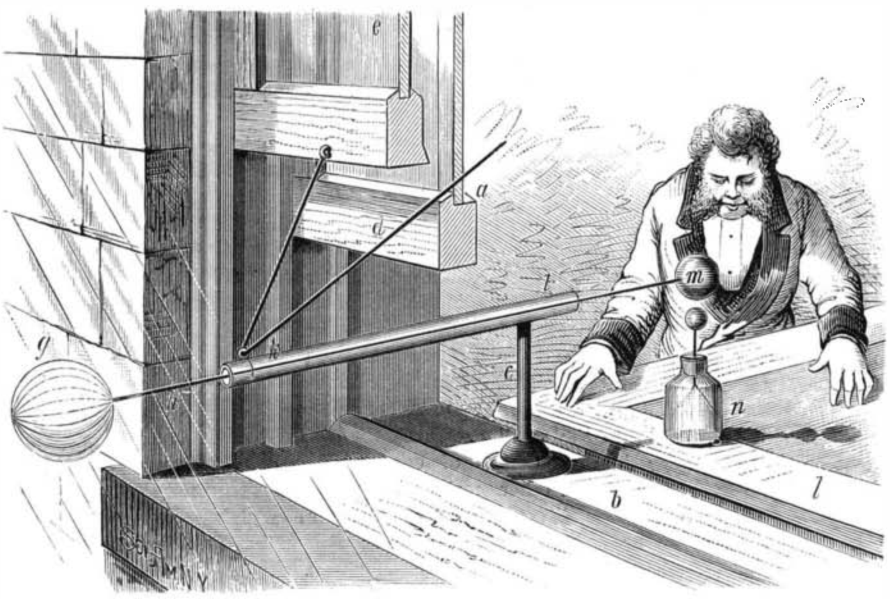
## APPARATUS FOR DETERMINING THE ELECTRIC CHARGES OF FALLING RAIN.

When it was demonstrated by Benjamin Franklin that thunder clouds were masses of watery vapor charged with electricity, the conclusion was very natural that the rain falling from such clouds might possess the same charge, and the electricians of a former generation contrived apparatus to prove this and to estimate the amount of the charge. In consequence of the advance of electrical science and the multiplicity of various pieces of novel apparatus, the old contrivances are now nearly forgotten, but our attention has been called to this subject by the recent suggestion that the ignition of petroleum tanks, now so alarmingly frequent, may sometimes be caused by rain from a thunder cloud.

It may, therefore, be well to give to the readers of the SCIENTIFIC AMERICAN an engraving of one of these pieces of apparatus as it was in use nearly a century ago by investigators of atmospheric electricity. It consists of a globe, *g*, of brass wire attached to a conducting wire, *h h*, which passes through a long glass tube, *k l*, supported by an insulating stand, *c*, placed on the window sill, *b*, and a few cords, *d*, attached to the upper sash, *e*, the lower sash, *a*, being raised. The end of the wire is provided with a brass ball, *m*, reaching over a table, *t*, on which a gold leaf electrometer, or any other equivalent apparatus, may be placed, which, being brought into contact with, or even in the vicinity of the charged globe, *m*, will indicate the electric charge of the rain.

Experiments with this apparatus have shown that the drops of occasional showers are most always more or less charged with electricity, and that it is only totally absent during foggy, moist days and rain storms of long duration; that on the contrary, sudden rainfalls after a clear spell are always charged, and that, as was expected, the strongest charges are obtained during thunder storms. Even traces of electricity have been observed without any rain falling, the air itself being charged.



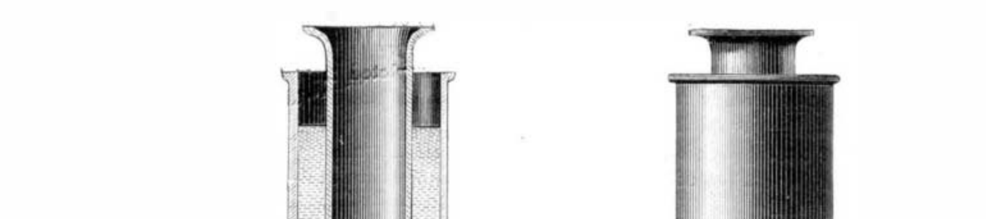
APPARATUS FOR DETERMINING THE ELECTRIC CHARGES OF FALLING RAIN.

## DAVEY'S SIMPLEX MOTOR.

We give engravings of a form of motor for small powers, invented by Mr. Henry Davey (and called by him the "Simplex"), which is being constructed by his firm, Messrs. Hathorn, Davey & Co., of Leeds. This little engine is exceedingly simple and direct in its construction, and it is probable that it may take a not unimportant place among the small power motors in the improvement of which so much has been done of late years. Mr. Davey's machine is in reality a steam engine, in so far that it works almost entirely by steam, but as a steam engine it has the special feature that it has no boiler, in the sense at least of any vessel containing a considerable quantity of water. A reference to the engravings will show that it has a single cylinder only, made with a very large piston rod so that the area above the piston is much greater than that below. The space above the piston is, in fact, the real working cylinder, while the space below is only a compressing pump. The steam distribution is effected by a slide valve shown in Fig. 2, while the pump chamber has connected to it two small single-beat valves, one (Fig. 1) opening inwards, and the other (Fig. 2) opening outwards into a coil which lies within the furnace, this coil taking the place of the boiler. It is inclosed in a cast iron casing lined with firebrick, and the fire is placed below it, as shown. The way in which the engine works is as follows: On its up-stroke the piston draws a quantity of air into the cylinder below the piston, and along with this air a small quantity of water is always taken in. This last comes about by the help of the little cup above the suction valve, into which a fine stream of water is constantly running. On moving downwards the mixture of air and water is first compressed up to a point determined by the working pressure of the engine, and then pushed through the delivery valve into the coil, when the little puff of water is at once flashed into steam. There is no valve between the delivery valve of the pump and the slide valve, but perfectly free communication, and each time a new portion of water is introduced into the coil, a corresponding portion of steam passes away to the steam cylinder. Here it works exactly in the usual way, about which nothing more need be said. It will be seen that the engine may be briefly described as a steam engine which has no boiler, but takes in its feed water as it requires it instead of working always from a large reservoir of steam and water. The air does not appear to play any appreciable part in driving the piston; its chief use is to insure that the water, when sent into the coil, is really blown in as spray, and not allowed to drop or run in.

One of the first of these motors (having a cylinder 3·5 inches in diameter, and 4 inch stroke) has been for some time at the Engineering Laboratory of University College, where the students have made a number of experiments with it, working under various conditions. The motor has been very considerably improved since this particular one was made. In his later engines Mr. Davey has used a small separate pump set on the top of the cylinder, instead of employing the space under the piston for a pump, and in the larger sizes he is making the cylinder double-acting.

This little motor is very substantially made, it takes up very little space, is easily started, and has no explosible boiler, and we do not see why it should not be made very economical of steam, although this has not been attempted in the first instance. There is plenty of room in the world for all the small engines that have yet been brought out, and we shall be glad to hear that Mr. Davey has been successful in getting his well into use.—*Engineering.*




DAVEY'S SIMPLEX MOTOR.

## Color Blindness in Dyeing.

While the attention of scientific experts is being called to this subject, in reference to railroad employes and all persons concerned in the distinguishing of colored lights and signals, as connected with the necessary precaution in the protection of human life in traveling, it might not be deemed an undesirable opportunity for us to call the attention of our special community to the immediate bearing which this defectiveness of vision has on operative dyers. It will readily be granted that no artisan has more necessity for extreme nicety of ocular discernment in shades of color than the one whose whole occupation is among them; and that on the critical truthfulness of his vision depends the accurate production and reproduction of tints, which to fail in would cost serious sums to his employer.

Color blindness, in the full meaning of the term, is not likely to exist among dyers, but it is not only likely, but very possible to produce at least some of the effects by the changing of colors; that is to say, the workman who has his eyes engaged constantly on a red, for instance, if put on to a green may find himself in trouble, and so on through various colors. Now, as to tint shades, is it not very evident that the impression received on the eye by looking on one tint continually will incapacitate the sight for the perception of a true and exact shade of that color?—and yet extreme accuracy is demanded. Let a dyer working on a red for some time have his attention turned to a blue, and will he not at first see a purple? Most certainly, because the visual rays are fraught with red,—and when brought to bear upon the blue, blend with it, at first strongly, and gradually thereafter.

All have not been gifted alike; it is evident that with some workmen this affection may be still more injurious than with others. Those of bilious temperament are subject to a yellowish influence on the vision, which must of necessity prove fatal to the truth of observation in color.

There is no sense more exquisitely delicate than that of sight, and there is no man more dependent on its ability than the dyer.

In taking up the trade of dyeing the early learner knows nothing of the nature of his sight, but goes at it as though it were plowing, or any other calling in which the sensitiveness of the eye is not called into requisition at all. But how important is the constitution of the eye to him who is engaged in a study of colors which must be carried to the most minute perfection. Now, how necessary is it that an examination by a qualified expert should decide on the healthy state of the eye before the trade is chosen. And still further, how advisable is it that occasional examination should be made by a doctor of the eyes of every workman in the dye-house, to decide whether there is any decrease of visionary power, and to prescribe the fitting treatment if there is.

Every employer should consider this matter, and see if his interest is not concerned in it; for the health of the sight of a good, faithful man is as much their concern as the bodily health is his.

While on this subject we may as well suggest the very simple practice to testers of colors of having a purely white material as a plain on which to rest the sight when alternately viewing colors; by this means the eye is enabled to take in the succeeding tint without any influence from the former one.—*Textile Colorist.*

## Invaded by Slugs.

Four or five years ago a Rochester gentleman received from Germany a box of bulbs in which he found a number of large slugs. They were unwisely set free in one of the city parks where they seemed to have thrived to an alarming degree, spreading over the city in a way to make them a serious nuisance. They are much larger than any native slugs, measuring from four to six inches in length, and are likely to become very injurious to vegetation.

## NOTE ON TURPENTINE, ROSIN, AND ALLIED PRODUCTS.*

Of the turpentine collected in this district very little is shipped North. Most all of it is distilled upon the water courses near the pine forests. The small quantities of crude turpentine now sent North are used in making printer's ink.

Turpentine is distilled in copper stills now. Formerly iron stills were used. Then the resulting oil was red. When the first copper still was used in Wilmington the clear uncolored oil shipped North was rejected, because it was not considered genuine "spirits."†

All crude turpentine is distilled with water. The part which water plays in the process well be seen hereafter.

The present distinction as to the grades of rosin are somewhat different from *yellow* and *transparent.*

It is not the presence of water which makes rosin *yellow.* If water gets into rosin, which it does sometimes by accident, the rosin becomes opaque. All the better grades of rosin are yellow or amber color, more correctly; but the term "yellow rosin" is not used here commercially or otherwise. The grade of the rosin depends, *first,* upon the quality of the turpentine, and *second,* upon the skill in distilling. "Virgin turpentine," the first exudation from a newly chipped tree, if skillfully distilled, will yield "window-glass rosin," of which there are two or three grades. If by any means water gets into prime rosin it becomes opaque. This accidental addition of water must take place after the rosin has been drawn off from the still.

"Yellow dip" turpentine, which is the running of the second and subsequent years, yields the medium grades of rosin; while the "scrapings," the inspissated gum from the

COLLECTING TURPENTINE.

tree facings, yields an inferior rosin, from very dark to almost black. The black rosin is not due to burning in the still, as has been stated.

Anhydrous rosin is the greater part of the stock produced; the opaque rosins, being accidental, are limited.

The following description of the process of distillation may explain further.

A fifteen-barrel copper still (barrel weighing 220 lbs. each) is charged early in the morning. Heat is applied until the mass attains a uniform temperature of from 212° to 316° F. This is continued until the accidental water, that is, the water contained in the crude turpentine as it comes from the forest, has been driven off.

The first product distilled over is pyroligneous acid, formic acid, ether and methylic alcohol, with water. This is known as *low wine.*

All the accidental water having been distilled off, a small stream of cold water is now let in, so that the heat is kept at or below 316° F., the boiling point of oil of turpentine. The oil of turpentine and water now come over, and the mixture is caught in a wooden tub. This tub is constructed as follows:—

The distillate is caught at *A* from the still and separates into water and oil. At *B* there is an overflow spout, which discharges into the tub *D.* The water is kept low enough in the lower part of the tub to prevent its overflowing through the cock *B* into the receptacle *D.* From this receptacle it is put into oak casks, well made with iron hoops, and securely glued inside.

The distiller tests the quality of the flow from time to time in a proof glass. The distillation is continued until the proportion of fluid coming over is nine of water to one of oil of turpentine. At this stage the heat is withdrawn, the still-cap is taken off, and the hot rosin, which remains in a fluid state in the still, is drawn off by a valvular cock at the side of the still near the bottom

* By Thomas F. Wood, M.D., in *New Remedies.*

† The commercial name for oil of turpentine.

This rosin passes through a strainer before it reaches the vat, to rid it of foreign substances, such as straw, pine cones, chips, etc. From the vat it is bailed by wooden buckets, fixed on a long handle, into the barrels.

Rosin is graded by standard samples fixed upon by the "Produce Exchange."

The yield of oil of turpentine from "virgin dip" is about six gallons to barrel.

The yield of oil of turpentine from "yellow dip" is about four gallons to barrel.

The yield of oil of turpentine from "scraping" is about two gallons to barrel.

Other-products now attract our attention, viz., the distillation of *rosin oil.*

The rosin oil of commerce is produced in the following way: Rosin is introduced into an iron still, the lower grades being used for this purpose, and heat is applied until the temperature reaches from 316° to 320° F. Water and pyroligneous acid and naphtha come over first, and for some time, until the rosin is exhausted of naphtha. The heat is then raised to near the red heat of iron, when the rosin boils, and water and *oil of rosin* distill over together. This is crude rosin oil. It is a heavy, nearly opaque, whitish viscid fluid, opalescent on the surface.

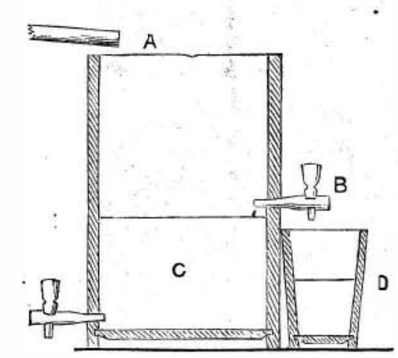
This crude *rosin oil* is rectified by redistillation, and the resulting oil is transparent, dark-red by transmitted light, with a decidedly bluish cast by reflected light. It is deeply opalescent, more so than petroleum oil.

The residuum left in the still is a black mass with a shining fracture, giving the hues of crystal aniline.

Other products still remain to be spoken of, viz., *naphtha* and *oil of tar.*

Tar when distilled yields pyroligneous acid, water, *naphtha,* or spirits of tar, and *oil of tar.* The naphtha, when purified by a second distillation, is clear and of a very pleasant terebinthinate odor. The *oil of tar* comes over in the latter part of the process, and a black residuum remains in the still resembling pitch. All but the last-named of these articles have a commercial value.

Tar is distilled in iron retorts, just as rosin is. There are many complex bodies which have come to the attention




TUB FOR SEPARATION OF TURPENTINE FROM WATER.

of the manufacturers during their operations. Some of them have been very intelligently worked out and identified by Mr. William A. Martin, the chemist of the works we have visited. Some remain to be investigated. Terebinthine products have always been exceedingly interesting chemically, and just now we are moving toward practical commercial results. I am expecting to announce, at no distant day, that we have made a sure step in the right direction.

## The English Channel Tunnel.

The works which are going on at Abbot Cliff Tunnel, between Folkestone and Dover, on the Southeastern Railway, in connection with the sinking of a shaft for testing the geological formations of the locality, with a view to the formation of a tunnel between England and France, were inspected July 20, and pronounced satisfactory by M. Léon Say and the French engineers, including M. Duval, M. Oreton, and the Count de Montebello. A shaft 90 feet deep has been sunk from the level of the engine house at high water, and a heading has been driven to the level of high water mark for the purpose of depositing the chalk. Powerful machinery has been fixed for the purpose of driving an atmospheric drill, with which it is intended to drive a heading as far as Dover, a distance of three miles, under the line of railway, the heading at Dover to be 300 feet deep. The experiments are being carried out under the direction of Colonel Beaumont and Captain English. The Southeastern Railway Company have made a grant of $30,000 for the purpose.

## Food Value of Root Crops.

Chemical analysis gives the following results with regard to the food values of different root crops:

| Total Amount of Nitrogenous or Flesh-forming Material. | Pounds. |
|---|---|
| In 1,000 pounds of potatoes | 20·03 |
| In 1,000 pounds of mangolds | 11·25 |
| In 1,000 pounds of sugar beets | 10·00 |
| In 1,000 pounds of turnips | 21·25 |
| In 1,000 pounds of carrots | 13·12 |

| Total Amount of Carbonaceous or Fat-forming Material. | Pounds. |
|---|---|
| In 1,000 pounds of potatoes | 237·4 |
| In 1,000 pounds of mangolds | 107·2 |
| In 1,000 pounds of sugar beets | 174·4 |
| In 1,000 pounds of turnips | 81·7 |
| In 1,000 pounds of carrots | 139·1 |

## THE DOWD TUNNELING SYSTEM.

FIGURES 1 and 2, see next page, illustrate the Dowd tunneling system, in perfecting which the inventor, Mr. O. B. Dowd, of 122 East Nineteenth street, New York City, has been engaged for some years past. It furnishes means of excavating for and constructing tunnels in soft and treacherous ground, and under great pressure.

The system provides a shield absolutely safe for the workmen while passing through strata of hard and soft mud, quicksand, "land-springs," poisonous gases, etc., and capable of passing bowlders and making an entrance in rock.

It provides for excavating the immense amounts of silt, clay, etc., by steam power instead of manual labor to insure rapid progress, and it provides for the construction of a tunnel with water and gastight walls, having strength even under pressure of about four tons to the square foot to allow a margin of safety of 50 to 1, and to resist constant pounding of heavy trains on its inverted arch; at the same time it has the longitudinal rigidity of a tubular bridge, so that in parts passing through "land-springs" or exceptionally soft pieces of ground there is no danger of breaking out cross sections of the tunnel. (Special attention has been called to this difficulty by able engineers, and the trouble was *practically* illustrated by the breaking out of portions of the Cleveland tunnel, under Lake Erie, the sections retaining their cylindrical form and moving several feet from line of the remaining tunnel.)

A water and gas tight joint is formed in the rear of the shield, and in the front edge of the tunnel sections afford firm and reliable support for hydraulic jacks by which the shield is propelled and guided.

Figure 1 is a longitudinal sectional elevation of a portion of a tunnel, and the shield employed in its construction. A represents a cylindrical iron shield of great weight and strength, having internal diameter slightly greater than external diameter of tunnel, B. The shield is made water-tight in front by an adjustable head (C), composed of strong

A TURPENTINE STILL.

iron sections, and has a large central opening in which is fastened by bolts, etc., the collar, D, which forms the bearing for shaft, E. This shaft carries the strong rotating steel tunneling arm, F, on each side of which are blunt edge cutting tools.

The arm is about one foot in front of shield head. G is a cog-wheel upon shaft, E, for revolving it, which is effected by two oscillating compressed air or steam engines, as shown in cut on opposite sides of the cog-wheel, G. (When steam is used the smoke-pipe is connected with the ventilating exhaust tube, to carry the smoke out of the tunnel.) Shaft E is hollow and has a tube within it extending to the junction with arm, F, and the arm has two longitudinal water passages indicated in cross-sectional view, Figure 2, by dotted lines; each is connected with the water passages shown on either side of arm, F. A tube in the shaft is arranged so that by a part revolution of it the connection can be made so as always to drive the water through the side of the arm which is moving forward.

The shield being in place, the shaft and arm are moved slowly, revolving in either direction, and small quantities of water are forced through the shaft and arm to dissolve the silt and clay as they are scraped from the heading by the cutters, and form a semi-fluid, about the consistency of thick cream, according to the amount of water forced in, so that the arm is found to move easily in this sort of disk of soft material. Between this and the head of shield another disk forms, about a foot thick, of much harder consistency, and in silt or clay remains adhering to the head of the shield. It is sometimes found desirable to force compressed air through the shaft and arm, and good results are obtained. The air disintegrates and drives the earth from the front of the arm, and forms minute bubbles, and gives greater elasticity to the silt, etc., allowing the arm to move freely.

It should be observed that no part of the disk in which the arm moves is a vacuum or air-filled space, as this can occur only in exceptionally firm silt or clay; on the contrary there is a constant pressure on all sides of the arm and on the head