contain sacred figures, or tablets inscribed with the records and precepts of the Buddhist faith. The phoonyes, who shave their heads and wear yellow robes, possess great collective wealth in the landed estates belonging to their various corporations. — *Illustrated London News*.

HOW PLANTS ARE FERTILIZED.

PROBABLY most of us are familiar with the pollen of plants, however little we may know of its nature and use. Even the most unobserving of people can scarcely fail to notice the showers of yellow and reddish pollen shed by the lilies, and many a one has had a very close acquaintance with it, when, in his eagerness to catch the odor, he has put his face too close to the flower. In fact, so abundant is the pollen, and so easily shed, that florists clip off the stamens before placing the lilies in the market. To the naked eye the pollen appears like very fine dust, usually yellow or brown, but occasionally whitish or even pink. It seems to be the same in size and form in every flower, so that one is almost entirely unprepared for the wonders revealed by the microscope. Under a powerful lens the yellow dust is seen to be made up of myriads of tiny globes, some nearly transparent, others filled with a granular substance. They are of a great variety of shapes, hardly any two being exactly alike. Some are round, others oval; some have their outer coat smooth, while we find many covered all over with prickles, as in the asters, for example. Others show belts of membrane covered with sharp points. The most common forms show three of these belts. In the accompanying drawing, Fig. 1, this may be seen in the spring beauty, *a*, oxalis, *c*, and willow, *h*. The common succory (*Cichorium intybus*), a familiar blue flower in many fields, and a nuisance to boot, has globular grains, each with a network of ridges around it, each ridge rising into jagged teeth on the outer edge.

Another curious form is that seen in the bear berry, *d*, and, it is said, in all other members of the heath family. Here we have four smooth grains united into one. Again, some grains show a central body with several small projections from the angles. Such grains may be seen in the evening primrose family and in the Shepherdia, *f*, among other plants. In some the projections may be larger than the central mass. Other common forms, seen in the accompanying illustration, are the trillium, *g*, hyacinth, *e*, and poplar, *k*. There seems to be no end to the variety of forms of the grains, though in many cases the species of the same genus seem to be nearly alike. Still this may have but little significance, for some plants of the most diverse families have pollen grains very similar. Just why these particular forms have been developed is a puzzle.

The roughness of the outer coat of the grain was mentioned above. That brings us to a more minute study of the structure of the grain. We find it to consist of a sac surrounded by two coats, the outer of which is always nearly or quite perforated in one or more points. The interior is filled with more or less granular and dissolved food matters, such as starch, oil, sugar, and dextrin. A nucleus can generally be found in the grains, and in some two.

As to size, they vary greatly, though the grains of the same species are usually pretty uniform. The largest yet examined by the writer were those of a "snake cactus," which were about 1-265 of an inch in diameter. The smallest were those of the common hazel nut, which average only 1-1050 of an inch.

A very interesting fact is that some plants have two or three forms of flowers, differing principally in the length of the style and of the stamens, and that pollen from the two forms differs in size and perhaps slightly in form. More wonderful still is the fact that the pollen of the short-styled form has very little if any effect on the flowers of the same sort, while it readily affects the stigmas of the long-styled form.

We know that the work of the pollen is to fertilize the undeveloped seeds or ovules in the pistil, but how many can tell how it is done? About the time of flowering there appears in the ovule a little sac, lined with delicate membrane, and containing a tiny globule of gelatinous matter—the germ of the future plant. Now this germ has, in itself, no power of growth. It needs to be fertilized by the pollen or it never develops.

FIG. 1.—COMMON FORMS OF POLLEN. (Largely Magnified.)

But the question at once comes up, how does the pollen get at the ovule? It can be seen sticking to the stigma, but that is often a long way from the ovules, and raised high on a slender style. Since it cannot get down to the ovule, it does the next best thing. From its inner coat grows out a tube, long or short, as the case may be, and through this flow part of the contents of the cell. This tube, as it lengthens, pushes its way down through the substance of the style till it comes to the ovule, and at length reaches the sac of which we have spoken. Here its contents become united in some way with those of the germ cell, which now begins to grow. The first step in this growth is a division of the single cell into two. These new cells keep on forming in the same way till we soon have the perfect form of the plant in miniature, still in the ovule, which has

now become a seed, capable of producing the new plant as soon as it is placed under proper conditions.

In some plants the pollen tube must gain a great length in order to reach the germ cell. One of the best examples is the "Indian corn." In this, as every one knows, the tassel on top is a cluster of many small flowers, bearing only stamens, while the cob with its grains represents a spike of ripened fruit formed from flowers bearing only pistils. The silk is the style, and in order to reach the grains, the pollen must fall on it and must send its tube down through the whole length. It is evident that the grains at the base of the cob have much longer styles than those at the tip, but, being on the outside of the tuft of silk, they stand a better chance of catching pollen grains. The grains at the tip are

FIG. 2.—POLLEN GRAINS OF WILLOW, SHOWING TUBES.

usually less well developed than the others, partly, perhaps, from their unfavorable position in the cluster of silk and partly because they mature later than the others. Notwithstanding these facts about corn, we can readily see how a hard rain storm, when the corn is just in tassel, may ruin the crop. The rain washes the pollen from the styles, and by the time more reaches them they have passed their receptive stage. The germ cell, then, never develops, and the ovules never become seeds.

A still more wonderful plant, at least as to the growth of the pollen tubes, is the night-blooming cereus. Those who have seen this know that down its pure white bell reaches a snowy white style five or six inches long, perhaps more. Of course the pollen has to send its tubes the whole length of that. Now the wonderful thing is that, inasmuch as the flowers last only a single night, the pollen tubes must grow to the ovule in the course of a few hours at most, since, as a rule, flowers do not wither till their work is done.

Any one who has the use of a compound microscope can easily watch the growth of pollen tubes for himself. There is no difficulty at all in making them grow. All that is necessary is to shake the pollen from the flowers into a solution of cane sugar, and set it in a moderately warm place. Then examine it carefully at frequent intervals with the microscope, and you can trace the different stages. Or you can sow a new lot each day and get all the stages before you at once. The writer has had greater success with native plants than with cultivated ones. A plant whose pollen shows very vigorous growth is the willow. Some grains sowed in the evening were by morning literally matted together with long tubes, so that it was almost impossible to draw them. Fig. 2 shows some of the stages in the growth of willow pollen, quite highly magnified.

Another point of very great interest, but one which we can touch only briefly here, is the manner in which the pollen is spread. In many plants it is carried by the wind, especially in trees and shrubs which bear thin flowers, high in the air. These we find, as a general rule, have small and inconspicuous blossoms. In most plants, however, the carrying of pollen is performed by insects, and to that end flowers have their bright colors, while there is no end to the wonderful contrivances for letting in the right insects and keeping out all others. — *L. N. J., in Country Gentleman*.

A BOTANICAL ATROCITY.

By MILLER CHRISTY.

AMONG all the many ingenious contrivances for effecting her various ends which Nature makes use of, none are of a more fascinating interest to the student than those by means of which the flowers of plants are fertilized and their seeds distributed over the ground to spots where they may hope to obtain a foothold—or, to speak more correctly, a roothold.

We are all of us accustomed to speak glibly of the "struggle for existence," and we are apt to think that nowhere throughout the whole wide range of nature is this struggle more severe than in the case of our own exalted species, in these days of excessive "competition" and "over-population." But a little reflection may well lead us to doubt whether this is really so, and even to perceive that the struggle is much keener with many other species than with our own. How many, for instance, of the nine millions of ova found in the roe of a single codfish ever produce a mature fish? How many, again, of the tiny wriggling tadpoles that blacken the margins of our country ponds in spring ever attain maturity as full-grown frogs? And what proportion of the seeds produced by any one plant or tree ever finds itself so fortunate as to be able to take root and grow, unsmothered by the surrounding vegetation? Probably, in all these cases, not the one hundredth part survives to reach maturity. Were it otherwise, indeed, the ocean would quickly become packed solid with codfish, the land overrun with frogs more numerous than at the time of the second Egyptian plague, and the surface of the soil entirely concealed by a dense mass of impenetrable and tangled vegetation. An "infant mortality" so prodigious, in our own species, would certainly appal even the soulless official mind of a registrar-general.

If, then, the struggle for existence is so severe in nature, it can hardly be wondered at that many exceedingly ingenious contrivances have been, in the

course of time, devised by plants in order to insure the wide dispersal of their seeds, so that each may enjoy as good a chance as possible of alighting upon some spot where there is sufficient room for it to germinate into a healthy plant. It may be truly said that, as a general rule, with all living things the chief aim and object of their lives is the perpetuation of their species by means of offspring. With plants this is well shown by the extreme ingenuity of many of the contrivances for insuring proper fertilization, and the consequent production of good seed. And it may, I think, be said with equal truth that second only in importance to this great function, the production of seeds, comes the proper dispersal of those seeds, to which end many almost equally ingenious devices have been adopted. Very many seeds are furnished with minute hooks which fasten themselves on to the wool of passing animals, and thus accomplish the great end in view; others are peculiarly adapted for dispersion by means either of wind or water; others are scattered broadcast after passing through the intestines of birds; while many plants have actually developed means for throwing their seeds to a greater or less distance. There are even some seeds which, in thus effecting their own ends, do so at the expense of living animals; but no known seeds, probably, employ means more atrociously and barbarously cruel than those employed by the seed of a species of grass known as *Stipa spartea*, which is excessively common over a large extent of the North American prairies. Briefly described, this villainous instrument is nothing more or less than an automatic vegetable corkscrew, with an exceedingly sharp point, and capable, by its own action, of boring itself into the bodies of living sheep and other animals, and of finally killing them by so doing.

The plant producing this "instrument of torture" has a very wide range of distribution in America. It inhabits the drier portions of the plains and prairies of the West, almost, if not quite, from the Mississippi River on the east to the Rocky Mountains on the west, and from Texas and Mexico on the south to the lonely Peace and Saskatchewan Rivers on the north. The great and only redeeming feature in its character is that, for purposes of pasturage, its leaves are more succulent and valuable than those of any other of the prairie grasses, and that, although too short and tussocky to be made into hay, they formerly provided the buffaloes with their chief winter forage, and now perform the same office for the tame cattle on many a Western ranch. On this account it has received, among other popular names, that of "buffalo grass"—indeed, its range in the west of America is pretty nearly co-extensive with the ancient range of the buffalo.

During autumn, winter, and spring, the buffalo grass is in all respects a most moral and respectable plant; but early in the summer, it begins to plan evil ways. First of all it throws up three or four tall flower stalks, each about a couple of feet in height, and bearing six or seven of the horrible instruments of torture already mentioned. These ripen about the middle of July, and for the next two or three weeks make themselves troublesome, not only to the lower animals, but also to man, in districts where the plant grows abundantly. It now is fully launched upon its evil ways, and begins to deserve its other popular names, as "spear grass," "oat grass," "go-devil oat," "wild oat," "needle grass," etc. As one walks over the prairie at this time of the year, suddenly there comes a sharp prick, as of a pin, on the leg, just above the ankle. Stop one must, to investigate the cause, or the pricking will become more severe, and then the traveler finds that one of these seeds, and very often several, has bored its way clear through one's trousers and sock till it has reached the flesh. With man it is an easy matter to prevent the mischief going any further, but the case is very different with sheep, woolly-haired dogs, and other animals. Those cannot rid themselves of the "spears" the moment they begin to prick, and in time the consequences begin to be serious. There is no question that the seeds are able to penetrate the skins,

AWN OF STIPA SPARTEA (IN ITS DRY OR TWISTED STATE.)

and bury themselves deeply in the flesh of these animals. When this is done, death sometimes supervenes, though oftener as a result of the extensive ulceration thus set up, than as a result of the direct action of the seeds.

Next, a word as to the structure of these unpleasant natural tormentors. In general appearance a complete seed—or, to speak with greater botanical precision, a complete "fruit"—a good deal resembles a twisted piece of wire having several slight bends in it and being rather thicker in some places than in others. The seed proper is elongated, brown in color, somewhat less than an inch in length, and generally not very unlike a harmless oat in its appearance. At one end, however, it is provided with an excessively fine, sharp point, surrounded with many delicate barblike hairs, point-

ing backward; while at the other end it is produced into a stiff, slender awn, or shaft, rather less than two inches in length. This portion is usually quite straight, though always sharply twisted up upon its own axis, seven or eight revolutions being usually observable. At the top of the shaft there is a bend, usually somewhat larger than a right angle, which is termed the "lower knee," and in about half an inch another sharper bend, which has been called the "upper knee," after which the awn is still further produced into a stiff tapering bristle, somewhat less than three inches in length, entirely untwisted, and set with many exceedingly minute but sharp teeth, all pointing backward. The whole apparatus, for such it may be called, is thus about six or seven inches in length. A glance at the accompanying illustration, however, will give a clearer idea of the seed than the most elaborate description. The foregoing is a description of the instrument when in a perfectly dry state. On its becoming wet, the "hygrometric action" of the awn (as it is called) comes into play, and the appearance of the whole contrivance quickly becomes changed. The shaft then begins to untwist, the knees commence to straighten, and in a short time the whole awn becomes perfectly straight from end to end, so to remain until it is again dried, when the former twisted and bent condition is resumed. This curious power of untwisting and straightening itself when moistened, and of again twisting up when dried, seems to continue for an almost indefinite time—probably until the awn commences to undergo natural decay. It is a power which is also possessed, though in a less fully developed degree, by various other seeds. In most, if not all, of the members of the genus *Stipa*, in several other grasses, in some of the Erodiums, and even in the common wild oat, this curious hygrometric peculiarity of the seed is observable.

Let us examine how this power aids the seed in its nefarious designs. It is in this way. Suppose a ripe awn, in its dry or twisted state, to have become entangled in the wool of a sheep, or to have fallen among the grass. It there remains inactive, until moistened by a shower of rain or a heavy dew. Then, as we know, the shaft commences to untwist, rotating the point of the seed; for, as the bristle or arm of the awn forms at first a right angle with the shaft, it is certain to catch in the grass or wool, and thus prevent the head of the shaft from revolving as it untwists. But all this time, as we also know, the "knees" are straightening, raising the arm and causing it to press upward. In rising it will probably press against a blade of grass or catch in the wool, its many fine teeth affording it a more or less firm hold upon either. Under these circumstances, the continued efforts of the arm to rise will have the effect of pressing forward the revolving point of the seed, causing it to penetrate slowly and by degrees into the flesh of the animal, the ground, or any other sufficiently soft substance which may be opposed to it. Thus our automatic boring apparatus will be in full operation. Having penetrated to a slight depth, the barb-like hairs round the point prevent it being withdrawn when the awn retwists on again becoming dry; so there it remains, ready to penetrate further and further as often as succeeding drought and moisture cause the awn to twist and untwist again.

There is, as has been already said, no question that the seeds are in this way able to penetrate the skins of animals and actually enter the body. On the plains of the West its possession of this power is well known, and I have myself often seen and heard of instances of its effect. I have never, it is true, actually seen a sheep that had been thus killed, because sheep are not allowed to die of it, but are killed for the butcher. There is, however, not the least question that the seeds have the power of causing death, either directly or indirectly. A recent American writer, speaking of this subject, says that, after the seeds have penetrated the skin, "the awns break off, and the needles penetrate the vital part of the sheep, causing painful death. . . . The points, too, not only enter the body of the sheep in this way, but also stick in the nostrils, nose and lips, where, however, they do less harm than when eaten and swallowed into the stomach, in which event death must follow." I have been repeatedly assured when "out West," by butchers and others, that the "spears" are very commonly found beneath the skins of sheep after death—especially about the shoulders; indeed, I have myself seen them in this position, while I have been several times told by settlers of sheep they had been compelled to kill, "to save their lives," as Irishmen are supposed to say. I have, moreover, demonstrated that the seeds do possess this power by experiment in England. Some seeds, which I placed among the wool of two sheep, quickly penetrated to a depth of half an inch, after which I removed them, thinking that the animals were probably less interested than myself in the result of my experiment. Indeed, the keeping of sheep on the Western prairies would be rendered almost impossible, on account of the prevalence of this deadly grass, were it not for the fact that its evil effects can be avoided by a few simple precautions, such as a careful examination of the sheep during the time the seed is ripe, or "folding" them during the same period.

But sheep are not the only animals that suffer. Woolly-haired dogs are almost equally troubled, if proper care be not taken. I have heard of such dogs having, like the sheep, to be killed "to save their lives," when the whole of the breast and stomach has been found to be a mass of ulceration. I have also heard of a colly, which came so thoroughly to understand the nature of the "spears," that he would never enter the long grass while they were ripe; while one settler told me that he had found it necessary to shave his dog all over when the "spears" were ripe, to prevent their catching in his long matted hair.

Now, could any epithet be too strong to describe correctly a seed which conducts itself in such an atrocious manner? I think not. It must however be confessed that it is a little difficult to see exactly how the plant is benefited by its seeds being introduced into the bodies of animals. Their dispersal would, it is true, be usually assured, but the great object of that dispersal—namely, germination—would probably be deterred, unless it be that the seed has some strange power of retaining its vitality for a long period after its burial in the flesh of a sheep. It can hardly be supposed that the seeds are intended to grow there, or we should be presented with the strange spectacle of the sheep growing their favorite food on their own bodies! But this is too absurd.

It may, perhaps, be that the simple and beautiful piece of mechanism possessed by the seed of *Stipa spartea* is simply to enable it to bury itself securely in the ground where it may take root—to sow itself, in fact; but if so, what shall be said of the plant which uses such a power for such murderous purposes as have been described! The whole matter is not yet quite cleared up.—*Knowledge*.

HIGH METEOROLOGICAL STATIONS.

EUROPE cannot compete with the United States in the loftiness of its stations for taking meteorological observations. There are only two stations on the European continent which reach any very great height, being about 10,000 feet and 11,000 feet respectively. Among the stations in America is Pike's Peak, which has an altitude of 14,100 feet—or only about 1,600 feet lower than the summit of Mont Blanc—and exceeding by more than 3,000 feet any meteorological station in Europe. These great heights are much more accessible in the United States than in Europe, there being five stations in America where a height of 11,000 feet or more is reached by railroads built for facilitating mining work. The highest of those in North America is Mount Lincoln, in Colorado, the mining works on which are 14,297 feet above the sea level, and it has a meteorological station conducted by Harvard College. Another station is placed part way up the mountain, at a height of 13,500 feet. In the Andes range, in Peru, continuous meteorological observations are also carried on, the loftiest point for this purpose being 14,300 feet above the level of the sea.

A New Catalogue of Valuable Papers

Contained in SCIENTIFIC AMERICAN SUPPLEMENT during the past ten years, sent free of charge to any address. MUNN & CO., 361 Broadway, New York.

THE SCIENTIFIC AMERICAN Architects and Builders Edition.

\$2.50 a Year. Single Copies, 25 cts.

This is a Special Edition of the SCIENTIFIC AMERICAN, issued monthly—on the first day of the month. Each number contains about forty large quarto pages, equal to about two hundred ordinary book pages, forming, practically, a large and splendid Magazine of Architecture, richly adorned with elegant plates in colors and with fine engravings, illustrating the most interesting examples of modern Architectural Construction and allied subjects.

A special feature is the presentation in each number of a variety of the latest and best plans for private residences, city and country, including those of very moderate cost as well as the more expensive. Drawings in perspective and in color are given, together with full Plans, Specifications, Costs, Bills of Estimate, and Sheets of Details.

No other building paper contains so many plans, details, and specifications regularly presented as the SCIENTIFIC AMERICAN. Hundreds of dwellings have already been erected on the various plans we have issued during the past year, and many others are in process of construction.

Architects, Builders, and Owners will find this work valuable in furnishing fresh and useful suggestions. All who contemplate building or improving homes, or erecting structures of any kind, have before them in this work an almost endless series of the latest and best examples from which to make selections, thus saving time and money.

Many other subjects, including Sewerage, Piping, Lighting, Warming, Ventilating, Decorating, Laying out of Grounds, etc., are illustrated. An extensive Compendium of Manufacturers' Announcements is also given, in which the most reliable and approved Building Materials, Goods, Machines, Tools, and Appliances are described and illustrated, with addresses of the makers, etc.

The fullness, richness, cheapness, and convenience of this work have won for it the Largest Circulation of any Architectural publication in the world.

MUNN & CO., Publishers,
361 Broadway, New York.

A Catalogue of valuable books on Architecture, Building, Carpentry, Masonry, Heating, Warming, Lighting, Ventilation, and all branches of industry pertaining to the art of Building, is supplied free of charge, sent to any address.

Building Plans and Specifications.

In connection with the publication of the BUILDING EDITION of the SCIENTIFIC AMERICAN, Messrs. Munn & Co. furnish plans and specifications for buildings of every kind, including Churches, Schools, Stores, Dwellings, Carriage Houses, Barns, etc.

In this work they are assisted by able and experienced architects. Full plans, details, and specifications for the various buildings illustrated in this paper can be supplied.

Those who contemplate building, or who wish to alter, improve, extend, or add to existing buildings, whether wings, porches, bay windows, or attic rooms, are invited to communicate with the undersigned. Our work extends to all parts of the country. Estimates, plans, and drawings promptly prepared. Terms moderate. Address

MUNN & CO., 361 BROADWAY, NEW YORK.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, \$5 a year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, \$2.50 stitched in paper, or \$3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, \$7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

	PAGE
I. BIOLOGY.—On Tortoise (<i>Chrysemys picta</i>) with Two Heads.—By E. H. BARBOUR.—A curious freak in nature described, with illustrations of the normal type and of the monstrosity.—4 illustrations.....	10690
II. BOTANY.—A Botanical Atrocity.—By MILLER CHRISTY.— <i>Stipa spartea</i> , a variety of grass which by its seed or awn produces the death of large animals.—1 illustration.....	10693
How Plants are Fertilized.—An interesting study in plant life and of the process of seed production.—2 illustrations.....	10693
III. CHEMISTRY.—Filtration with Filters of Metallic Felt.—By CHARLES H. MUNROE.—An ingenious and original suggestion in laboratory manipulation, with table of results.....	10699
IV. CIVIL ENGINEERING.—Covered Reservoirs.—By CHARLES H. SWAN.—A discussion of the expediency of covering reservoirs, and the need for it in different countries.....	10693
On Variable Load, Internal Friction, and Engine Speed and Work.—By ROBERT H. THURSTON.—An elaborate review of the conditions of prime motor economy, with numerous tables of tests of engines and illustrations of the same with indicator curves.—5 illustrations.....	10684
V. ELECTRICITY.—Electric Lighting in America.—By Prof. GEORGE FORBES.—An English view of the progress of electric lighting in this country in its most recent developments, with special reference to the Westinghouse alternating system.....	10682
VI. MISCELLANEOUS.—Nature's Barometers.—Prognostications of the weather as furnished by birds, animals, and other natural signs.....	10688
Some Experiences with Birds.—A charming paper, giving experiences with European birds, by a bird lover.....	10691
Statue of Buddha.—The colossal statue of Buddha at Mandalay illustrated and described.—1 illustration.....	10692
The Geiser-Thingvalla Collision.—Description of the collision, with view of the Thingvalla after the accident.—1 illustration.....	10690
The Great Lakes.—High and low water level in the great lakes.—Its relations to rainfall and threatened interference with navigation.....	10687
VII. PHOTOGRAPHY.—Reducing the Density of Negatives by Various Agents.—By Dr. CHARLES EHRLMANN.—The various agents for reducing density discussed, with comparison of the results attained.....	10681
VIII. PHYSICS.—The Graphophone and Phonograph.—A very full account of the inventions of Edison, Bell, and Tainter, with complete illustrations of the rival talking machines.—11 illustrations.....	10679
The History of a Scientific Doctrine.—By S. P. LANGLEY.—The beginning of Prof. Langley's memorable paper read at the Cleveland meeting of the American Association, reviewing the history of the undulatory theory of life.....	10689

Useful Engineering Books

Manufacturers, Agriculturists, Chemists, Engineers, Mechanics, Builders, men of leisure, and professional men, of all classes, need good books in the line of their respective callings. Our post office department permits the transmission of books through the mails at very small cost. A comprehensive catalogue of useful books by different authors, on more than fifty different subjects, has recently been published, for free circulation, at the office of this paper. Subjects classified with names of author. Persons desiring a copy have only to ask for it, and it will be mailed to them. Address,

MUNN & CO., 361 Broadway, New York.

PATENTS.

In connection with the Scientific American, Messrs. MUNN & Co. are solicitors of American and Foreign Patents, have had 42 years' experience, and now have the largest establishment in the world. Patents are obtained on the best terms.

A special notice is made in the Scientific American of all inventions patented through this Agency, with the name and residence of the Patentee. By the immense circulation thus given, public attention is directed to the merits of the new patent, and sales or introduction often easily effected.

Any person who has made a new discovery or invention can ascertain, free of charge, whether a patent can probably be obtained, by writing to MUNN & Co.

We also send free our Hand Book about the Patent Laws, Patents, Caveats, Trade Marks, their costs and how procured. Address

MUNN & CO.,
361 Broadway, New York.

Branch Office, 622 and 624 F St., Washington, D. C.