A Giant Electric Torpedo That Eats Thru The Earth.

A GIANT torpedo that burrows its own way through the earth like a worm and can be exploded under any desired spot, has been tested on Staten Island so successfully that the government of one of the Allies now battling against Germany is negotiating with the inventor for its purchase.

The inventor is Clifford P. Marye, a civil engineer of New York. He calls it the "subterrane," because it may become to land warfare what the submarine is to sea-fighting. The idea is not entirely new, says the *New York World,* for it was partially developed many years ago as a possible method of tunneling, but was abandoned because much more expensive than the pick and shovel or the hydraulic shield methods. In modern warfare expense is no object.

Many creatures live underground and travel long distances by tunneling their way. The mole, for example, burrows a route through the earth with his powerful hand-shaped forefeet, and can progress underground almost as rapidly as upon the surface. But the mole digs his way and casts up the earth over him, as every gardener knows only too well.

An earthworm progresses through the ground in a different manner. It chews its way along, and passes the earth right through its body, only casting up such as it has to remove in making permanent tunnels.

The subterrane is said to be able to burrow its way through the earth almost exactly as does the earthworm.

The greatest difficulty in ordinary tunneling is the disposal of the earth as it is dug. The longer the tunnel, of course, the greater is this difficulty, as all the earth has to be hauled out the full length of the tunnel. Through soft earth it is possible to bore a tunnel as one bores a pencil through a lump of dough, removing nothing, but pressing the yielding earth aside and building up the tube behind the boring shield. In this way the Pennsylvania tunnels under the North River were bored. But such a method is useless in earth where there is much rock, gravel, boulder, clay, &c.

A torpedo to propel itself through the earth for any considerable distance must be able to go straight ahead, no matter what obstacles it encounters, and it must do this without removal of the earth behind it. In other words, it must eat its way through the earth; drawing this into its interior and passing it out behind, thus filling up the tunnel as it goes.

This is just what the subterrane does. The first one that was tried on Staten Island ate its way through sand and was dug out when exhausted. The second one ate its way into sand, earth and clay, in which were boulders, rocks and the roots of trees. It has never been possible to recover it, and it is still somewhere under the hills overlooking the Narrows. Of course these two experimental machines contained no explosives.

The Marye land torpedo, here illustrated, is a cylinder, forty feet long, eight feet in diameter, with small rigid steel fins standing upright all over its surface—these to prevent it from being deflected from its direct course by obstacles or changes in the character of the earth.

At the fore-end is a revolving cutting head the full diameter of the cylinder, working on the principle of a gimlet, with the additional faculty of grinding or triturating the earth and stones and drawing them back into the interior of the machine. Through the hollow center is a spiral that turns and passes the "digested" earth out to the rear. At the rear are four electro-hydraulic plungers which revolve intermittently, spreading the ejected matter evenly against the earth already there, and press powerfully against this mass, thus forcing the whole apparatus forward.

Within the subterrane are two electric motors of 600 horse power each, one of which moves the cutting head and spiral conveyor, while the other actuates the revolving of the plungers. In addition, there are four 30-horse power electric motors which work in concert through four hydraulic pumps and make the rear-end plungers behave like hydraulic rams. The whole is operated by engineers from a distance by means of an electric cable wound upon a drum in the subterrane and unwound as it progresses. This cable may be as much as five miles long. Through it the motors receive their power and the movements of the several motors are governed. Specially sensitive microphones are supposed to keep the engineers informed as to what progress is being made.

The explosion chamber is situated to the rear of the principal motors and is in the form of a ring, the full diameter of the subterrane, the spiral conveyor passing through its middle. It is large enough to hold 400 cubic feet of any explosive that may be employed.

The speed at which this war-monster can eat its way through the earth depends on the skill of its engineers, also upon the character of the earth—rock, for example, necessitating very slow progress. Mr. Marye says that from 40 to 100 feet an hour is the average. This progress consists of alternate forward movements and pauses; during the pauses material is accumulated and deposited at the rear.

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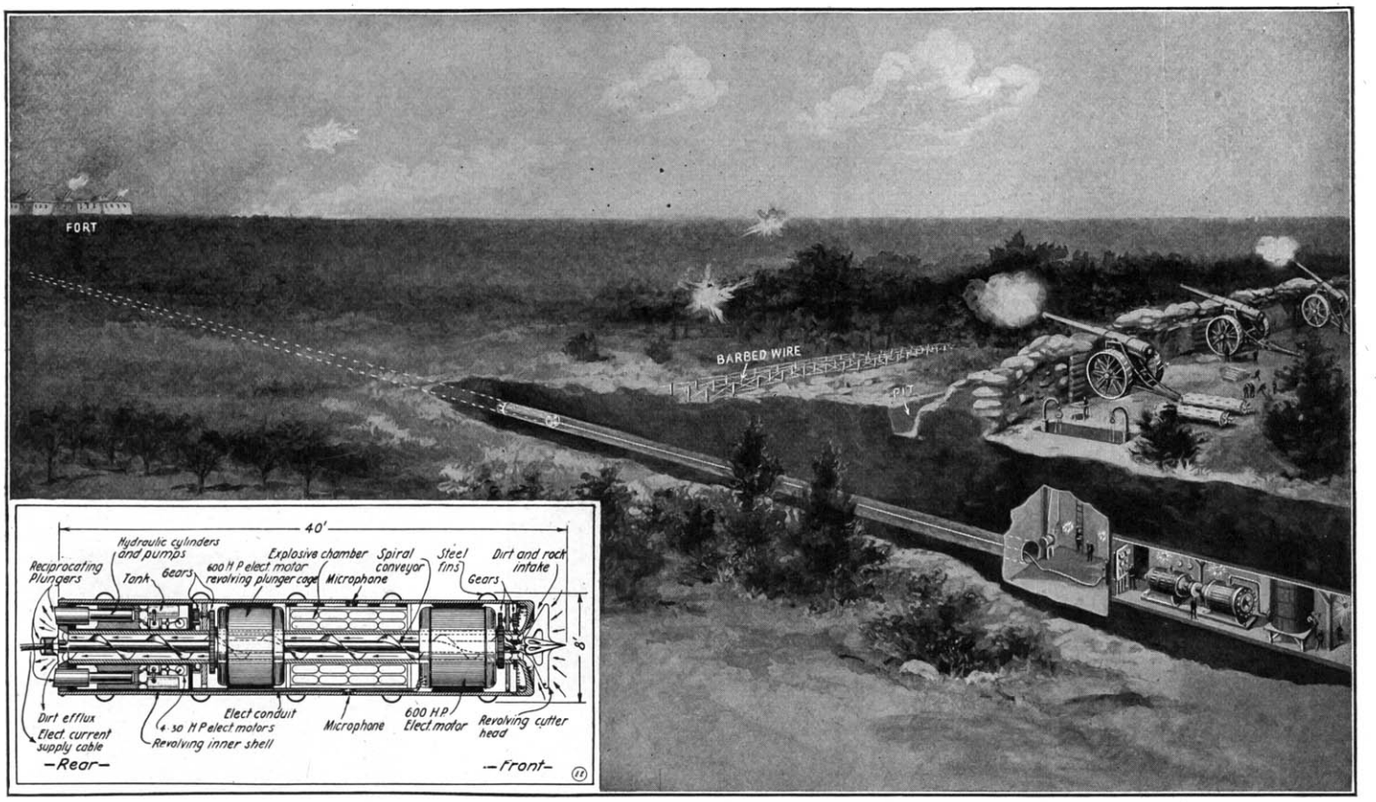

Sectional View of the Latest Advance in Military Science—the "Subterrane"—an Electrically Propelled Land Torpedo, and Its Mode of Attack. It Can Burrow for Miles and When Under the Enemy's Fort, a Press of the Button, and the Fort is No More.

A GIANT ELECTRIC TORPEDO THAT EATS THRU THE EARTH.

(*Continued from page 551*)

When it is planned to fire a subterrane torpedo at a fortress, or a citadel, the machine is lowered into a trench at the desired depth and carefully aimed towards the doomed place. It is then started on its way. Several days will elapse before it reaches its goal, maybe several weeks. All the time, however, the engineers are listening at the telephones that communicate over the cable with the microphones in its machinery and when at last they know it is below the fort they have only to touch the button that closes the electric circuit and makes a spark in the explosion chamber, when 400 cubic feet of dynamite or lyddite will hurl the enemy's fortifications into the air.

GUIDING TRAINS BY TELEPHONE.

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secure an additional circuit by means of the phantom.

In October, 1907, the first successful installation of telephone and selector equipment for train dispatching was completed on the lines of the New York Central. This was closely followed by a number of installations on the Chicago, Burlington and Quincy, where it was proven, to the satisfaction of officials of other roads watching these first service tests, that the telephone and selector combination could be used equally well for single track as for double and multi-track operation.

These pioneers in telephone dispatching blazed the trail for the network of railroads traversing the United States and Canada. Out of a total of 285,000 miles of railroad in the two countries over 95,000 are now equipt for this method of handling train movements. Not only is the telephone and selector equipment used on the train wires, but similar apparatus is used on message wires for the transmission of messages other than those relating to train orders.

With the telephone, the dispatcher issues orders verbally, using the same terms and forms as he would with the telegraph, his speed being limited only by the rate at which the operator can copy the messages. The average railroad telegraph operator sends at the rate of 25 words a minute, while a speed of 100 words or more is possible with the telephone. It is only natural, therefore, that more business can be handled by the operators with less physical effort. Complete reports of the passing, arrival or departure of trains can be given in the fractional part of a minute and information regarding accidents and other occurrences outside of the daily routine sent to headquarters verbally in such complete form that the chances of misunderstanding and the necessity for additional messages are eliminated.

When the dispatcher wishes to call, he turns a key corresponding to the station with which he wishes to communicate. The loud ringing bell at the station called insures an immediate response, whereas the comparatively feeble click of the telegraph relay or sounder frequently causes a delay in answering. Furthermore, other stations may be called in on the line while a message is being transmitted. This is a feature used continually on heavy traffic divisions where there is a high rate of calling.

Accuracy in transmitting orders is assured by the practise of having the dispatcher write down the words as they are spoken and checking this record word for word, as the order is repeated back by the operator who has previously written it down simultaneously with the dispatcher. With the telegraph, the dispatcher writes down the order only when it is repeated by the operator and may not catch the errors in the repeat due to the natural impulse to write down the message as originally sent out by him.—*Photos courtesy Western Electric Co.*

WHY A MERE SPECK OF RADIUM COSTS $5,000.

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crystallization. Then the radium chlorid and barium chlorid are treated with ammonium carbonate and the carbonates secured are dissolved in hydrobromic acid and are evaporated, giving bromid crystals. These crystals are then sealed up in glass tubes, and finally by what is termed "higher fractionation" the radium is separated in the form of *radium bromid.*

This is the present final state. Science up to now has not succeeded in producing pure radium metal.

It has been calculated that the radium in the ore is exactly or nearly 1-200,000,000 of the bulk, so it is easy to see that having to pass tons of material thru so many delicate processes, in order to secure what anyone would call a speck of dust, is a fair reason for the great cost of the radium when secured.

It is now claimed, tho it has not been proved to the satisfatcion of some critics, that radium can be produced in the United States for something less than $37,000 per gram, which is less than half of what it cost in the open market two years ago.

It should not be forgotten in trying to explain the cost of radium that it costs labor to get out the ore, and that it is now valued at about $120 per ton.

There is another reason, aside from that of production, which will go far toward explaining the value of radium. Just because there is so great a demand for it all the world over the market value is great, as is the case with any commodity of which the supply is very limited and for which the need is great.

Radium is being used for treating many diseases, from cancer all down the line to minor skin affections and inoperable diseases. Study of radium itself has shown that there are three main streams of rays emanating from a bit of radium. They have been called the Alpha, Beta and Gamma rays.

If a magnet be held near a bit of radium it will attract the Beta rays most strongly, the Alpha rays next, but the Gamma rays not at all. It is of the utmost importance to control these various rays, for while one kind are adapted to one affection another may be required for a second, while the first should be shut off. It has been found by experiment that a thin sheet of metal, or even a sheet of paper, will shut off the Alpha rays; a much thicker piece of metal is needed to shut off the Beta rays, and the Gamma rays will pass thru anything but lead, and that must be of considerable thickness to shut them off.

A safe for holding radium has therefore been constructed of very heavy walls of lead inside the steel chamber, so that the radium does not escape, or, rather, make itself felt in the room outside the safe. There is no thought of stopping the emanations, for that has heretofore proved impossible, and besides, a grain of radium will outlast many generations; so why economize in a practically inexhaustible source of energy?

The extraction of radium, properly considered, is therefore only one of the concentration of all of the stored up energy in the ore into the smallest possible bit, and this may explain why it is so costly.

One of the latest preparations for this purpose of rendering certain articles luminous in the dark, contains a base of zinc sulfid, together with a small quantity of radium bromid, the alpha-particles of which, continuously bombarding the crystals of the sulfid, render it luminous in the dark with a pale greenish glow of about the intensity of a rubbed phosphorous match. By increasing the quantity of radium compound included in the paint the more brilliant can this phosphorescent glow be made. On aeroplane compasses used by the European armies, the luminous compound employed is of such intrinsic brilliancy that its glow can be seen even in contrast with twilight. Such a high mixture of radium compound, however, rapidly disintegrates the zinc sulfid so that the life of the paint may be barely twelve months. In the intensity to be used on the new switches, which has been found most practical for average use on watch dials, etc., the figures are readily visible in a darkened room, and such paints have an assured luminous life of ten to fifteen years, if not longer. This latest product does not require to be placed in the light in order to make it glow. The action is continuous, being due to radium.

In order that ordinary flush switches already installed may be made luminous, the electrical manufacturer referred to has devised the ingenious expedient of luminous-head screws which can be used to replace the present screws, giving visible points of luminosity by which the switch can be located in a darkened room.

Possibly the most widely useful application of the genuine luminous *radium* paint is on watch dials. One of the largest manufacturers of watches in America has made preparations to bring out on the market even very cheap watches with *radiumized* dial figures and also the hands of these watches will glow on the darkest night.

It is reported that this particular watch manufacturer has spent $10,000 for the initial outlay in purchasing the necessary radium. The radium is mixed with a rather large quantity of zinc sulfid and when ready for application on the watches, as already outlined, the manufacturers' cost amounts to about $1.00 per square inch of the treated area, it is said.

One of the large electrical concerns is said to have successfully experimented with radium in a storage battery. A mere speck of the precious substance, properly placed in the electrolyte of the cell is stated to have produced wonderful results as regards output in ampere-hours; even to the point of boosting the output 25 to 30 per cent above the normal rating.

[*Those interested in radium will find a valuable discussion on its properties and energy components in the September, 1915, issue of this journal procurable at 15 cts. prepaid from the publishers.—Ed.*]

RADIO DRAFTSMAN WANTED.

Those who are well-versed in the radio art and are experienced in general electrical drafting, have an opportunity now to obtain a radio draftsman's position, which is being offered by the U.S. Government.

Examinations for this position will be held in all the principal cities where Civil Service examinations are given, on November twenty-first.

Those who desire to qualify for this position are advised to communicate with the Civil Service Board at Washington, D.C.

This is the first opportunity offered in many years to those who desire to enter the radio field.

Information as regards salary, qualifications, application blanks, etc., can be obtained by writing to the Chairman of the Board of Civil Service Examinations, Washington, D.C.