reactions: (1) dissolution in concentrated sulphuric acid; a coloration ensues, which is generally changed by the addition of water; (2) dissolution in water, with the addition of a few drops of hydrochloric acid; a new coloration is observed; (3) dissolution in water, with the addition of soda; very often a colored precipitate is formed.

The combination of these three colored reactions is generally sufficient to detect the coloring matter.

If the colorant is insoluble, mineral pigments will be obtained in the ash, in certain cases without chemical change (smalts, ferric oxides, etc.). In other cases the original pigments will be in characteristic form, while again the organic colorant will be difficult to distinguish, and the reactions must be determined on the paper itself.

VI. DETERMINATION OF THE RUPTURE LENGTH AND THE LENGTHENING.

By "rupture length" is understood the length of a strip of paper of any width and thickness, which would be reached by the strip suspended at one end under its own weight, and breaking at the point of suspension. This length is generally expressed in kilometers. There are several pieces of apparatus designed to determine the rupture length, but all are constructed on the same principle; they are dynamometers, which differ from each other by the method employed to subject the strip of paper to traction. The most convenient dimensions for this strip have been found to be 0.015 meter in width and 0.18 meter in length. This band is held at each extremity by a clamp and the two clamps are separated from each other by means varying according to the kind of apparatus employed. It follows that the band of paper undergoes traction, and when this is sufficient, the paper breaks. A hand fixed to the apparatus gives the rupture load; the lengthening is determined by the increase in the separation of the clamps.

The rupture length is now to be calculated. Suppose that the test has shown that the average weight of a strip of paper of 18 centimeters is p ; we must, according to the definition of the rupture length, calculate what length of the strip of paper of the same width is equivalent to a weight P (rupture load).

Let x be this length; we have $\frac{0.18}{p} = \frac{x}{P}$; whence

$x = \frac{0.18}{p} \times P$. $\frac{0.18}{p}$ is called the number of the strength of a paper.

The result x allows of comparing all papers together with reference to their solidity, for it is independent of the width and thickness of the sample.

RESISTANCE TO RUMPLING.

There is at present no apparatus for making the rumpling test; this must depend on the operator, and is ordinarily thus conducted: Half a sheet of the paper to be tested is first reduced to a ball, then spread out anew, and this operation repeated several times; the papers of quite inferior resistance will quickly exhibit holes under this treatment, so that their resistance to rumpling may be expressed as *extraordinarily small*.

The folded paper is afterward taken with both hands and rubbed smartly, as a washerwoman rubs linen in rinsing it. After some practice it is not difficult to class papers in a series of seven types, from that of *extraordinarily great resistance* to that of *extraordinarily slight resistance*. The attempt has also been made to determine the loss of resistance by folding, but as this result gives the same value for very different papers, no sufficient substitute has been adopted for the rumpling test.

Such is approximately the point which has so far been reached in the testing of papers; it is probable that chemical analysis, and especially microscopic examination, has surprises in store for us, with reference to the method by which papers have been manufactured. Observations of this kind will throw light upon certain points now obscure and afford an explanation of certain phenomena whose causes now elude us.

THE CONTAL NUT WRENCH.

THE tool represented herewith is designed for the use of automobilists, who often have occasion to loosen or tighten a bolt or one of the numerous nuts that are used in the construction of a carriage. The essential part of this wrench is a steel tube forming a tool carrier. Within the end of the tube is a square hole that may be used for turning nuts of that size directly, or for receiving

the tool is furnished a set of blanks corresponding to the various sizes of nuts and bolts that are likely to be met with. There may also be used, instead of a straight squared rod, a piece somewhat more complicated consisting of two rods united by a universal joint, so as to render it possible to loosen or tighten

operations in some of the districts even near the railroad lines and mills, owing to the difficulty of getting the logs over comparatively short stretches of country.

To invent a motor that would obviate this difficulty has been the study of Mr. A. O. Lombard, of Water-

THE CONTAL AUTOMOBILE WRENCH.

1 and 2. Ring displaced for the two opposite directions of revolution. 3. Wrench with its universal joint. 4. Arrangement for reaching out-of-the-way bolts and nuts.

nuts that are located in places that are not easily accessible.

One of the ingenious features of this tool is a ratchet arrangement that permits of revolving the tool carrier either from left to right, or from right to left. Externally to the tool carrier and on the end opposite that having the hole, is mounted a ratchet collar, the teeth of which mesh with those of a loose clutch collar. This collar is secured by a pin holding a washer which forms a bearing for a spiral spring placed between the collar and the end of the tool carrier and abutting at the other extremity against a shoulder formed upon the carrier. In order to obtain the ratchet control of the tool carrier, it became necessary to find a combination that should assure the interdependence of one or the other of the two sets of teeth. This object has been attained in the simplest manner. Around the tooth slides a coupling ring provided with a polygonal aperture, and capable of sliding longitudinally upon the corresponding periphery of the clutch collar, sleeve, and ratchet collar. This ring has a carefully calculated width, so that it may, through displacement, operatively connect the clutch collar with the ratchet collar, with the collar forming the head of the tool, or with both simultaneously. In the first two cases we have an intermittent motion; in the third position, the key forms but a single piece and plays the part of an ordinary fork-wrench. It is hardly necessary to say that the tool is provided at the extremity with a lever, which is placed in a position at right angles with the axis of the wrench when it is desired to make use of the latter, and parallel with it when the tool is to be placed in its case. This rod, which is of steel, is bent at the extremity, and kept flat near the bend. When it is slid through the two apertures through which it passes into the head of the tool, its flattened portion comes perpendicular with a slit that prolongs one of the apertures. This permits of pulling out one of the ends of the lever and making it describe a semicircle, and then a quarter-circle until it finally rests against the tool, where it is held by a flange at the end of its curved extremity.—Translated from *La Nature* for the SCIENTIFIC AMERICAN SUPPLEMENT.

LOG-HAULING MOTORS.*

By DAY ALLEN WILLEY.

A MOTOR designed specially for transporting lumber and logs over the rough roads and even cross country in the Maine woods has been the object of much interest among the lumbermen in this section of the

ville, Me., for several years. Mr. Lombard and his brother are interested in pulp-making machinery, and are familiar with the conditions in the Maine woods. As the result of the experiments, Mr. Lombard built a machine at his Waterville factory, which has already been used during one winter with quite satisfactory results. It is termed by the inventor a steam log hauler, and it may be said to lay its own roadbed automatically, as it moves along the snow-covered highway or field. It consists of a steam engine and boiler mounted on a framework of heavy beams. The front portion rests on a pair of sledge runners connected with the cab by chains, which turn the runners from side to side as the front wheels of an automobile are controlled. In fact, the chains form the steering gear. The boiler and firebox, which are similar to those on a small locomotive, rest upon a lag bed, which is one of the remarkable features of the invention. It is made of sections of Jupiter steel, each 12 inches long and 8½ inches wide. The sections are joined by metal hinges, which permit the bed to pass around two sprocket wheels, each 3 feet in diameter. The sprockets are placed on axles and are 5 feet apart. On each section of the lag bed or lag is what the inventor calls a toe calk, similar to the point on a horseshoe, but extending across the lag. The calk aids in traction, as it prevents the bed from slipping when the motor is moving.

The cylinders, as will be noted in the illustration, are located beneath the boiler, and are attached in such a way that the power is communicated directly to the sprocket or driving wheels. The machine is controlled by valves and levers as on an ordinary locomotive. When it is put in motion, the length of the lag bed is sufficient to allow it to move 5½ feet, when another section of equal length is laid down by the wheels, which, as the engine moves forward, pick up the "slack," or the portion on which it has been traveling. To use an ordinary illustration, the lag bed might be compared to a plank thrown on the ground as a foundation for the wheels of a vehicle, and taken up after it has passed over, to again be used for a roadway.

A series of ball bearings keep the lag bed true, even in going over rough surfaces, such as slight depressions and drifts. The runner frame in front is attached in such a manner that it adjusts itself to the contour of the surface without difficulty. Although the "Forest Echo," as this novel locomotive is termed, weighs 14 tons, the plan for furnishing it a movable roadbed is so successful that it can be operated over

STEAM LOG HAULER.

ing other pieces of steel tubing having in one end a square aperture corresponding exactly to the dimensions of a bolt or nut, and, on the other, a squared end to fit in the hole that terminates the tool carrier. With

* If the colorant is insoluble in water, the attempt should be made to dissolve it in alcohol.

ELECTRIC LOG HAULER.

country, owing to its novel features. The severe winters are attended with heavy snowstorms, which frequently make the highways impassable for ordinary vehicles or teams unattached, on account of the deep drifts. The timbermen have been obliged to suspend

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

the snowy surface without sinking. On an ordinary road it will attain a speed of four miles an hour, drawing four sledges with 17,000 feet of logs. It has also been used for hauling snow plows to open roads in the lumber districts, pulling the plow through drifts which had "stalled" a string of 24 horses.

In addition to the steam hauler, however, Mr. Lom-

bard has been working with an electric trolley hauler of his own design, with successful results. A power station was erected on Alder Creek, a branch of the Dead River, and here sufficient current was generated to operate two Westinghouse motors of 50 horse power in the aggregate. The necessary feed wires were installed on a mountain road about seven miles in length, where the grade is too steep to admit operating the steam hauler. The motors were placed on a platform, one in front and one in the rear, so they can be controlled singly or together as desired. A sledge runner was fastened under the front part of the platform, as on the steam hauler, and used to keep it in a direct line, being connected by an iron rod with a wheel turned by the motorman. The electric power is of course applied to the sprockets or drivers, in the same manner as it is applied to the trucks of an ordinary trolley car. On the electric apparatus the lag bed and sprockets are arranged in the manner already described. It has the advantage of being much lighter in weight, as the boiler and firebox are not required. It was tested last winter, hauling loads equal to those pulled by the "Forest Echo" up twice the percentage of grade.

The log haulers are considered so practical that the Messrs. Lombard are constructing two more to be operated by steam power, which will be employed by a lumber company on Alder Creek for getting all of its logs from the woods to its mills. This type has made trips of 25 miles, carrying loads, without being "stalled."

FIRE APPLIANCES AT THE EXHIBITION OF GERMAN CITIES IN DRESDEN.

THE great progress in the domain of fire appliances and methods of fighting conflagrations is clearly shown at the Exhibition of German Cities in Dresden. The automobile, much maligned on account of excesses committed by sportsmen, is doing excellent service in this field.

The city of Hanover exhibited the models of its automobile fire train, consisting of steam fire engine, gas fire engine, and a cart carrying a hydrant water

MODEL OF A FIREMAN WITH GIESBERG OXYGEN APPARATUS.

post or fire hook contrivance for connecting a nozzle hose or supply hose to the water main in the street. Hanover is the only German city possessing an automobile fire train. This considerably reduces the running expenses, as horses are no longer required.

The fire engine house of the exhibition, by the way, is equipped with a real automobile fire train, which is served by the crew of the Dresden fire department, and exhibited by the Waggon und Maschinenfabrik, A. G., formerly Busch, of Bautzen. The train consists of an automobile steam fire engine, an automobile crew-wagon, and an automobile ambulance. The steam of the engine drives during the trip a starting machine, and, while fighting the fire, a steam pump. With an additional pressure of ten atmospheres, 502 gallons of water are supplied per minute.

Besides the automobile fire train, the Bautzen firm also exhibits at the fire engine house of the exposition a mechanical tower ladder or revoluble telescoping ladder, constructed by the firm of Fries Sohn, of Frankfurt a. M. By means of compressed air or carbonic acid, which is kept in a steel receptacle, the four telescoping tubes are forced up. The different parts of the ladder are attached to the upper extremities; each tube portion, when forced up, carries along its portion of the ladder. In the hands of a well-drilled fire brigade, the ladder, four stories high, is made ready for use in twenty to thirty seconds. The pressure of about ten atmospheres is sufficient to send up a fireman and hose without delay. The whole ladder, with truck, is made of iron. It may be moved with the support in a circular direction, like a revolving crane, without having to turn the truck at the same time. To all these advantages must be added still another, viz., that it can be manipulated by two men, while four men are generally required to operate a mechanical ladder.

The city of Leipzig has exhibited excellent pictures of fire stations, which must be called model in every way. A diagram shows how a fire alarm is transmitted automatically. When the alarm comes in, the station

is notified by the device without the co-operation of the telegrapher. At the same time, the time-stamp clock records automatically the exact time when the alarm arrived. Furthermore, Leipzig exhibits the model of a fireman fully equipped and provided with a Giesberg smoke-protective oxygen apparatus. We present an illustration of the same, and, for comparison, one of a model with fireproof suit exhibited by the city of Kiel. Besides his fire-resisting suit, the Kiel fireman is wearing a protective mask over his head. The air to breathe is conveyed to him by means of a hose from the atmosphere. The Leipzig fireman, however, carries the air with him in a compressed state, so that he can move about freely and independent of an air hose and of the outside. The oxygen reaches his mouth from the steel receptacle on his back. The exhalations and the superfluous oxygen go into the bag on the chest, where they are sucked up by an injector and conveyed into a regenerating drum. There the alkali absorbs the exhaled carbonic acid, thus rendering the exhalations perfectly devoid of danger by purifying them. A man equipped in this manner can remain for two hours in a room filled with smoke or gas.

Of the other exhibits in fire appliances we may briefly mention the following: The fire chiefs Littmann and Herrmann, of Dresden, exhibited an artificial short circuit for strong current lines of electric street cars, by means of which the current in a trolley wire may be quickly interrupted without danger, if it hinders the firemen in their work. Furthermore, there

MECHANICAL TOWER OR REVOLUBLE SLIDING LADDER.

was exhibited a plan of the telegraph and fire alarm net-work system of the city of Dresden, with a stationary and wall alarm. The Dresden firm of A. G. Handel showed a novel dismountable fire engine which can be used on wheels as well as on sleigh runners, and possesses great mobility. Berlin put on exhibition the model of her latest fire station house with normal fire train, while Bremen sent very fine models of a fireboat (for seaports) and a gas fire engine. From Breslau came the model of a highly ingenious contrivance, by means of which the ventilators in the city theaters open at once automatically, when the iron curtain is let down in case of a fire; also a sliding-cloth which can be used both for jumping and sliding. Chemnitz exhibited a rain contrivance for the protection of the wood construction of a church steeple; also a rich collection of instructive material for firemen. Finally, there was on exhibition, from Kiel, the excellent model of an up-to-date fire station, and, from Königsberg, a combined fire alarm and accident call.

The exhibits comprising the department for extinguishing fires are so varied and numerous that they afford a perfect survey of the highly developed fire departments of Germany.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from *Illustrierte Zeitung*.

THE GERMAN TOWNS EXHIBITION AT DRESDEN.

LITTLE notice has been taken, says a correspondent of the Manchester Guardian, of the German Towns Exhibition which has been open in Dresden during the summer. The Germans take the development of their towns seriously. As in England, though to a less extent, the population is more and more concentrating in the large towns, creating problems of administration, of health, of transit, of education, which demand the attention of the best intellects available. In Germany the service of the town is regarded as in the highest degree honorable. There is a highly-trained professional class who fill the higher posts, in most

cases elected to the position, but giving their whole time to the work and receiving salaries. There are, in addition, unpaid elected councilors, as in England, among whom are to be found prominent business and professional men.

The object of the Dresden exhibition is to show the state of German towns at the beginning of the twentieth century, and to give those interested an opportunity of comparing the development of the various municipal services. The chief organizer was the Oberbürgermeister of Dresden, Herr Bentler, assisted by a committee which includes the officials of the chief German towns. Each department of the exhibition is under the control of a special committee of experts in that department. Invitations to exhibit were sent to all German towns, and exhibits have been sent by 128 of varying size and importance. Firms and companies which contract for municipal services or supplies were also offered space for exhibits, and they are well represented in a special pavilion and in separate buildings in the grounds. The main exhibition has eight sections: (1) Town engineering (street construction, bridges, harbors, waterways, etc.); (2) Town Extensions, Building Regulations and Housing; (3) Public Art; (4) Public Health, Police; (5) School Organization, including education for those beyond school age; (6) Poor Relief, Care of the Sick, Charitable Institutions; (7) Finance and Administration, including savings banks; (8) Registration and Official Books, Papers and Appliances, Statistics and Literature. There are, in addition, three separate exhibitions—the trades exhibition (already mentioned), a gas and waterworks exhibition, and an electrical undertakings exhibition.

One cannot in a brief article deal with all the sections which deserve attention. I may, however, refer particularly to the sections dealing with streets and with town extension and housing. The continental mind, perhaps from a subtle military influence, seems more awake to the need for wide, well-made streets in towns, both from considerations of transit and of public health, than the English mind. From the time when Baron Haussmann drove straight lines of communication through Paris, there has been an evident tendency to meet the modern need of rapid transit in a similar way. But the straightness of the street is

MODEL OF A FIREMAN'S SUIT OF THE KIEL FIRE DEPARTMENT.

not everything, by any means. It has to be wide enough for its traffic, and possibly different kinds of traffic will have to be provided for in one street. If the amenity of the town is to be preserved or increased, trees must be planted, and advantage should be taken of natural or artificial perspectives. The surface should not only be able to bear the traffic, but should be capable of rapid and effective cleansing. Finally, it is along the street lines that the drainage, water, gas and electric-supply system run, and a well-organized town will arrange these so that access can be had to them without disturbing the street. Such are some of the matters which the street engineer has to consider. There are here numerous diagrams showing streets in plan and section, often with photographs and models. In the exhibition grounds one finds side by side every possible variety of paving material, and there are also actual street sections to show the arrangement of underground works. Apparently wide streets are to be the rule in German towns. Judging from the exhibits, the whole tendency is in this direction. Separate tracks for slow traffic and for fast traffic, for foot passengers, for cyclists, and for riders are being constructed in several towns.

Better than "Haussmannizing" is to foresee the growth of a town and to make provision beforehand for the streets that will be required. Perhaps nothing in the exhibition is more interesting than the plans (many of which are large-scale relief models) of the German towns, showing the streets and roads which are not yet made. The officials of the chief towns have profited from their past difficulties, and now insist that their towns shall grow on scientific principles.

The housing question is often acute in German towns. In some cases the municipalities are themselves building dwellings for the working classes, although co-operative building societies and private firms, with the assistance of public funds and under the supervision of the town councils, are the main agents in supplying the needs of the community. The build-