tures of energy required in them under different conditions. Without attempting an exhaustive enumeration of these processes, the following may be noticed as of the first importance from the work performed in their activities.

Constructive metabolism in the repair of tissues; vaporization of water exhaled by the lungs and skin; work of the involuntary muscles in respiration and circulation of the blood; energy expended in mental activities and the functions of secretion and excretion; loss of heat by radiation from the body; and work done by the voluntary muscles.

TABLE 4.

The energy of food consumed by different animals to produce a given increase is expended as follows, under conditions above noticed.

	In increase.	Lost in excreta.	In repairs and other physiological processes.
	Per cent.	Per cent.	Per cent.
Oxen	12	28	60
Sheep	16	23	61
Pigs	36	14	50
"Analyzed fat pig"	29	18	52
Guernsey cow. April	20	36	43
Guernsey cow. May	21	35	44

It will be seen from Table 4 that the largest percentage of the available energy of foods is expended in these strictly physiological processes concerned in maintaining the integrity of the animal machine. Under the conditions of feeding experiments, with fattening animals and cows giving milk, but little mechanical work is done by the voluntary muscles, and the last item of our enumeration of physiological processes might have been omitted as insignificant in relation to the enormous expenditures of energy in the other normal activities of the system to which attention has been directed.

If mechanical work is done by animals, it must be at the expense of the energy that might, under other conditions, be expended in the manufacture of animal products, as the physiological processes enumerated above must all be provided for in fattening animals and cows giving milk with a minimum of muscular exercise, as well as in the case of animals engaged in severe muscular work.

The energy expended in mental activities is of the first importance in its influence on the efficiency of the animal machine in useful work. The nervous system, through which mental endowments are manifest, has intimate relations with every part of the animal machine and the direction in which energy is expended is largely determined through its agency.

Practical farmers are well aware that animals fail to give profitable returns for feed consumed when restless and excited through any source of disturbance, or when dissatisfied with their feed and surroundings.

The available energy of a liberal supply of nutritious food may all be expended, and even the stored energy of the tissues drawn upon to carry on the increased physiological activities resulting from mental and nervous derangements of the nutritive machinery without any expenditure in profitable production. In conducting feeding experiments and in the interpretation of their results, this is one of the most difficult factors to deal with, as it may have a dominant influence on the final outcome.

The approximate estimates of the relative efficiency of different animals in utilizing the potential energy of their feed in useful work, which have been given in mere outline, will require revision and correction as we become better acquainted with the specific influence of the variable factors of food and environment on the work performed by animal machines. Even in their present imperfect form they may, however, serve to illustrate the significance of energy as a factor in animal nutrition and the futility of formulating diets and nutritive ratios in terms of their chemical constituents.

CONVENTIONAL DIAGRAMS OF ELECTRICAL APPARATUS.*

By D. W. C. TANNER.

IT has become apparent, more especially in the last few years, that the use of simple and comprehensive diagrams is necessary in order quickly and conveniently to represent the different forms of electrical apparatus and their innumerable arrangements.

Perhaps the most noteworthy of the efforts which have been made toward uniformity of symbols has been that of Prof. Francis B. Crocker, whose chart appeared in the Electrical Engineer of May 13, 1891, and was afterward reprinted in Houston's "Electrical Dictionary." This chart was compiled for the use of students at Columbia University. While many of the diagrams are in common use to-day, there are some which have become almost obsolete in so short a time as six years, and many totally new ones are required which have become necessary since the chart was published.

In 1873 C. H. Davis and F. B. Rae published a "Handbook of Electric Diagrams," which deserves but a passing notice, for the work was designed merely to show the circuits and mode of operation of a number of telegraph instruments, and not their simple representation.

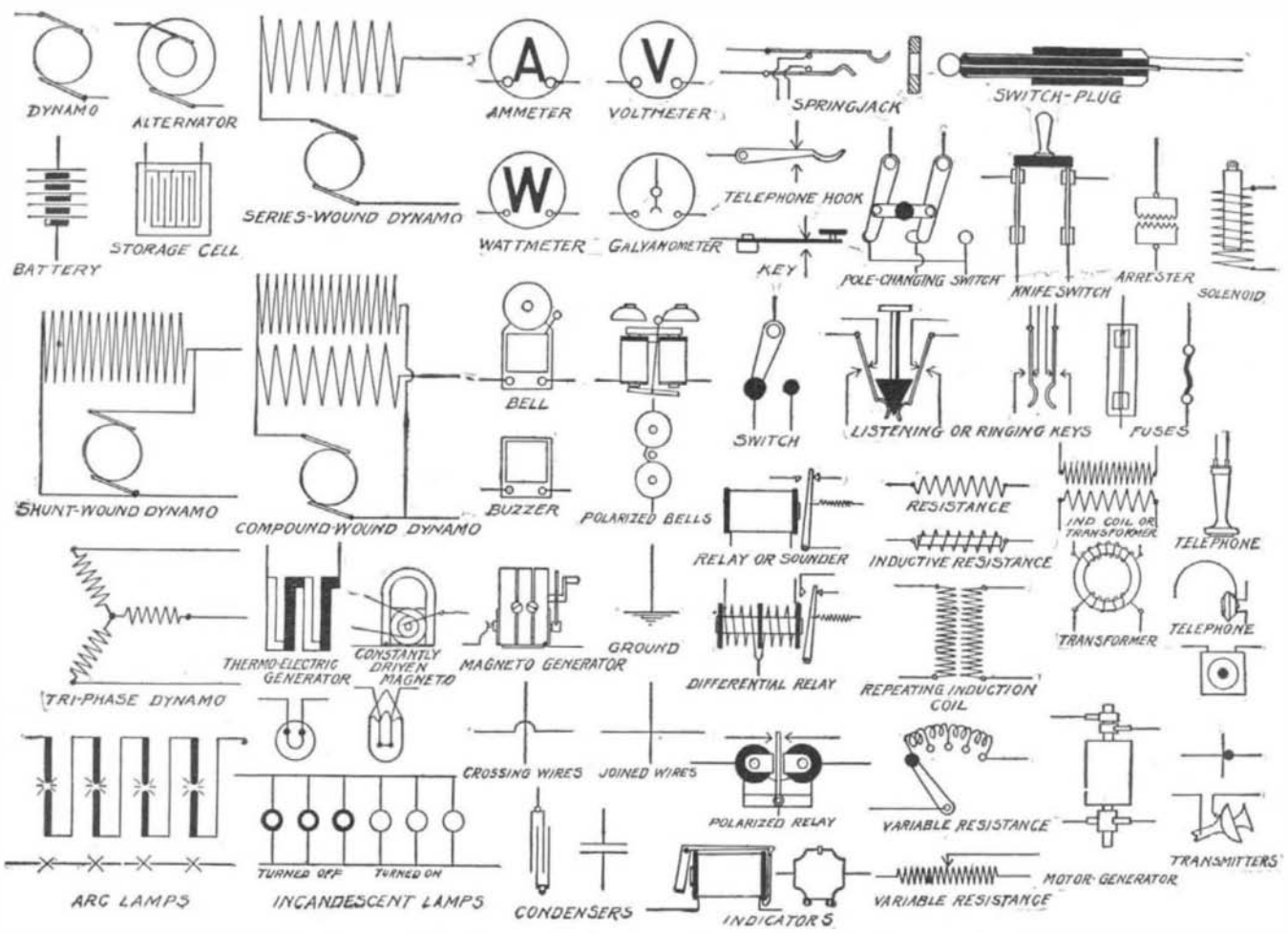
The Patent Office has done something toward simplification and uniformity, but by criticism rather than by definite instruction. If the diagram submitted does not please the examiner, it is promptly rejected, but often without giving the applicant a very clear idea of just what is wanted. The most that is done is to refer to the work of some attorney whose diagrams are considered good.

Prior to 1892, the method of illustrating a telephone exchange system varied pretty largely with the tastes of the individual. Very often a switchboard was shown in vertical section, complete, with the keys, spring jacks, plugs, etc., in their proper places, fully drawn in detail. About this time Mr. F. R. McBerty, of the Western Electric Company, began the work of simplification, and the present method of illustration, which is remarkably clear and easily understood, is very largely the result of his work.

The symbols shown in the accompanying chart have been selected as being those which, upon careful comparison with others, seemed to be the best adapted for the purpose. Of course, it is very difficult to make such a chart complete, but it is hoped that the majority of the symbols for which demand is most frequent will be found without difficulty.

Where more than one symbol is shown for the same device, the simpler form is intended to be used where it is desired to show a number of the devices, and that which bears a somewhat closer resemblance to the original will be best adapted where only one or two are required. The intention was not to show the circuits and mode of operation of complex systems or mechanisms, but only to indicate the symbols for the elemental or unit pieces or apparatus, which may be combined at pleasure.

* Abstract of a paner read before the Chicago Electrical Association. We are indebted to The Electrical Engineer for the article and engraving.



CONVENTIONAL DIAGRAMS OF ELECTRICAL APPARATUS.

SOME 523 inches of rain fall annually at Cherra Poonjee, in Assam, and in one year—1861—as many as 805 inches were reported, of which 366 inches fell in the single month of July! The average yearly rainfall in London is about 2 feet.

LABORATORY APPARATUS FOR TESTING GAS COALS.*

By Mr. G. JOUANNE.

THE chemical analysis of gas coals teaches us their elementary composition, in determining the quantity of oxygen, hydrogen, nitrogen, sulphur and other substances which they contain. The industrial analysis, which consists in determining the proportion of volatile matter, coke and cinder, gives some useful results; but both these analyses teach only a little from the practical point of view of working in our gas works, and they do not answer the daily questions of the director who wishes to keep account of the quality of the coal and to determine his selection upon effective results for his especial use.

In short, what we want to know above all for each kind of coal that we use is, 1, its yield in volume of purified gas suitable for illumination; 2, its yield in coke; 3, its yield in tar; and, 4, the nature and proportion per cubic foot of the principal impurities which must be eliminated from the crude product.

It is to aid this determination—that is, keeping in mind the practical testing of gas—that we have devised a system of apparatus which will distill at each charge one kilogramme of coal.

The cast iron retort in which the distillation is effected is of the usual D form; it is a reduced type of the retorts usually set in the gas works. For heating, a furnace is used formed of a cylindrical envelope of refractory clay, bound by a sheet iron jacket, having at its ends cast iron plates.

The furnace rests on a frame of cast iron and may be set up on a table or any other place convenient.

The retort is heated by means of a powerful gas burner, composed of a collection of Bunsen burners of large diameter, so arranged as to produce a long enveloping flame, and rapidly reaching the required temperature for a good distillation.

The coal to be distilled, previously broken and weighed, is put in an iron scoop resting on the sole of the retort.

The gas produced by the distillation is carried, by a tube fixed in the head of the retort, to an apparatus of several parts, so arranged as to act as hydraulic main, condenser, scrubber, etc. The gas leaving the retort first passes through the water of the lower vessel, which acts as a hydraulic main; then it circulates through a series of tubes forming the condenser; the condensed tar and ammoniacal liquor fall directly into the lower vessel, then the gas passes up through a central tube to the washer, then to the purifier, where it comes in contact with beds of powdered lime and iron oxide, which produces complete purification. A "tubulure," with water seal placed at the top of the apparatus, allows the gas to issue and pass through an iron pipe to the gasometer, in which it may be kept as made.

The constituent parts of the purifying condenser are cast iron, united by means of water seal joints, thus allowing the successive removal of each part and its replacing without recourse to bolts.

The gasometer is composed of a sheet iron tank and has a train accurately fitted, which indicates directly on a graduated scale the exact volume of gas produced by the weight of coal submitted to distillation. The apparatus being set up and made ready for use, the test is made as follows:

The quantity of coal to be distilled, broken in small pieces, is weighed dry, having been desiccated previously if necessary, and placed in the sheet iron scoop, which is then introduced into the retort when it has attained the desired temperature. The retort is quickly sealed by means of a clay lute and eccentric lever which works easily.

The products of the distillation are collected in the

* Translated from Le Gaz, by Mr. Herman Poole.—From American Gas Light Journal.

main where the tar is dropped. This being cone shaped and having a cock at the bottom, the tar and liquor can be drawn off at the end of the test, from which the tar can be separated by decanting, and weighed.

The amount of ammoniacal liquor deposited in this vessel can be separated and weighed, or may be found from the difference after the tar is taken off. A similar method can be used with the liquor in the washer.

After passing through the washer it reaches the purifier, where it is acted on successively by iron oxide, which absorbs the sulphureted hydrogen, and by slaked lime, which retains the carbonic acid, and then goes to the gasometer, by means of which it is easy, as we have already seen, to ascertain, by simply reading the scale, the volume of gas obtained, and, consequently, the yield of purified gas suitable for illumination.

While the test was made on only a kilo of coal, still we can always, if we work carefully, deduce sufficiently near the yield which would be produced by a ton of coal in ordinary working.

In order to ascertain the yield in coke, it is only necessary to weigh the residue—the scoop taken out of the retort after distillation.

If we wish to determine the proportion of impurities contained in the gas produced from the coal submitted to the test, it is sufficient to make a distillation from a known weight of coal, and passing the produced gas through the purifier not charged with purifying material. The gas thus collected may be submitted to a series of tests proper to determine the quantities of impurity—sulphureted hydrogen, carbonic acid, carbonic oxide, ammonia, etc.—contained in the crude gas.

Our apparatus "essayeur-analyseur" is then to be used, and these determinations may be easily made by means of titration liquids.

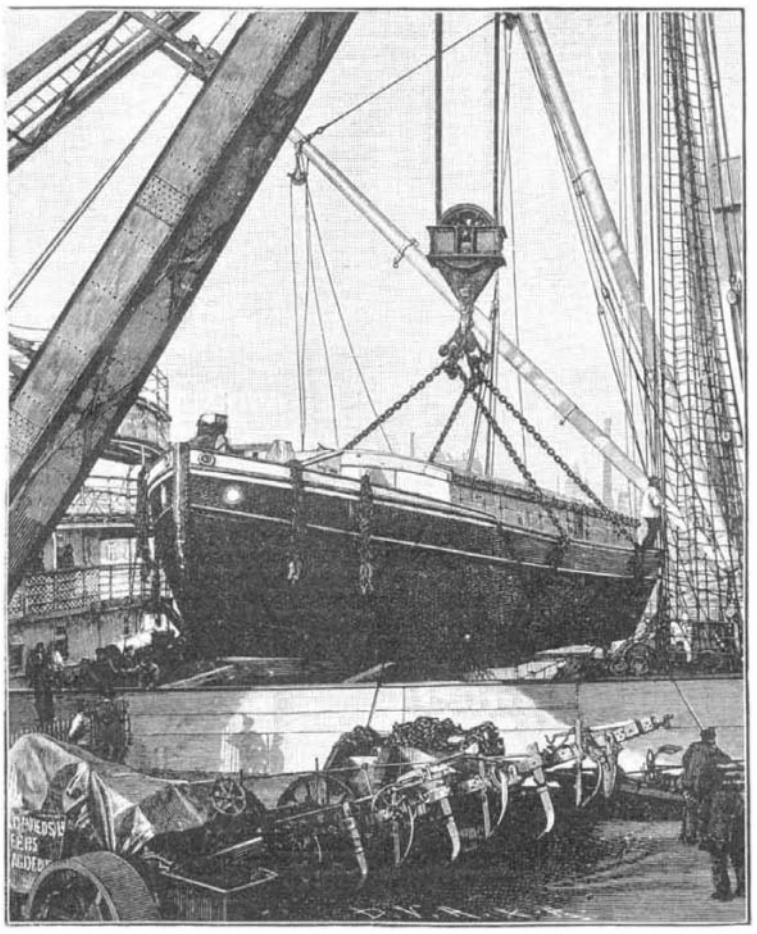
The determination of the illuminating power of the gas contained in the holder of the apparatus may be effected by means of a photometer set up in a dark chamber, as usual in such tests.

We have devised a special arrangement of double projection photometer, based on the simultaneous observation of the equality of lights and shades, and which renders the photometric observation very easy and sure, even for inexperienced persons.

The collection of the apparatus described forms a complete laboratory for making all practical tests relative to the yield of coal, the purification of gas and its illuminating power.

THE NEW GERMAN MAIL STEAMER KONIG.

THE German East Africa Line has put a new steamer, the König, in service between Hamburg and the German colonies in East Africa. This steamer, which is arranged for carrying passengers as well as freight, was built in the yards of the Reiherstieg-Schiffswerfte und Maschinenfabrik, of Hamburg. It is made of steel and is 400 feet long, 47½ feet wide, and 33 feet deep, and has a capacity of 5,500 tons. The engines are of the three cylinder type, and receive their steam from three double boilers, which have been tested for twelve atmospheres and are provided with eighteen fire boxes. The two, which together indicate about 3,000 horse power, worked admirably during the recent trial trip, giving a speed of almost 13 knots an hour, with 75 revolutions, and a medium draught of 15 feet. Besides the steam capstan and steering device, there are seven steam winches of the largest kind for loading and unloading, and two for raising the ashes. The König is provided with six lifeboats, a gig and a steam launch. In the hold there are nine watertight bulkheads which reach to the main deck and can be closed in less than a minute. The König carries only one smokestack and is schooner rigged. The masts serve to carry the sails and on each there are seven hoisting booms, by means of which heavy freight can be loaded and unloaded. The vessel is lighted at night by electricity, which is used for the top and side lights, and it is also used with reflectors during loading and unloading. Arrangements are made for first, second, and third class, and steerage passengers. Special care was given to the ventilation in view of the tropical climate in which the vessel will be used and no pains have been spared where the comfort of those on board is concerned. On the forward end of deckhouse, which extends to the forward end of the bridge and is surrounded by a sort of gallery, is the saloon for the first class passengers, and above this saloon, which is on the main deck, is the ladies' room, with its piano. The staterooms for the first class passengers are under the saloon; further aft are the smoking room, library, etc. Aft, in the deckhouse, are the second class staterooms, which are also most tastefully arranged, while the rooms for the third class passengers are aft in the ship, and the quarters for the steerage passengers are forward of the bridge. The captain's room and navigation room, as well as the rooms of the officers, engineer, etc., are on the bridge deck. The quarters for the crew are under the forecastle, where a negro kitchen is also arranged for the passengers from the East African coast. The saloon is finely decorated and the promenade deck, which is partly covered by an awning, is so spacious that it will accommodate hundreds of passengers comfortably. Our illustration shows the placing of the lighter Beira on board the König. This lighter was built in Harburg for Portuguese East Africa. It is an iron vessel about 69 feet long and 17 feet wide, and has a draught of 5 feet 8 inches. It weighs more than 24 tons. We are indebted to Uber Land und Meer for the cuts and particulars.



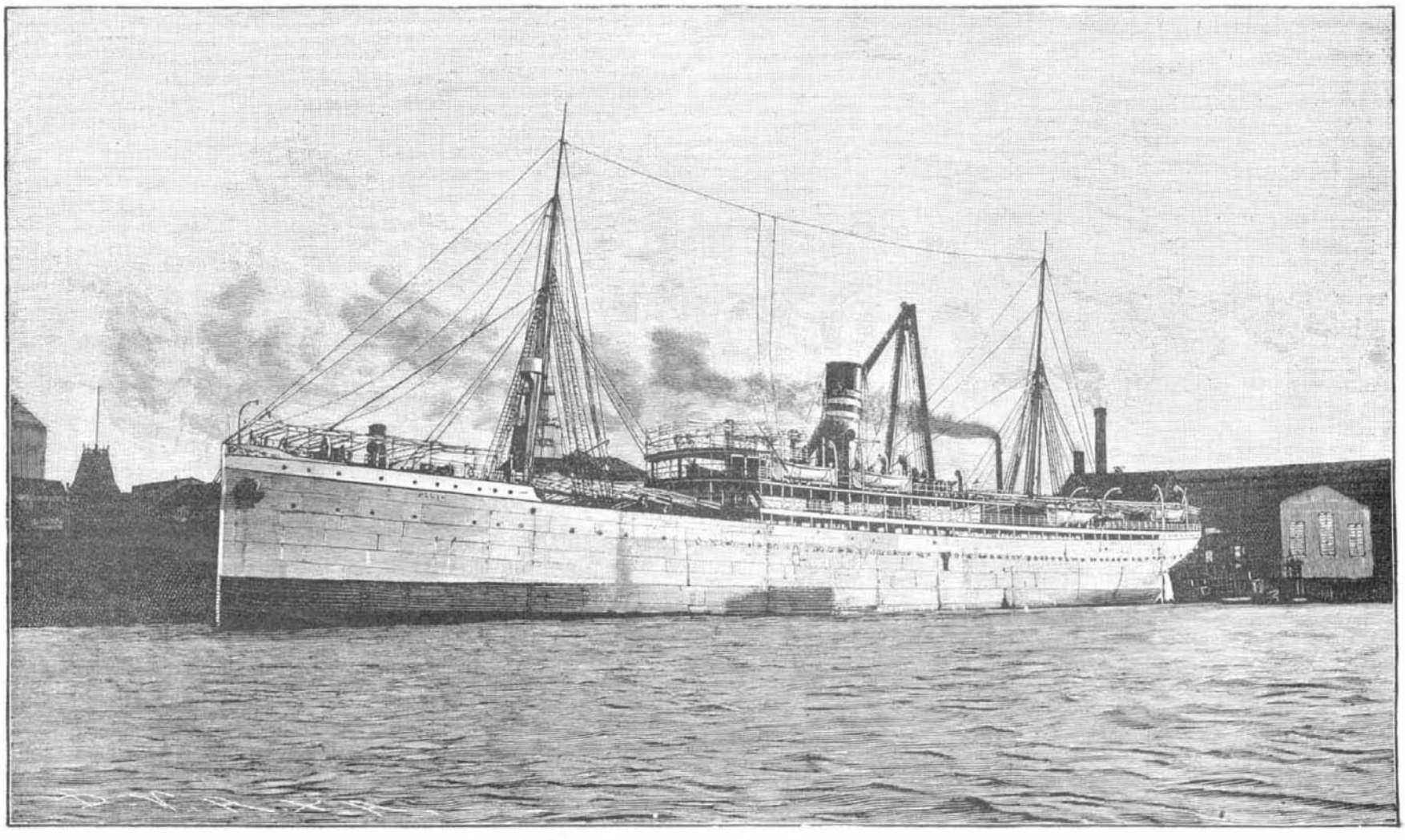
PLACING THE LIGHTER BEIRA ON BOARD THE KONIG.

From an instantaneous photograph by John Thiele, of Hamburg.

STREET TRACTION IN FRANCE.

THE SCIENTIFIC AMERICAN SUPPLEMENT of February 6 contains a statement by a Mr. B. Abdank, a consulting engineer of Paris, which is calculated to produce very erroneous impressions in regard to the economy and efficiency of compressed air when utilized with properly constructed motors, and an explanation and correction seem to be required.

If steam should be applied to a defectively constructed



THE NEW GERMAN MAIL STEAMER KONIG.