perceptible recoil, although the guns in reality have a definite amount of movement at the departure of the projectile, sufficient to relieve the mountings of undue shock.

In all cases, except for the larger calibers for boat service and for the field, these guns are laid by means of a stock, or shoulder piece, bearing against the left shoulder (as in the Hotchkiss revolving cannon) and a pistol grip with trigger, which the gunner grasps with his right hand. He fires the moment his sights bear upon the object aimed at, by pulling the trigger, so that it will be seen that this gun has the general characteristics of the Hotchkiss mounting, viz.:

1. The gun is mounted on a pivot and trained direct by the shoulder without the aid of any elevating or directing mechanism; thus enabling it to be pointed easily and rapidly from moving and rolling vessels against swiftly moving objects.

2. The sighting and firing are effected by a single man, as clearly indicated in the perspective view upon the opposite page.

The gun is made of Whitworth's fluid-pressed steel, oil tempered. The body consists of a tube and a jacket carrying the breech and the trunnions, so that the longitudinal and transverse strains are divided. The jacket is shrunk over the tube, and to prevent any slipping they are locked together by a screwed collar, carrying the fore sight. The gun is exactly balanced in the trunnions,

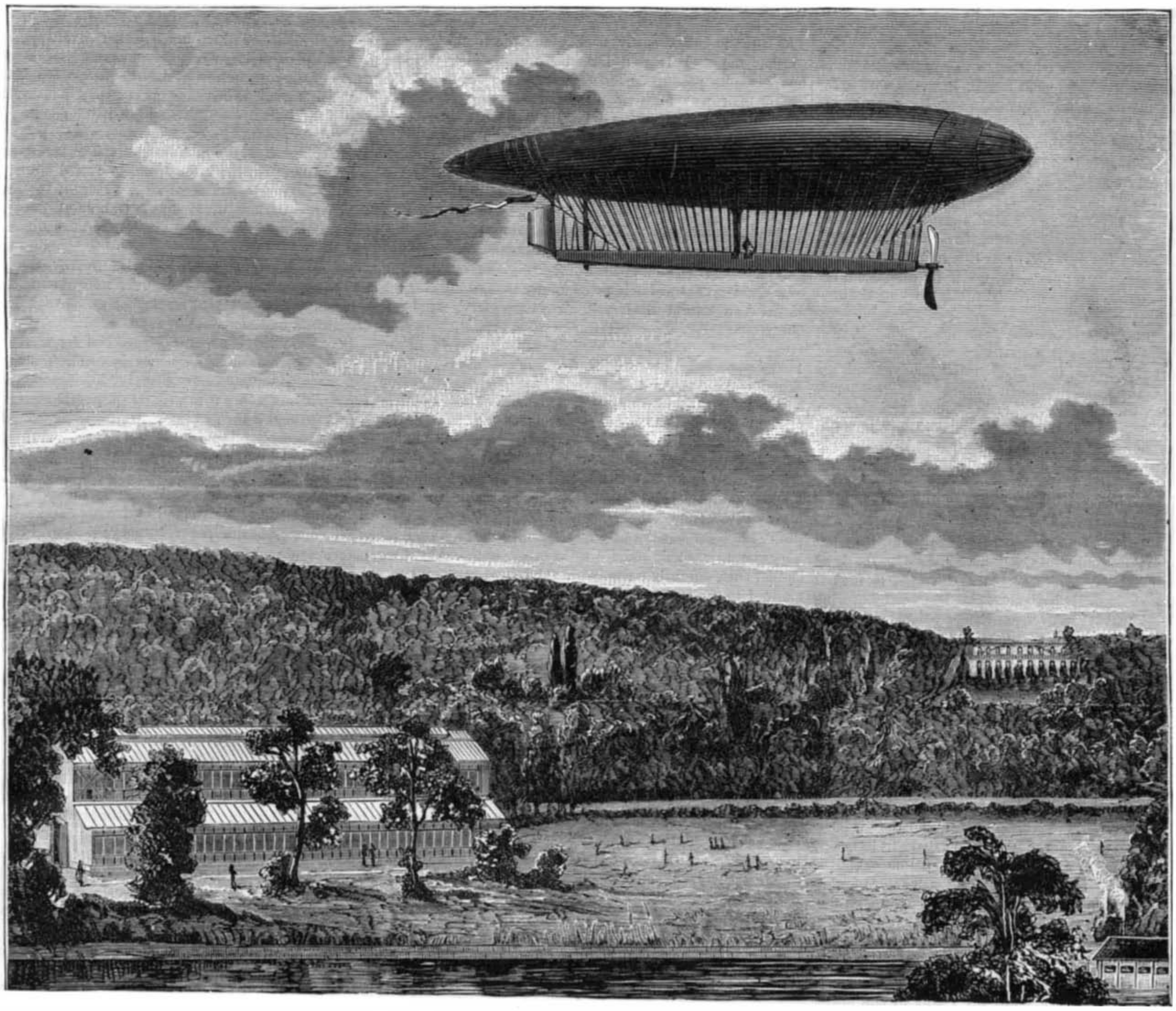
The breech action belongs to the class of guns with a breech block sliding vertically through a mortise, and actuated by a lever, the movement of which opens the breech, extracts the fired cartridge case, and cocks the hammer for the next shot. The action is composed of the following parts, viz., the wedge, with its stop-screw for limiting the run; crank and crank handle, for moving the wedge up and down; firing hammer and its rocking shaft; main spring, trigger sear, trigger spring and trigger, and the extractor.

A STATISTICIAN, Dr. Farr, we believe it was, recently stated that if one could watch the march of 1,000,000 people through life. the following would be observable: Nearly 150,000 would die the first year, 53,000 the second year, 28,000 the third year, and less than 4,000 in the thirteenth. At the end of forty-five years 500,000 have died. At the end of sixty years 370,000 would be still living; at the end of eighty years, 97,000; at eighty-five, 31,000; and at ninety-five years there would be 223; at the end of 108 years there will be one survivor.

MESSRS. RENARD AND KREBS' ELECTRIC BALLOON.

The problem of steering balloons, which was for a long time regarded as visionary, has made great progress in recent years, and may now be considered as solved. Captains Renard and Krebs have the honor of being the first to successfully accomplish this, and therefore merit the gratitude of their contemporaries. But, of whatever interest be their work, we must not forget those who have preceded them, and shown them the path that they should follow. Before speaking of the memorable ascension of Aug. 9, 1884, we think it indispensable to trace the history of the steering of elongated balloons provided with screw propellers.

It was in 1852, thirty-two years ago, that the way was opened by our great engineer Henri Giffard. It was then that a true aerial ship, of elongated form, and provided with a screw and rudder, was for the first time seen to rise into space. This ship was 44 meters in length, and its equatorial diameter was 12 meters. The balloon was surrounded on every side, except beneath and at the ends, with a netting whose extremities united on a stiff wooden bar. At the extremity of this latter there was a triangular sail, movable around a rotary axis, which served as a rudder and keel.



MESSRS. RENARD & KREBS' ELECTRIC BALLOON.

At six meters beneath the bar a steam engine mounted upon a wooden frame was suspended along with its accessories. The propeller, which consisted of two large blades, was 3·4 meters in diameter, and made 110 revolutions per minute. Empty, the engine and boiler weighed 150 kilogrammes. Provided with water and coal for starting, they weighed 210 kilogrammes; the accessories to the engine and the supply of coal and wood weighed 420 kilogrammes more.

Henri Giffard had then no financial resources. He agreed to make his first ascent on a certain day at the Paris Hippodrome. On the 24th of September, 1852, the balloon was inflated with illuminating gas, and Giffard ascended all alone to the sharp whistling of his engine. The wind was very strong that day, and the inventor could not think of stemming the aerial current, but the different maneuvers were effected with the completest success. The action of the rudder made itself felt very plainly, thus proving that the aerial ship had a very appreciable velocity. At an altitude of 1,500 meters, Giffard met slower currents, and found it possible at moments to keep head to the wind. The future inventor of the injector had performed an experiment which caused him to be called by a celebrated writer of the time "the Fulton of aerial navigation."

Giffard's efforts, which were renewed by him in 1855, were followed by the fine experiment executed by Mr. Dupuy de Lome, on the 2d of February, 1872. This gentleman's balloon was 36 meters in length, and about 15 in equatorial diameter. It had a capacity of 3,500 cubic meters, and was inflated with pure hydrogen. The propelling screw was 6 meters in diameter, and was actuated by seven men in the car. The motor was assuredly insufficient, but De Lome, under the influence of his screw, nevertheless obtained an appreciable deviation from the line of the wind, and ascertained that his aerial ship had a velocity 8 kilometers per hour.

What had been wanting up to this time was a motor that was truly adapted to balloons—a light motor that did not necessitate the use of fire, and that should lose no weight during its operation. As long ago as 1881 Mr. Gaston Tissandier made known the result of his studies and experiments upon the "Applications of Electricity to Aerial Navigation." In a note presented to the Academy Aug. 1, 1881, he expresses himself thus:

"The recent improvements made in dynamo-electric machines have given me the idea of employing them for the directing of balloons, concurrently with secondary batteries, which, although of relatively light weight, store up a large amount of energy.

"Such a motor, connected with a propelling screw, offers advantages over all others, from an aerostatic standpoint. It operates without any fire, and thus prevents all danger from that element under a mass of hydrogen. It has a constant weight, and does not give out products of combustion which continuously unballast the balloon and tend to make it rise in the air. It is easily set running by the simple contact of a commutator.

"I have had a small elongated balloon made, which terminates in two points and is 3·5 meters in length by 1·3 meters in diameter at the center. This balloon has a capacity of about 2,200 liters. Inflated with pure hydrogen, it has an excess of ascensional power of two kilogrammes.

"The balloon is provided with a small Siemens dynamo-machine weighing 220 grammes, whose shaft is connected, through the intermedium of a gearing, with a very light, two-bladed helix, 0·4 meter in diameter. This little motor is fixed to the lower part of the balloon, with a secondary battery weighing 1·3 kilogrammes. The screw, under such circumstances, revolves at the rate of 6½ revolutions per second, acts as a propeller, and gives the balloon in still air a velocity of 1 meter per second for more than forty minutes. With two secondary batteries mounted for tension, and weighing 500 grains each, I can gear with the motor a screw, 0·6 meter in diameter, that will give the balloon a velocity of about 2 meters per second for about ten minutes. With three elements the velocity reaches 3 meters. I have renewed the experiments a large number of times."

It will be remembered that this model was exhibited while the Exhibition of Electricity in 1881 lasted. After these first experiments Mr. Tissandier had constructed at the Siemens works a light dynamo machine, and soon devised a new style of bichromate of potash pile, which gave him a powerful and light generator of electricity that was more favorable than accumulators of the same weight. He then resolved to construct a screw-propelled electric balloon designed to work in the free air. M. Alb. Tissandier, his brother, joined efforts with him, and it was at the expense and with the collaboration of the two in common that the first trial of aerial navigation by electricity was made last October. The Tissandier balloon was 28 meters in length and 9·2 in diameter at the center. As we have already given an illustrated description of it,* we need not here repeat it, but may pass on to the remarkable experiments of Messrs. Renard and Krebs.

The balloon constructed by these gentlemen is 50·42 meters in length and 8·4 in diameter, and has a capacity of 1,864 cubic meters.

The motor is constructed in such a way as to make itpossible to develop upon the shaft 8·5 H. P., representing for the current at the entrance terminals 12 H. P. It transmits its motion to the shaft of the screw through the intermedium of a pinion that gears with a large wheel.

The pile is divided into four sections that are capable of being grouped for surface or tension in three different ways. Its weight is 19·35 kilogrammes.

On August 9, 1884, at 4 o'clock in the afternoon, the air being nearly quiet, the balloon, being freed and possessing a very slight ascensional power, arose slowly in the air. The machine was set in motion, and under its impulsion the balloon soon quickened its pace, faithfully obeying the least indication of its rudder.

The first direction taken was from north to south, over the plateau from Choisy to Versailles. So as not to stand over the trees, however, the direction was changed and the fore end of the balloon pointed toward Versailles. Over Villacoublay, about 4 kilometers from Chalais, the aeronauts, entirely satisfied with the behavior of the balloon thus far, decided to retrace their steps, and attempt to descend at Chalais, notwithstanding the slight space that existed free from trees. The balloon made its half turn to the right by a very slight angle (about 11°) given to the rudder. The diameter of the circle described was about 300 meters. The dome of the Invalides, taken as a directing point, then left Chalais a little to the left of the route. Reaching the level of this point, the balloon changed its direction to the left with as much ease as it did before, and was soon hovering at a height of 300 meters over its starting point.

Its tendency to descend at this moment was shown the more by a maneuver of the valve. During this time it became necessary to run backward and forward several times, in order to bring the balloon over the spot chosen for anchorage. At a distance of 80 meters above the ground the rope was thrown out, and, being seized by men, the balloon was drawn down to the very field from whence it had started.

In our engraving the balloon is shown in profile, at the moment when it is beginning to be set in motion. The screw is in front, and, in revolving, it drives the air laterally over the two sides of the large, elongated car, 33 meters in length. We are informed that the dynamo employed was constructed by Mr. Gramme. The generator of electricity consists of a battery of piles whose nature has not been made known by Captain Renard. The travelers stand in the center of the car, and one of them runs the machine, while the other governs the rudder.—*L'Illustration.*

Predicting the Weather from the Color of the Stars.

From the fact, determined by W. Spring, that the color of pure water in great bulk is blue, M. Ch. Montigny explains the predominance of this color in the scintillation of the stars just before and during wet weather. The luminous rays, he argues, traversing the air charged with large quantities of pure water are necessarily tinged with the blue color of this medium. The excess of blue thus becomes an almost certain means of predicting rain. This theoretic conclusion corresponds with the results of his observations continued for several years past on the appearance of the stellar rays in connection with the state of the weather. During the few months of fine weather in the present year blue has been much less conspicuous than in the corresponding months of previous years since 1876, when wet weather prevailed. It also appears that green, which had always coincided with clear skies during the fine years before 1876, has recently again become predominant. Hence he thinks it probable that we have got over the cycle of bad seasons, and that dry weather and more normal summers may be anticipated, at least for some time to come. The above is from *Nature*, and the same number contains an abstract of a paper by Professor C. Michie Smith, on green colored suns, in which he concludes that this phenomenon is due to the presence of unusual quantities of watery vapor in the atmosphere.

* SCIENTIFIC AMERICAN SUPPLEMENT, No. 416.

German Shop Practice.

A German correspondent of the *Railroad Gazette* says: "Wood working machinery in German shops is comparatively small in amount, owing to the great and yearly increasing use of iron in all parts. This is due to increasing cheapness of iron as compared with wood, and of wrought iron as compared with cast in proportion to its security. The use of wrought iron instead of cast is very extended. I saw narrow gauge stock building at Chemnitz and Leipzig with iron frames throughout, which had absolutely no cast iron in any part except the journal boxes. The increased use of iron is regretted by some master mechanics, on account of the greater rigidity and of the consequently greater violence of shocks in train service. A surfacer, band saw, cut-off saw, or driving planer and boring machine are the tools ordinarily found in German wood shops. Suctions for carrying shavings to the boiler room are not used in the shops I have seen. The shavings are used, however, very extensively for firing, in combination with about nine times their weight of coal slack.

This coal slack costs 84½ cents per ton delivered at the railroad. It is fired automatically with a hopper and a screw, which pushes the fuel in under the fire. It is also fired by being run from a hopper above the fire door over a grate, inclined forward, from which it drops into the fire. The latter is raked partly back under the inclined grate, so that the fuel is well heated before joining the fire, and its smoke products pass over the front portion of the fire on their way to their flues, and are very effectually consumed. This firing method is common, I believe, to several styles of firebox, but I do not remember to have heard before of its application to this kind of fuel, to which it is well adapted. By the use of this fuel and firing the boilers of the Chemnitz shops of the Saxon State Railway evaporate 100 pounds of water at an expense of 1·11 cents.

Trial of Sheaf Binder Harvesters.

A competitive trial of sheaf-binder harvesters extending over eight days was lately made under the auspices of the Royal Agricultural Society, near Shrewsbury, England. On the sixth day, according to the *Engineer*, the competition was narrowed down to eight machines, two of the McCormick and one each of the Howard, Kearsley, and Wood make having been thrown out from the previous day, leaving three of Hornsby's, two of Howard's, and one of Samuelson's, Wood's, and McCormick's respectively. In the morning nothing was done beyond testing with dynamometer, in consequence, as far as we could gather, of the next field not being staked out and mown round. It was not ready till somewhere about one o'clock. Out of a field of 18 acres, about seven or eight were parceled off in one piece, the eight machines being required to take a preliminary run up one side and down the other, followed by three similar cuts, officially recognized. Only one attendant was allowed to follow, and he was prohibited from touching the binder, unless called upon. This system gave the ordinary onlooker a much better opportunity of forming an opinion as to the relative merits of the competing implements. The test here assigned was much more severe than any previous one, partly on account of a boggy hollow in one portion of the field, and partly because of the flat condition of the crop. Hornsby's 4,569 was the first to start, and it managed to get through without much difficulty, and with only a slight pause. Next came Wood's selected machine. It made several stoppages; a good deal of straw and grain were wasted, in consequence of the reel having been set too backward and too low; and the delivery was by no means perfect. Howard's No. 45 left a clean cut stubble, but the nature of the crop made separation difficult, many of the sheaves hanging together. A leather band in the barley caused one stop. In Samuelson's portion we noticed an undue proportion of 'baby' as well as 'giant" sheaves, and some loose ones. Many heads of grain were left on the ground, in laid parts the corn and straw were considerably knocked about and wasted, and the pressure on the driving wheel seemed to be too heavy. Still the machine got through the most difficult portions without much trouble. Howard's No. 47 had three stops in the three journeys; some sheaves were missed, and the separation was not easy. A McCormick harvester finished the day's work; it left a few sheaves unbound, and a small, badly laid piece was uncut; but all things considered, it did fairly all through.

On the next and last day they were the most varied, most exciting, and most difficult of all. The only competitors now left were Hornsby (3 machines), Howard (2), and Samuelson (1). Hornsby made a very good commencement on the remainder of barley left from the previous day. The delivery and separation of sheaves were difficult processes to manage for all the competitors, and it may be doubted whether there was a very substantial difference in the work done. To make good performances was out of the question. Samuelson's was brought to a stop of two or three minutes in one place, and presumably for that reason they were not allowed to complete their plot. In the afternoon the judges pitched upon another piece of barley nearly an acre in extent, more flattened than ever, with the additional disadvantage of being purposely winding and hilly. For this final test Howard's 47 and Hornsby's 4,568 machines were ordered out. But now the competitors were used to rough work, and they submitted to the undertaking without a murmur. Each was given a preliminary canter, and then made to go two runs of about three minutes each round the plot. Howard, who led the way, was stopped with a large hedgehog on the secondround, the knife cutting deeply into the unfortunate creature, otherwise the machine went smoothly both up hill and down dale. Hornsby's machine made as nearly as possible similar work, Howard, perhaps, having the advantage with their very useful butting board. Throughout this day, more than previously, the work of the two machines seemed to be pretty nearly on an equality, so that when the last cut was taken as the clock struck three, the opinion was formed that the judges would have a particularly difficult task in arriving at a decision beyond recall. Nevertheless, an hour later the awards were announced as follows:

Class 1.

First prize of £100 for a sheaf binding reaper, the binding material to be other than wire: Awarded to Messrs. Hornsby and Sons, for No. 4,568.

Second prize of £50 for a sheaf binding reaper, the binding material to be other than wire: Awarded to Messrs. J. and F. Howard, for No. 47.

Class 2.

Separate sheaf binder, the binding material to be other than wire: Prize withheld.

The "Drop" Method of Chemical Analysis.

The customary methods of testing medicinal agents, which are both tedious and require a larger quantity of material, can be superseded by a method which requires merely single drops of the reagent as well as of the liquid to be examined.

For this method the following regents are needed:

Red and blue litmus paper and turmeric paper.

Extract of indigo paper, which is turned yellow by hot nitric acid and caustic alkalies, but not by ammonia.

Rosaniline paper as a test for alcohol.

Potassium ferrocyanide paper as a reagent for ferric salts (blue), copper and uranium (deep brown), gold (greenish brown), platinum (brownish green to reddish), thallium and vanadic acid (yellow).

Potassium sulphocyanide paper is turned decidedly yellow by bismuth nitrate, bluish black by salts of copper, red by solution of gold, white by mercuric nitrate, black by mercurous nitrate, and blood red by ferric salts.

Potassium iodide paper is turned red by mercuric salts, green by mercurous salts, yellow by solution of lead. For detecting chlorates 2 to 3 c. c. of the liquid are placed in a small test tube along with a slip of the paper; 1 c. c. of dilute sulphuric acid is then added, and heat is applied. If chlorate is present, the liquid turns yellow.

Mercurous nitrate paper serves when moistened to detect ammoniacal gas, which turns it black; caustic alkalies and alkaline monocarbonates stain it greenish brown to black, while the alkaline bicarbonates leave it colorless.

Silver bichromate paper turns yellow with free hydrochloric acid.

Besides these, the author mentions a number of other papers less frequently needed. The use of all consists in letting a drop of the liquid in question fall upon a slip of the paper.

The author tests for arsenic (arsenious and arsenic acids) by means of slips of sheet brass, 2·5 to 3 centimeters in length and 15 to 17 centimeters in length. The hydrochloric solution is mixed with a little oxalic acid, or the ammoniacal solution is supersaturated with hydrochloric acid and mixed with oxalic acid in order to reduce arsenic to arsenious acid. A drop of the solution is put upon a brass plate and sharply dried; the place of the drop is then washed with water, when a dark spot of a permanganate color reveals the presence of arsenic. Dark thin outlines still appear in case of dilution with 150,000 parts.

In cases where the papers and the brass plate are not used the auther places the two drops (of the reagent and the liquid in question) neareach other upon a slip of glass, and mixes them. The transparency of the glass renders the slightest turbidity visible.—*Dr. H. Hager, Pharmaceut. Central-Halle and Chemiker Zeitung; Chem. News.*

Railway from Sweden to Lapland.

The North of Europe Railway Company (Limited) has been formed in London, for the purpose of constructing a line of railway from Lulea in the Gulf of Bothnia to Ofoten Fjord in the North Atlantic Ocean, and thereby open up the rich stores of mineral wealth in that part of Lapland, and especially in the mines of Kirunavaara, Liosavaara, and Gellivaara. The legal guarantee has been deposited with the Swedish and Norwegian Governments, and Mr. P. Von Ehrenheim and Captain C. G. Hjertaboth, gentlemen of high standing in Sweden, and Lieutenant Lund in Norway, have been appointed resident directors. It is expected that one-third of the line, the Lulea-Gellivaara section, will be completed before the end of this year, the country being fairly level and easily traversed. Great results are anticipated by the local authorities from the opening up of the districts by this railway and also in peopling the northern provinces of Sweden, which now consist principally of waste lands, and are almost uninhabited. The province of Norrbotten, in Lapland, contains 105,000 square kilometers out of the 440,000 which form the whole of Sweden (nearly one-fourth of the kingdom), while its population only amounts to 92,000, or not quite one person per square kilometer; nevertheless Norrbotten is Sweden's richest province, its iron ores being unsurpassed anywhere in quality or magnitude. The great drawback to this province has always been the want of communication with the other parts of Sweden; along the banks of the river Tornea the land is fairly well populated.