingenious. It was something on the lines of the well-known distributor employed on motor cars for directing the ignition to different cylinders. The apparatus consisted of two concentric cylinders. The outer cylinder had a number of apertures leading to the valves of the explosion chambers; there were as many apertures as valves to be controlled. The inner cylinder was hollow; a pressure of oil being maintained inside it by means of a pump. It had one aperture and was caused to revolve, and as its aperture came opposite the apertures in the outer cylinder, the oil pressure was delivered to the different valves in succession. Thus the pressure was delivered to the air entry valve of an explosion chamber, then it was cut off, and the opposing spiral spring closed the valve, the oil pressure passing on to the gas valve which was opened and closed in its turn, and so on. The explosion chambers were arranged to operate one after the other, but not so that those adjacent to each other would fire consecutively. As was to be expected, the 1,000 horse-power turbine was by no means perfect. Troubles arose with the working of the valves, and the writer understands that a firm in a neutral country is improving the turbines.

The turbine was tried with almost every kind of fuel—with gas from a town's gas works, with gas from a producer, with blast furnace gas, with oil of various specific gravities all taken from petroleum, and with coal dust. Coal dust apparently was the only fuel employed that was not satisfactory, and the writer understands that the reason was the same as that which led to the failure of coal dust in the cylinder of an internal combustion engine; viz., the formation of a certain amount of coke. With gaseous and oil fuel, there was no difficulty about obtaining complete combustion. With coal dust there was; and the minute quantity of unconsumed ash or coke led to the valves not working properly. When oil fuel was employed, a spraying apparatus actuated by compressed air was added, very much on the lines of that used with the Diesel engine. The exhaust gases also, which though expanded down below atmospheric pressure, still carried a large quantity of heat, were employed to raise steam in a boiler, the steam being used either to drive the gas and air pumps or for the gas producer when gas was taken from a producer for the test.

It is claimed for the gas turbine that it will occupy a much smaller space than a gas engine to furnish the same power, and in view of the fact that electricity is becoming more and more the agent for the delivery of power, rotary motion as against reciprocating motion must be an advantage. The following are some figures that were given out, comparing the relative spaces occupied by, and the weights of, the gas turbine and a reciprocating gas engine, to perform the same amount of work:

The gas engine with blowers and gas boiler, it was claimed, was about a third of the weight of a reciprocating engine to furnish the same power, and it occupied less than a third of the space.

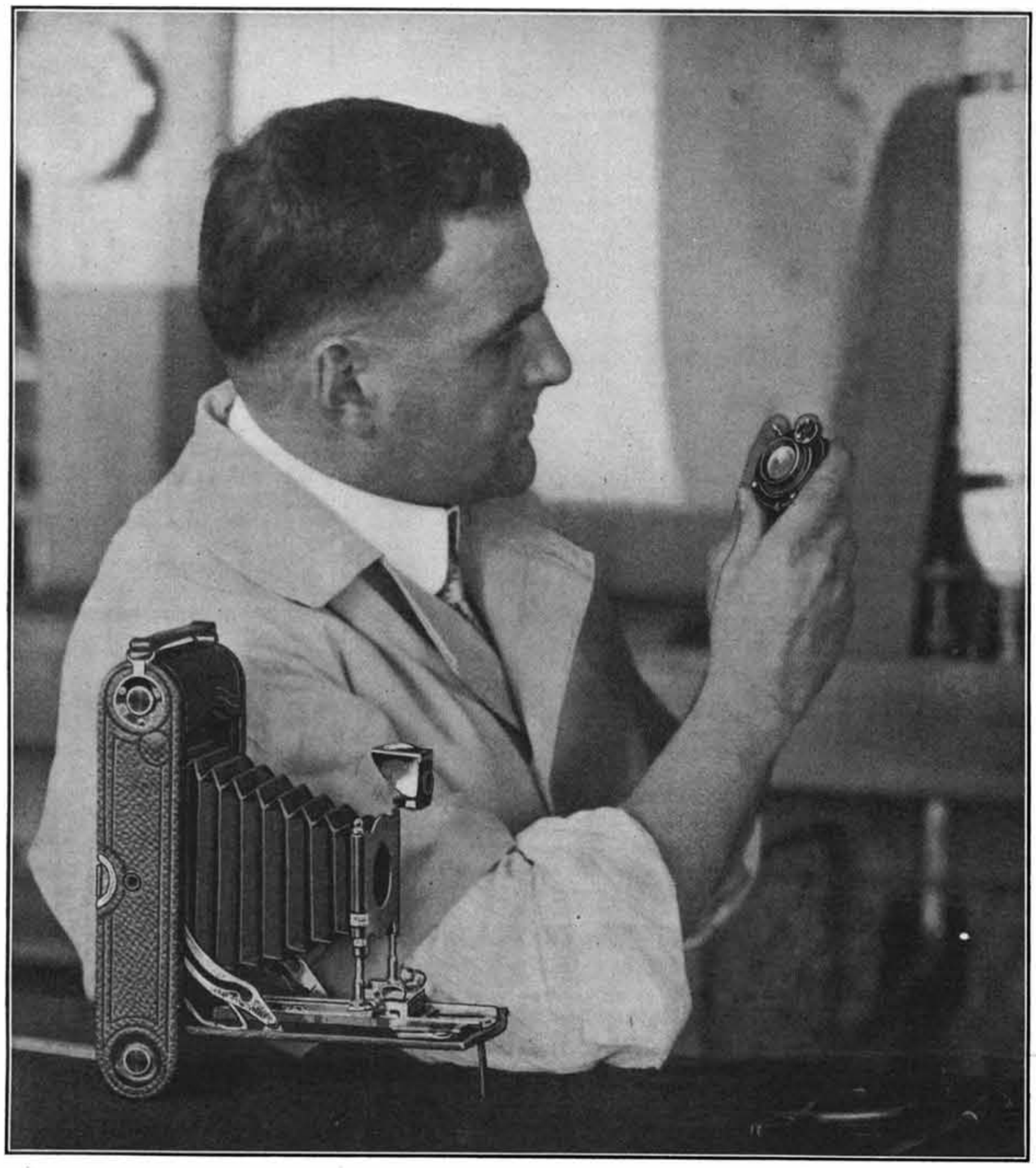
It is claimed also that once the difficulties inseparable from a new form of apparatus are overcome, the gas turbine may be constructed in very much larger units than the reciprocating gas engine. It is claimed that gas engines up to 10,000 horse-power should be possible, while it is remembered that 2,500 horse-power is at the present time practically the limit with reciprocating gas engines.

On the Trail of Villa

(*Concluded from page* 327)

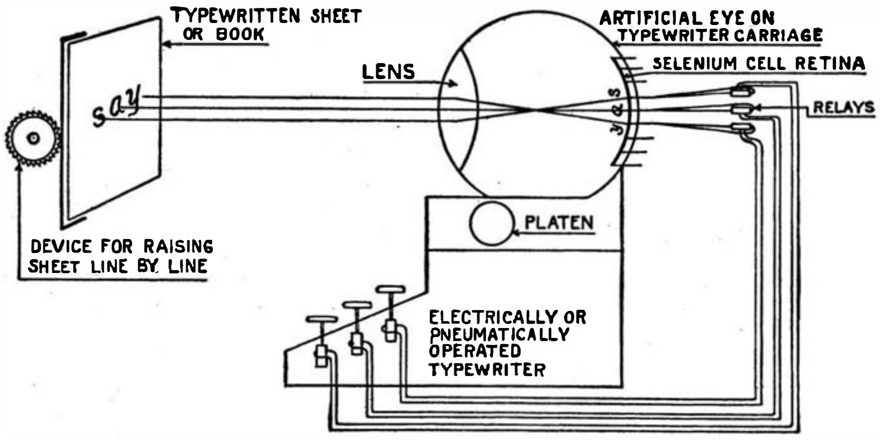
duties an invading expedition with its necessary supply.

The international boundary line is about 2,000 miles long. El Paso, the base for the scene of the present trouble, is about midway east and west. Columbus and Hachita, the reported starting points of the expeditionary forces, are about 100 miles to the west of El Paso. The physical difficulty of guarding such a line as the boundary can hardly be overestimated. In addition, it must be remembered that an army is not a police force, is not trained for and is not intended to do police duties. An army works en masse. It is organized and trained for the purpose of meeting and defeating the organized military forces of the enemy state. It is not its ordinary function to prevent highway robbery or cattle stealing. It can punish the perpetrators of such crimes, as it now proposes to punish Villa, cost what it may. The protection against violence and crime which an army provides is based upon the fear which it inspires. That fear is caused by the feeling that any overt act will be followed by a swift, sure and terrible punishment. Our border army has inspired no such fear. It has been tied down by a policy of very unwilling inactivity and non-interference. The border Mexicans have felt that they could take almost any liberties with it which they wished. And they

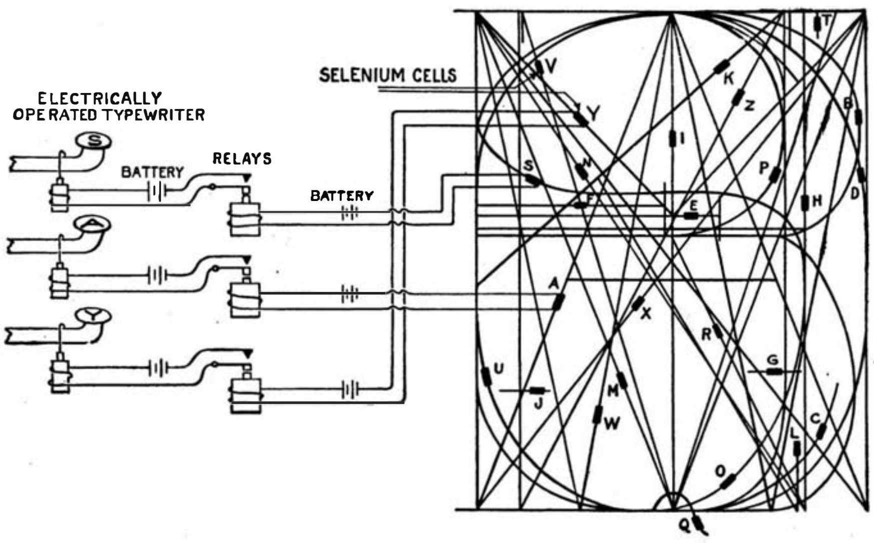


A Typewriter That Copies With Its Own Eye

DESPITE the fact that the self-operated typewriter described in the following paragraphs has not as yet been actually constructed and tried out, not a little interest attaches to it for the suggestion it offers. Provided with a huge mechanical eye, this typewriter of the future will be capable of copying automatically any reading matter that may be placed in front of it.



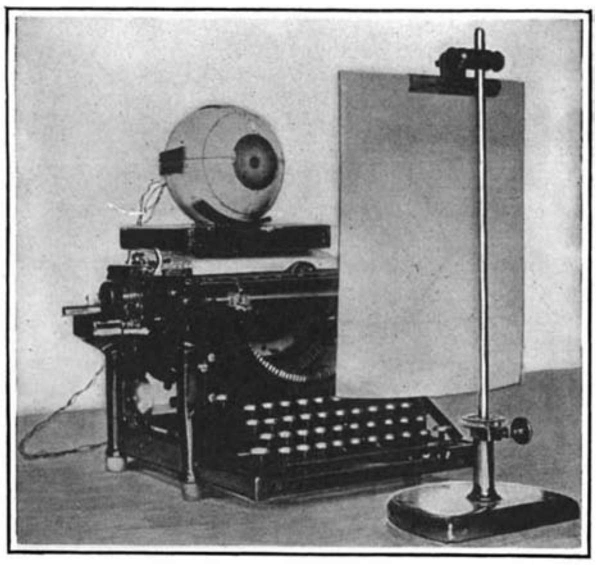
Diagrammatic scheme of the main components and their relationship in the self-operated typewriter



Arrangement of the selenium cells which form the retina of the typewriter eye

The typewriter that copies with its own eye is the idea of J. B. Flower, an electrical engineer of Brooklyn whose name is not an unfamiliar one to the readers of this journal. The artificial eye is preferably attached to the carriage of the typewriter in order that it may move at the same rate of speed. It moves, step by step, over the line of printed or typewritten language appearing on a sheet of paper which is placed in front of the machine.

The artificial eye of the automatic typewriter must of necessity be of complicated construction. Essentially, it comprises a lens and a number of selenium cells arranged so as to form a retina similar to that of the human eye. The sheet of paper containing the copy to be duplicated is placed at a suitable distance from the artificial eye, so that a clear image of the letters will be produced on the multiple selenium cell retina. It is imperative that the eye move parallel to the read letters in order not to ruin the focus. The principle followed in connecting the selenium cells (low resistance cells) is that all the letters falling on the retina must be superimposed in one position; then the point or points in any one letter form which do not correspond to those of another letter form are the point or points which stand for that letter. These points can be connected to the typewriter for operating that particular letter form or character without chance of interfering.



The typewriter that writes what it sees with its own eye

THE READING TYPEWRITER

The method of operating the new typewriter is to place the typewritten sheet or book of which it is desired to make a copy in a special stand or device for raising the sheet line by line. The sheet is now held in a vertical plane parallel to that of the selenium cell retina. For the sake of exposing the operation of the mechanism, it is assumed that the word being copied is "say." Upon starting the typewriter by turning on the electric current, the image of the letter "s" will appear on the selenium cell retina and its shadow will stand over the selenium cell marked *S* and no other, hence the current passing through it will decrease in amount allowing the relay armature to move, thus closing the local circuit and actuating an electromagnet which in turn operates the "s" typebar of the typewriter and prints the desired character on the paper. The carriage now automatically shifts the artificial eye over one letter space, with the result that the image of the letter "a" now appears on the selenium cell retina and its shadow stands over the selenium cell marked *A* and no other, thus causing the typing of the letter "a." Following the same procedure, the letter "y" is typewritten. For spacing, the typewriter is provided with a mechanism which, when the carriage moves over one letter space and no type key is operated, the space lever is brought into operation. Means are also provided for automatic line spacing, carriage return, paper insertion and removal, and other phases of typewriter operation.

As previously stated, the reading typewriter is based on the principle that when the standard letters of the alphabet are superposed one on top of the other, there will always be one point in each letter form which is not common to any other letter form. On typing the alphabet on the typewriter with all the letters superposed, it will seem at first that the statement just made is incorrect. The seeming difficulty, however, is not a real one but is due to the small scale of typing. If the typewritten letters are magnified 50 times so that they occupy 3 inches square each, and are then superposed, all of which can be accomplished by the artificial eye, it is found that the distinguishing points of each letter form are not covered; in fact, they stand out beautifully individualistic, as is indicated in one of the accompanying sketches.

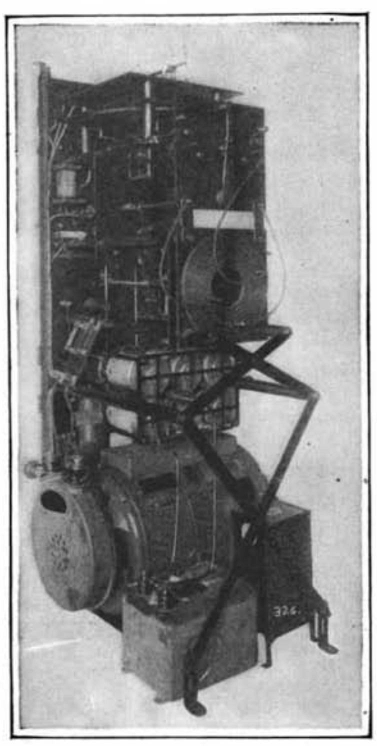
Unit Design in Marine Wireless Telegraphy

By J. Andrew White

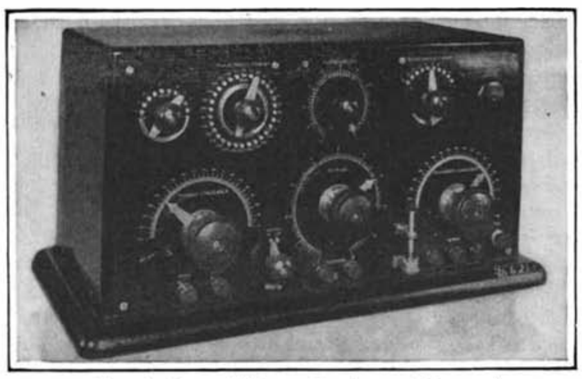
THE transition of an art into a science invariably reflects a number of epochal steps which are widely heralded in the lay press; on the other hand, small notice is taken of developments which scientific workers recognize as those having the most important bearing on ultimate achievement. By way of illustration, radio communication, or the field of the wireless telegraph, has been marked by many brilliant feats of individual skill in annihilating space and setting up odd and startling uses for the ether wave energy; but little has been heard of concerted action among engineers toward the mechanical perfection which is found in the more matured arts. From the onlooker's viewpoint, standardization of wireless equipment has been a matter for the future to take care of, a step to be taken only with the perfection of individual apparatus. Communication over distances once incredible has so occupied the attention of the world that it is scarcely known that the past few months has seen the solution of many problems in marine working, wherein the humanitarian values of the wireless telegraph have been so aptly illustrated in the past. The progress made in mechanical features is strikingly revealed in the announcement by an American wireless company that all its future equipments will conform to a standard design of the unit type, the complete transmitting apparatus being mounted on a single panel and the receiving equipment contained in a case of uniform design.

Aside from the interest aroused in the mechanical development revealed in this new equipment, the standardization feature opens up new possibilities in the acceleration of progress in the wireless art. Commercial operators will no longer have to master a number of types of installation, varying in arrangement, one might venture to say, with a frequency exactly proportionate to the number of ship transfers provided within the period of each individual's service at sea. Many of the staunchest vessels of to-day having been built at a time when wireless telegraphy and its legal status in maritime affairs did not have to be considered, no provision was made by ship designers for installation of apparatus or accommodations for operators. With widely varying conditions of space and location to contend with, the sets were installed principally according to the best judgment of the man assigned to the task. This objectionable condition is now obviously overcome with equipment of standard design available; and uniformity of installation and method of operation may also be expected to furnish cumulative operating experience that will prove of great value in the solution of engineering problems and safeguarding of life at sea.

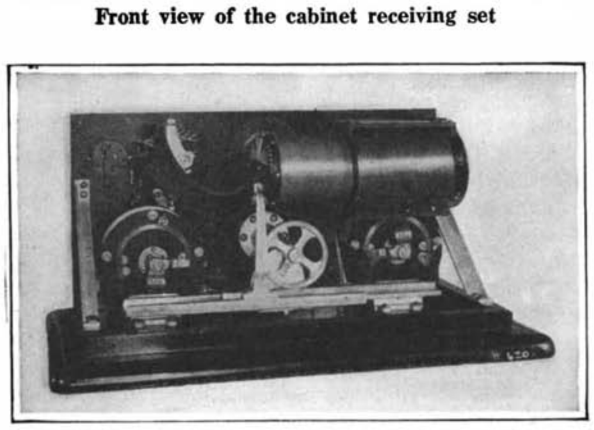
From the purely commercial side the new equipment possesses many advantages over its predecesors. The (*Concluded on page 336*)



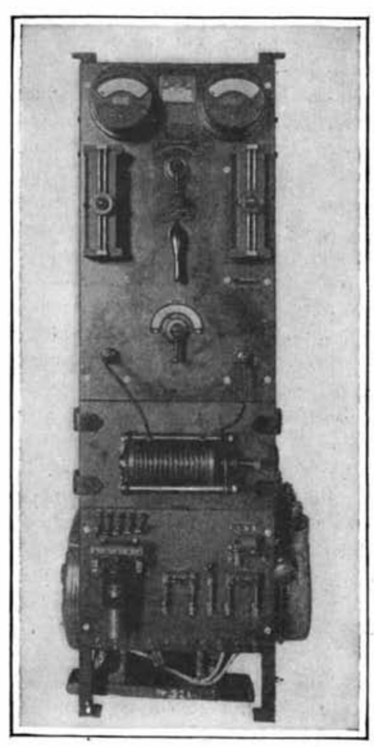
Rear view of the transmitter



Front view of the cabinet receiving set



Rear view of the cabinet receiving set



Front view of the transmitter

TRANSMITTER AND RECEIVING SET OF UNIT DESIGN FOR USE ON SHIPBOARD