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INDICATING FIRE DAMP IN COAL MINES.

The apparatus invented by Henry Guy Carleton, of New York, for indicating fire damp, is herewith shown. It consists, essentially, of one or more indicating balances to be permanently placed in a goaf or drift of the mine, as shown, and a registering balance to be used by the observer in the testing room, connected by well-insulated wires as shown. Each balance holds in equilibrium a thin glass bulb of about 300 cubic inches, capacity hermetically sealed. They are counter-balanced at the same moment by the weights, W and W', respectively, and hence will be equally affected by future variations in the atmospheric pressure. Attached to the vertical arm or pointer, H, of each balance is a soft iron needle, *d*, gilded to prevent rusting. Its ends plunge freely into helices of insulated wire, *a* and *b*.

The helices on both instruments are exactly of the same size and electrical resistance, and of sufficient internal diameter to exert but feeble influence on the needles with an ordinary current. The right-hand helix of balance No. 1 is connected with the right-hand helix of balance No. 2, and is supplied at will from battery II. with a current whose strength can be lessened gradually and delicately by resistances thrown into the circuit by the rheostat, as shown, enabling the magnetic force of the helices to be regulated to a nicety. The left-hand helices are similarly connected, through battery I. and rheostat (Diagram, page 52).

The vertical arm, H, of balance No. 2 has a platinum tip capable of electrical contact with insulated screw, *c*. Connection from binding post 4 to the vertical arm is made by means of the mercury cup, *m* (see engraving), into which a wire from the beam is dipped. By contact between H and *c*, the relay in the observing room is kept closed. Breaking contact opens the relay, whose back stroke shunts the local circuit on the bell, ringing it continuously. The resistance coil, *g*, connected to binding posts 3 and 4, prevents a spark passing when H and *c* break. The case surrounding balance No. 2 is of marble or unglazed tiling, excluding air currents and dust, yet admitting gases by diffusion. Chloride of calcium, in the holder, D', keeps the interior free from moisture. The whole is protected from injury by a perforated iron case, as shown. Once placed in its position in the mine, its temperature will be constant.

Balance No. 1, in the observing room, is provided with two riders, moved along the graduated beam as shown. If more delicate readings are desired, additional riders of less weight may be also employed, a separate way being provided on the beam. Balance No. 1 is incased, dried by chloride of calcium, and placed in a room artificially maintained at constant temperature by means well known.

By this arrangement it will be seen:

1st. That as the two bulbs, S and S', are equal in bulk, and balanced at the same moment, they will be affected equally in weight by an increase or decrease in atmospheric pressure.

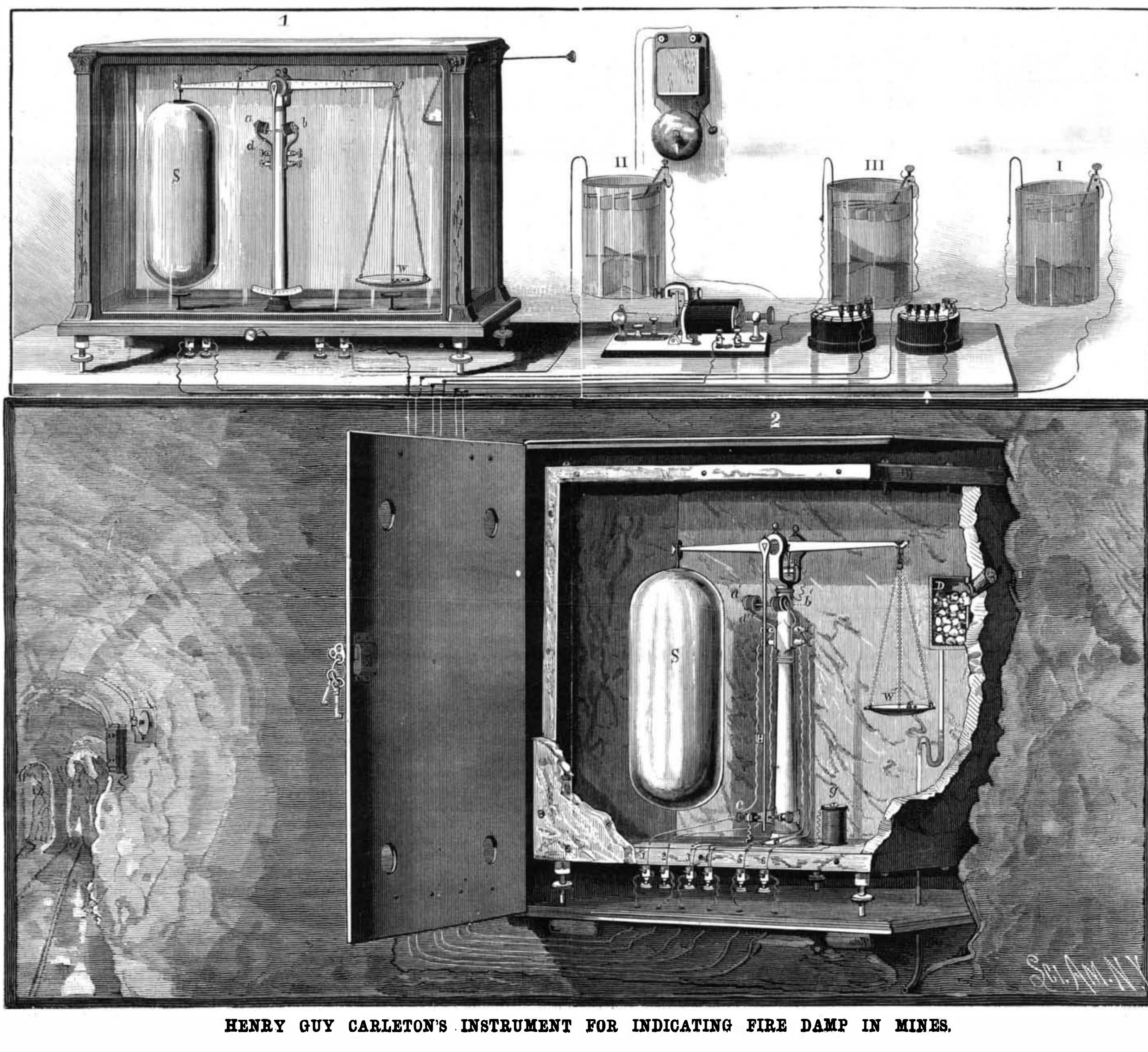
2d. That the right-hand helix of each instrument will exert the same amount of force on its responsive needle, both being supplied with current from the same battery, and that the same rule will apply to the left-hand helices.

3d. That as each instrument is kept in an atmosphere of constant temperature and equal hygrometric condition, it will only be sensitive to a change in the pressure of said atmosphere or a change in its atomic weight.

GRADUATION AND ADJUSTMENT.

Both instruments are balanced at the same moment by their weights, W and W', respectively. The case of balance No. 2 is then filled with pure fire damp at normal pressure, obtained from a "blower" in the mine. (This will obviate the necessity of correcting for that percentage of carbonic acid always associated with

(*Continued on page* 52.)



HENRY GUY CARLETON'S INSTRUMENT FOR INDICATING FIRE DAMP IN MINES.

INDICATING FIRE DAMP IN COAL MINES.

(*Continued from first page.*)

marsh gas in fire damp, as would be necessary if pure marsh gas were used.)

Care, of course, is taken to keep a stream of the gas flowing in, to counteract the diffusion of air through the case. Bulb, S', will now sink, its increase in weight being about 39 grains, H will break contact with *c*, and the bell rings. The observer now switches on battery I., which applies a force of say 45 grains through helix, *a'*, to the needle attached to the vertical arm of balance No. 2. This more than compensates for the increase in weight, H is brought back to *c*, and the bell ceases to ring. The observer now throws in small resistances until H breaks again, and thus finally satisfies himself that the amount of force applied through helix, *a'*, of the distant instrument is just enough to balance it and no more. Now, as this amount of force is also exerted by helix, *a*, upon the needle of Balance No. 1, its equilibrium is disturbed. Rider, *r*, is therefore shifted until equilibrium is restored. The position of this rider equals the force applied through helix, *a*; equals the force applied through the helix of the distant instrument, No. 2; and necessarily equals the increased weight of the bulb, S', in pure fire damp. From this point, therefore, to zero, the observer graduates his beam into hundredths and minor subdivisions. The graduation is then made in similar manner for carbonic acid, employing rider, *r'*, and battery II. In practice, these graduations would be made before the instruments were placed in position, allowances being made for the depth and increased temperature to which each balance is to go.

Thus adjusted, the instrument will act under the conditions named as follows:

1. *Rising Barometer and no "Fire Damp."*—The pointer of the observer's instrument will be deflected to the left. On applying battery II., both balances will come to equilibrium with the same amount of electrical force—the distant instrument indicating by the bell, as described.

2. *Falling Barometer and no "Fire Damp."*—The bulbs in both instruments will sink when the atmospheric pressure is below the point at which they were adjusted. Equilibrium will be restored to both by force applied from battery I., as described.

3. *Rising Barometer and "Fire Damp."*—The observer will find, on applying current from battery II., that the distant instrument comes to equilibrium with a weaker current than his own. Keeping that in equilibrium by the current, he moves the rider, *r*, until his own balance is in poise. The position of this rider necessarily gives him the percentage of fire damp in the case of the distant instrument.

4. *Falling Barometer and "Fire Damp."*—Both balances are disturbed, but balance No. 1 is only affected by the change in barometric pressure, while balance No. 2 is affected both by that and by the fire damp. Hence, the power now applied by battery I., sufficient to balance the distant instrument, will overweight the observer's. The amount of this overweight is determined, as before, by rider, *r*, and the percentage of fire damp is given.

The tests for carbonic acid are similar, rider, *r'*, being found necessary to restore equilibrium to the observer's instrument.

GENERAL SYSTEM.

Applied to a general system, a number of balances like No. 2 would be placed in various portions of the mine, the left-hand helices all being on one circuit, and the right-hand helices on another, connected with the one balance to be used in the observing room. Separate wires would be run for the bells serving to indicate the movements of each instrument. The tests would then be simultaneous, full battery power being thrown on, and then gradually weakened by the rheostat; measurements being taken on the observer's balance as each bell gave warning that one or more of the distant balances were in equilbrium. Thesetests could be frequently made, and notification promptly signaled to the miners in any drift in which a dangerous percentage was observed, or to the fire boss and his assistants.

NOTES.

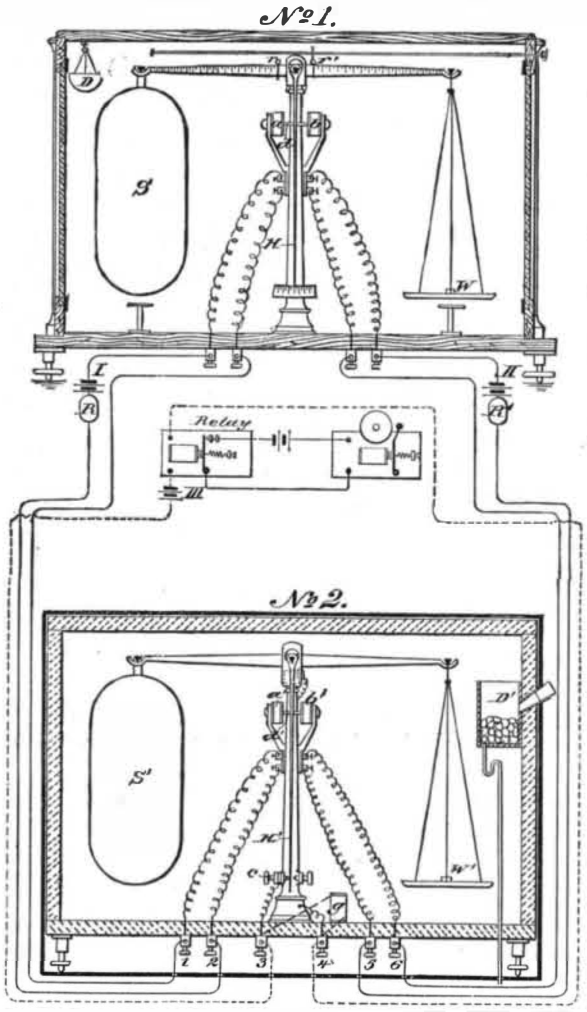
1. The percentage of carbonic acid exhaled from coal usually runs from 0·30 to 2·1 per cent. in fire damp, varying in different mines, but practically constant in any one. There may be a sudden increase by an explosion, but ventilation would soon restore the normal condition. The quantity produced by the lamps and men is insignificant, since the ventilation necessary to keep the mine free from fire damp sweeps away the carbonic acid from this source as fast as formed.

2. Should it be desirable to test for marsh gas only, balance 2 may be surrounded by an air tight case, provided with a tube opened or shut at will by a mercury valve operated by an electro magnet controlled from the observing station. This tube would be opened for, say, five minutes. During that time the external gases would diffuse perfectly through the tube into the case, but both moisture and carbonic acid would be immediately absorbed by caustic potassa placed in D'. The tube would then be closed, and measurements taken, pure marsh gas being the standard. These tests would be made as often as desired, the observer having full control of the valves on all the instruments and operating all on one circuit.

3. While a separate circuit is shown for the right-hand or left-hand helices, it is practicable, by a simple device arranged by the inventor, to operate either helix at will from the observing station, and yet use but a single circuit.

4. With bulbs of 300 cubic inches capacity, a balance weighing to $\frac{1}{10}$ of a grain will give the percentage of marsh gas to $\frac{1}{8}$ of one per cent. The bulbs weigh 6 ounces. This weight may be lessened 86 grains by filling them with pure hydrogen. A reading to $\frac{1}{8}$ of one per cent is close enough in practice.

5. The instrument is especially designed for use in goaves, where large accumulations of the gas are more liable to form. A decrease in atmospheric pressure forces it out in the workings, where it may be fired by a shot, a defective lamp, or other causes. It having been settled that the explosions supposed to be wholly due to coal dust depend on marsh gas in conjunction with the dust, the necessity for close watch upon even small percentages is obvious.



INSTRUMENT FOR INDICATING FIRE DAMP IN MINES.

6. As marsh gas spreads with tolerable rapidity, one instrument will guard a considerable area, especially in a goaf where ventilation is neglected.

A Torpedo Catcher.

The construction of torpedo catchers was as much a necessity in naval warfare, after the development of the torpedo system of small, quick steaming torpedo craft, as armored protection for battle ships became in consequence of the growth of the gun. The catchers, or police of the sea, do not differ, except in bulk and speed, from the active and dangerous little enemies which they are intended to capture or destroy; and in this respect the Admiralty would appear to have applied the old detective principle of setting a thief to catch a thief. The first of the new craft yet afloat was tried in Stokes Bay, near Portsmouth, lately, with remarkable results, not only as regards speed, but also as regards maneuvering power. This latter quality of the torpedo catcher was even more noteworthy than the former, and has been secured by the application of a principle which, though successfully tried in steam pinnaces and launches and in various submarine miners, built for the royal engineers, had not previously been adapted to first-class torpedo vessels.

During the past four years we have on various occasions noticed the gradual development of the invention of Mr. John Samuel White, of East Cowes, which is now popularly known in the service as his "turn-about" system. Boats built according to this plan have their deadwood removed in order to obtain facility in turning, and are fitted with an inner and an outer rudder, simultaneously actuated, either of which would suffice to steer the vessel in the event of the other being lost or disabled. The present experimental torpedo boat was undertaken by Mr. White for the purpose of demonstrating the applicability of his invention to larger vessels, and with a view to her acceptance by the Admiralty on her fulfilling all the conditions guaranteed. She is considerably larger than any of the existing torpedo craft in Her Majesty's navy, being 150 feet long, 17 feet 6 inches broad, and 9 feet 6 inches deep. Her displacement is about 125 tons. Her lines resemble those of similar vessels now in use but she is fitted with a turtle deck and a spur ram. Like the others, she is built of thin steel, and has a conning tower amidships, from whence she will be steered in action. Messrs. G. E. Belliss, of Birmingham, the makers of all the machinery of Mr. White's boats, joined with him in the undertaking, supplying compound engines of the three-cylinder type, the high pressure cylinder being 20 inches, and the two low pressure cylinders 24 inches in diameter, the whole being supported on light steel columns. The stroke is 18 inches. Great care has been taken in the design to keep the weights as low as possible, having due regard to efficiency. There are two air pumps driven off the low pressure crossheads, while the feed pumps are driven direct from the crank shaft. Steam is supplied by two locomotive boilers, with the feeds so arranged as to insure an equal supply of water to each boiler; and, as the result of the trial, the possibility of successfully employing two boilers with forced draught without difficulty, either as regards the feed or priming, was clearly demonstrated.

A great feature in the design is the division of the boiler room by a longitudinal water tight bulkhead, the connections being arranged so that either boiler can be worked independently in case of accident. The vessel is also steered by steam. The trial, which was conducted by Mr. White and Mr. Morcom, on the part of the builder and engineers, was witnessed by Commander the Hon. F. R. Sandilands, of the steam reserve; Mr. T. Soper, R. N., and Mr. Smale, of the Controller's Department of the Admiralty; Chief Inspector of Machinery Alton, and Messrs. Mayston and Gowing, of the dockyard. Admiral Herbert and a number of naval officers also watched the running from the deck of the Camel. The weather was somewhat boisterous, but, notwithstanding the state of the sea, the vessel was remarkably steady, and also free from vibration, when going at her maximum speed. The total weight on board was 25 tons, 15 tons representing coal and 10 tons (furnished by iron ballast) her armament of Whiteheads and rapid firing guns. Provision, however, has been made for carrying 35 tons of coal in the bunkers, while the space forward and aft for the accommodation of officers and crew and stores is unusually large. Six runs on the measured mile were first made for the purpose of ascertaining the speed under the special conditions of load, which resulted in the realization of a mean speed of 20·79 knots, the mean boiler pressure being 126 pounds, the revolutions 319 per minute, and the indicated horse power 1,387. The highest speed in the direction of the wind was 22·43 knots, and the following times which it took to complete the miles will show the regularity with which the speed was maintained: With the wind, 2 minutes, 43 seconds, 2 minutes 40½ seconds, and 2 minutes 40½ seconds (repeated). Against the wind, 3 minutes 9 seconds, 3 minutes 7 seconds, and 3 minutes 5 seconds. The average indicated horse power per square foot of grate was 23, which was maintained with a mean air pressure in the stokeholes of 2½ inches, which was considered a very high result. The vessel was afterward tested in the usual manner for maneuvering power. At full speed, with the helm hard over 30 degrees, the starboard circle was completed in 1 minute 17 seconds (238 revolutions of the engines), and the port circle in 1 minute 12 seconds (270 revolutions). At half speed the starboard circle was completed in 1 minute 14 seconds (237 revolutions), and the port circle in 1 minute 15 seconds (246 revolutions). The diameter of the circles was about a length and a half of the boat, or 225 feet. The craft was finally run for three hours' continuous full power steaming, to test the endurance of the mechanism. No mishaps occurred, and the speed and revolutions were maintained throughout. The absence of vibration during the trial, as well as the very slight inclination on the helm being put hard down by the steam steering engine, was the subject of general remark, and Mr. White and Messrs. Belliss were congratulated at their joint success in the building and engining of what is regarded as the best type of torpedo catcher.—*London Times.*

Improvement of Hearing.

A prize is offered, of 3,000 francs, by Baron Leon de Lenval, of Nice, France, for the best readily portable instrument constructed according to the principle of the microphone, for improvement of hearing in cases of partial deafness. The Award Committee will receive instruments intended for competition up to Dec. 31, 1887. The awarding of the prize will take place at the Fourth International Congress for Otology, to be held at Brussels, in September, 1888.