SCIENTIFIC AMERICAN

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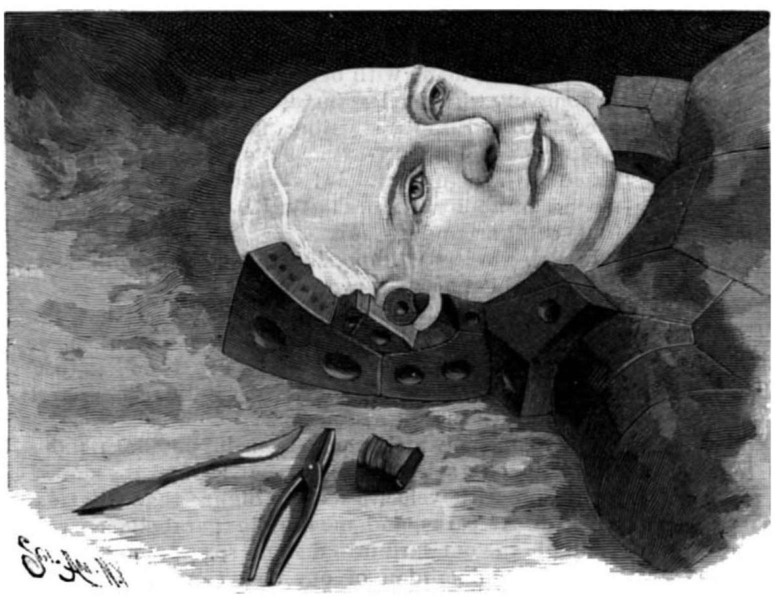
Vol. LXIV.—No. 26.] ESTABLISHED 1845. NEW YORK, JUNE 27, 1891. [$3.00 A YEAR. WEEKLY.

CASTING THE HENRY WARD BEECHER STATUE FOR THE CITY OF BROOKLYN.

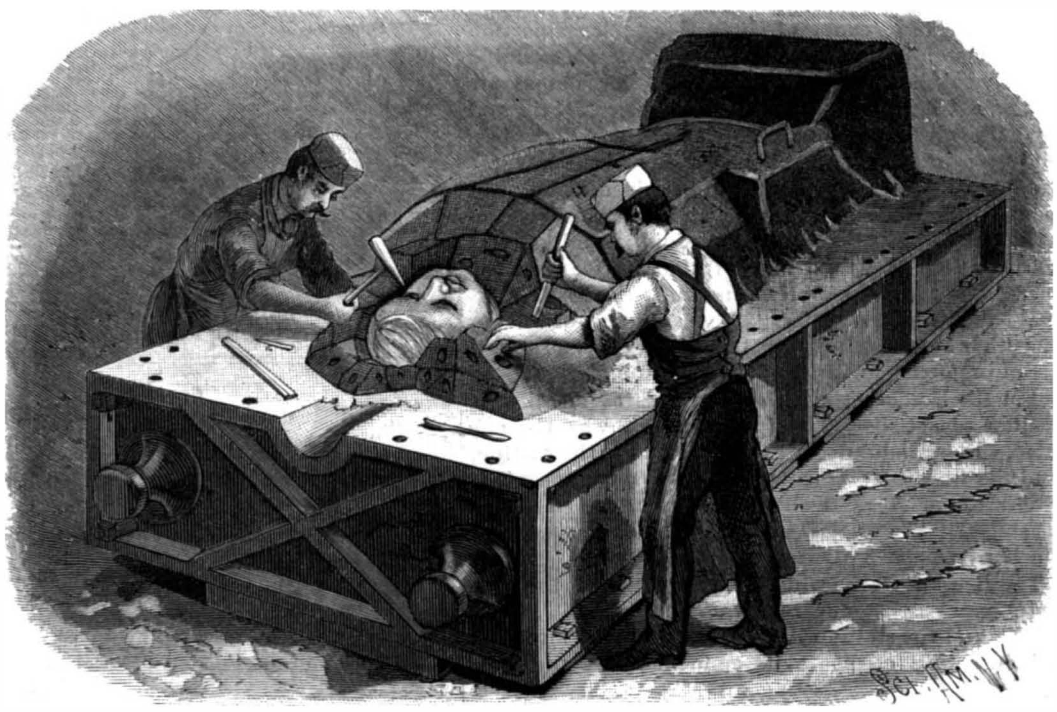
The Henry-Bonnard Bronze Company, of this city, have recently completed the casting of a statue of the late Henry Ward Beecher, to be erected in front of the Brooklyn City Hall. The statue is remarkable as being cast practically in a single piece, the head being of one piece with the body. Originally metallic statues were made in small pieces and were united by rivets or soldering. Some were cast solid. The present practice is to cast them hollow, and as thin as possible. This secures rapid cooling and tends to prevent any separation of the constituents of the alloy. It also economizes in metal.

The first step in making a statue is the production of the plaster model. This is supplied by the artist, and it comes from his studio of the exact size required for the final statue. The original studies in the case of colossal statues such as the present may be very small, but before the artist is done with his work, the full sized model is produced.

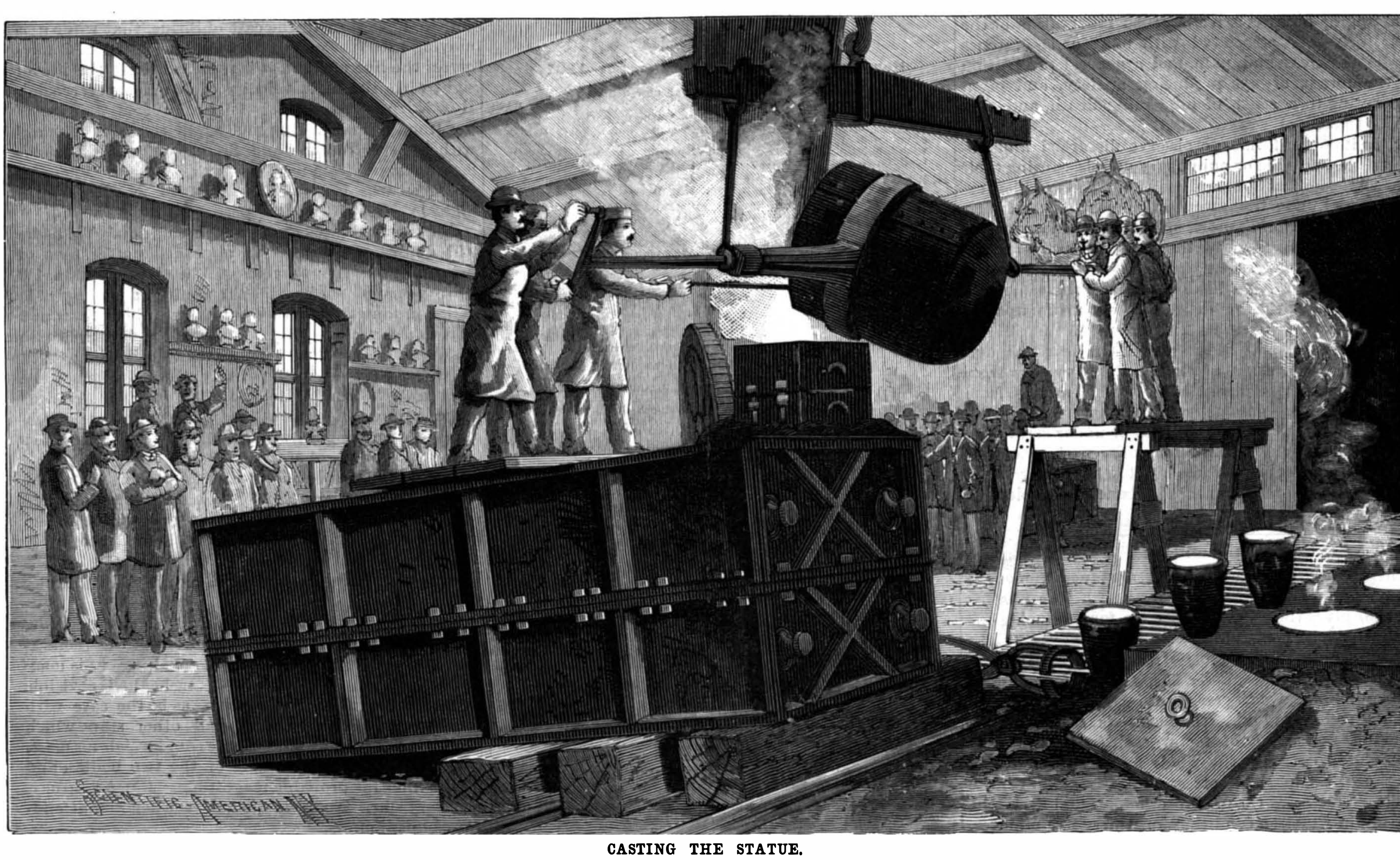
In the present case the statue was to be about nine feet high. The area of the flask in which the mould was to be made was seven feet four inches wide by thirteen feet six inches long. The model was established upon the lower section of the flask and the work of building up the mould began. The sand used is mined in France. It possesses to a high degree the property of consolidating, yet is very porous. A famous bed of the material is at Fontenay-aux-Roses, about 16 miles from Paris. This is compacted by wooden mallets and hand rammers of different shapes. As the artist produces his statue without any reference to its capacity for "drawing" from the mould, the bronze founder has to adapt his work to the most exacting conditions of undercutting and complicated outlines. The mould is therefore built up in very numerous sections, some of them extremely small. An exact count was not kept, but in the present statue between one thousand and fifteen hundred pieces were used in the mould. In one of the cuts, where the operation of moulding the head is shown, the idea of the subdivision of the mould appears. It will be seen that its sections represent irregularly shaped bricks, all fitting together with the utmost nicety and accuracy. The statue is eventually completely embedded in clay. The mould has now to be opened up, the edifice



MAKING THE MOULD.



TAKING THE MOULD TO PIECES.



CASTING THE STATUE.

CASTING THE STATUE OF HENRY WARD BEECHER.

of over a thousand sections is carefully taken down and the model is lifted from its resting place upon the lowest flask section. The mould is next rebuilt, the inner surface receiving a coating of foundry facing, and the interior is rammed full of clay to form the core. This core need not be solid. Some spaces may be left in it for the gases to collect in. Thus the mould is a second time complete and intact, but is filled with a clay figure instead of a plaster one.

The mould is a second time dismantled and the core is taken in hand. From its entire surface a layer of clay is removed, to average, as nearly as possible, one quarter of an inch in depth. This delicate operation provides the space for the metal to occupy in the casting process. This core thus reduced in size is replaced upon the flask and is properly supported. The mould is a second time built up, surrounding in this case the reduced core. A number of channels or gates are worked in the mould to allow the metal to run through to different parts of the figure. These resemble somewhat the trunk and branches of a tree. They start of comparatively large section near the pouring reservoir, and fork and diminish repeatedly, reaching the space between core and mould in many places. When all is perfectly dry, and the flask filled with sand so as to hold all the pieces in place, the operation of casting is proceeded with. In the present case seventeen weeks were required for the moulding.

The process of casting a bronze statue is executed either by surface or bottom casting. In the latter method a reservoir is arranged over the gates, which reservoir is large enough to hold all or a large portion of the metal. It has holes in its bottom corresponding exactly to the gates in the mould. These holes are plugged. The metal is poured into the reservoir, and by withdrawing the plugs the metal runs down into the space in the mould. The Beecher statue was cast by surface pouring. The metal held in crucibles was poured directly into the gates. This enabled a constant watch to be kept upon its fluidity and general nature as far as shown in its fusion. A man, as the metal was poured, kept scraping back all scoria, slag, and oxide from its surface. The adoption of one or the other system of pouring the metal rests, as a matter of preference, with the individual founder.

For the Beecher statue 7,400 pounds of metal were melted repeatedly. The fourth fusion was the one used. Eleven minutes were occupied in the casting, and the finished statue weighed 3,600 pounds. The rest of the metal represented the contents of the gates, waste, etc. The alloy was composed of copper 90 parts, tin 10 parts, zinc 3 parts.

The Beecher statue will be unveiled about the time this paper reaches our readers. The artist is J. Q. A. Ward, and the statue will, in the artistic and mechanical sense, be a credit to its eminent artist and to its founders.

Angina Pectoris—Its Nature.

Dr. R. Douglas Powell, in *The Practitioner*, argues that angina pectoris is a disturbed innervation of the heart or vessels, associated with more or less intense cardiac distress and pain, and a general prostration of the forces, always producing anxiety, and often amounting to a sense of impending death, and concludes that :

1. In its purer forms we observe disturbed innervation of the systemic or pulmonary vessels, causing their spasmodic contraction, and consequently a sudden extra demand upon the propelling power of the heart, violent palpitation or more or less cramp and paralysis ensuing, according to the reserve power and integrity of that organ—*angina pectoris vasomotoria.*

2. In other cases we have essentially the same mechanism but with the extra demand made upon a diseased heart—*angina pectoris gravior.*

3. The trouble may commence at the heart through irritation or excitation of the cardiac nerves, or from sudden accession of anæmia of cardiac muscle from coronary disease—*primary cardiac angina.*

4. In certain conditions of blood or under certain reflex excitations of the inhibitory nerves, always, however, with a degenerate feeble heart in the background, we may observe intermittence in its action prolonged to syncope—*syncopal angina.*

Artificial Gold.

There are a great many metallic substances known for producing metal closely resembling gold. The *Western Jeweller* gives the following formula for producing one of the artificial gold substances :

Take 100 parts (by weight) of pure copper, 14 parts zinc or tin, 6 parts magnesia, 56 parts sal ammoniac, 18 parts quicklime, 9 parts cream of tartar. Melt the copper, and add gradually the magnesia, sal ammoniac, quicklime and cream of tartar, each by itself, in the form of powder. Stir the whole for half an hour, add the zinc or tin in small pieces, and stir again till the whole is melted. Cover the crucible, and keep the mixture in a molten condition for thirty-five minutes. Remove the dross, and pour the metal into moulds. It has a fine grain, is malleable, and does not easily tarnish.

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Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF

SCIENTIFIC AMERICAN SUPPLEMENT

No. 808.

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ARCTURUS.

This brilliant star in the constellation of Bootes, now visible nearly overhead in the evening hours, was the subject of a very interesting lecture by Mr. Wm. H. Knight, recently delivered before the Cincinnati Society of Natural History. We give herewith a few extracts from the paper, which will appear in full in our next week's issue of the SUPPLEMENT:

Within the last two or three years a new and surprising value has been given to the parallax of Arcturus by Dr. Elkin, the astronomer of Yale University. Previous to his work at Yale he had acquired a reputation for painstaking observations and accurate results in the British observatory at the Cape of Good Hope. Equipped with a 7" heliometer provided with the latest improvements, he set himself the task of measuring the parallax of several prominent stars. Devoting himself specially to Arcturus, from no less than 89 observations, taken in connection with 10 comparison stars, he deduced the very small parallax of $\frac{18}{1000}$ or about $\frac{1}{56}$ of a second of arc, which is equivalent to a distance of 181 light years. This minute parallax (which is assumed to be approximately correct by other astronomers), combined with its large proper motion, gives Arcturus the tremendous velocity of 381 miles per second—a distance 40 miles greater than that which separates Cincinnati from St. Louis. Imagine a body moving from this city to the Mississippi River between the ticks of a clock.

Now, Dr. Elkin admits that there is what is technically called a "probable error" in his observations, but that error is + or —, and would be as liable to make the value of the parallax less than the figure named as to make it more. So that while the velocity of Arcturus *may* be 50 or even 100 miles less per second than computed, it may *possibly* be 50 or 100 miles more.

But until we get new data, based on more extended observations, made with better instruments, we may, in company with the leading astronomers of the world, accept Dr. Elkin's startling figures, and consider Arcturus as 181 light years away, and rushing through space with the unparalleled velocity of 381 miles per second, or about 21 times faster than the earth travels in its orbit around the sun.

Is such a velocity impossible? Is it incredible? Is unreasonable?

It has been mathematically demonstrated that the velocity with which matter, drawn from distant space, would fall upon the surface of the sun is no less than 383 miles per second, a velocity, it will be seen, almost identical with that of Arcturus.

Many comets which come from interstellar regions and visit our solar system sweep around the sun at perihelion with velocities even higher than that ascribed to Arcturus, and, moving in parabolic curves, again plunge outward into distant space, and passing beyond the dominion of our own sun, enter that of some other mighty star.

Thus far I have been considering the velocity of Arcturus *perpendicular* to or *across* the line of sight. But we have seen in the case of Sirius, that while it is moving with the comparatively low speed of 9 miles *across* the line of sight, it is receding *along* the line of sight with the high velocity of 20 miles per second. How is it with Arcturus? Is he approaching or receding from us? Mr. Huggins again comes to our aid with his spectroscope, and finds that, while Sirius is moving *away* from us at the rate of 20 miles per second, Arcturus is rushing down *upon* us with the far higher velocity of 55 miles per second.

But we need have no fear of a collision. While he will doubtless continue to approach us for tens of thousands of years to come, till he arrives within 140 light years or so, he will then, after a computable period gradually and then rapidly recede from us and from our part of the sidereal universe, and pursuing an unswerving course, with unabated velocity, he will, in a few million years, pass entirely out of the ken of the most powerful earthly telescope. For, while Arcturus is now approaching us at the rate of 55 miles per second, he is moving athwart our line of vision 381 miles in the same moment of time.

But *part* of that apparent motion of approach on the part of Arcturus is caused by the movement of our *own* sun, which, with its train of attendant worlds, swinging along through space at the estimated rate of 15 miles per second. Its course is directed toward the constellation Hercules, between Acturus and the Milky Way.

And now, having obtained some idea, however crude, of the great distance and rapid motions of this remarkable star, we are curious to learn something of his magnitude and physical structure. If he had a visible companion circling around him, as is the case with Sirius, Alpha Centauri, and some other stars which exhibit a measurable parallax, we could weigh his mass, or rather the combined mass of the two bodies, and thence infer his probable magnitude. But Arcturus is a solitary star. No telescope has revealed any attendant companion.

Our only resource, then, is to compare his light-giving power with that of other luminous bodies, and accept such conclusion as may be fairly drawn.

There are three well defined classes of stars, judged by the quality of light they yield. In the first class are the clear white and bluish white stars like Sirius and Vega. These are supposed to be the hottest stars and the most luminous in proportion to the extent of their surface. Then there are the golden yellow or pale orange stars, of which Arcturus and Capella are fine examples. These have begun to cool. Finally, we have the deep orange and red stars like Aldebaran and Antares. These have advanced still further in the cooling processs.

Now the spectroscope informs us that our sun belongs to the orange or Arcturus type, and if we could view it from distant space, we should see a lovely star of a pale golden yellow. The question arises, then, how far would our sun have to be removed in order to shine with a brightness no greater than that of Arcturus? According to Mr. Maunder, it would have to be removed to 140,000 times its present distance, or about half the distance between us and Alpha Centauri.

But Arcturus is 11½ million times as far away as the sun, and if our sun were placed at that enormous distance, its diameter would have to be 82 times as great in order to give a light equal to that received from Arcturus. I hesitate to present such figures, implying magnitudes far beyond any to which we have been accustomed, yet they are but the logical deductions of observed facts. In other words, upon Mr. Maunder's reasonable assumption, Arcturus must be a gigantic sphere, 550,000 times larger than our sun, with a diameter of seventy million miles, or more than large enough to fill the entire orbit of Mercury.

To make this contrast clearer, let us institute a simple comparison. Jupiter is larger than all the other planets and satellites of the solar system. The sun is a little more than 1,000 times larger than Jupiter. But Arcturus, if our inference is correct, is 550,000 times larger than the sun. By the side of such a majestic orb, our sun, grand and overwhelming as he is in our *own* system, would dwindle to an insignificant star.

Contemplating a world so vast, endowed with such mighty energies, and rushing with such resistless force through the great deeps of space, we cannot resist the questions: Whence came this blazing world? Whither is it bound? What is its mission and destiny? Is it simply a visitor to our sidereal galaxy, rushing furiously through it like a comet? Is it being constantly fed and enlarged by the worlds it encounters and the meteoric matter it gathers up in its wonderful journey? What would be the effect if it chanced to pass through a nebula or a star cluster? Was the new star which suddenly blazed forth in the nebula of Andromeda in 1876 due to a similar cause?

As this mighty aggregation of attractive energies sweeps along his celestial path, thickly bordered with stellar worlds, how many of those worlds will yield forever to his disturbing forces? How many will be swerved from their appointed courses by his irresistible power? How many will plunge into his fiery bosom and be swallowed up as a pebble is swallowed by the ocean?

Are there many great suns like Arcturus, flying on their special missions through space? The late Dr. Croll, in his work on "Stellar Evolution," published two years ago, conjectures that the original constituent bodies of the universe were endowed *ab initio* with high velocities, and that in their swift journeys through space each eventually comes into collision with one of his fellows.

The terrific impact of two bodies moving with a velocity of tens and even hundreds of miles per second transforms the energy of motion into heat, and both worlds are shattered into fragments, melted as in a furnace, and dissipated into luminous gas. And thus a nebula is formed which fills vast regions of space and is ultimately, in the lapse of untold ages, evolved into new systems of worlds.

Sublime as is our theme—a universe of mighty worlds, wonderful as is the complexity of their motions and influences, mysterious as is that power which pervades and rules the whole, more sublime, more wonderful, more mysterious is the human mind, which, from the standpoint of this little world, a mere speck in the great domain of creation, reaches out to the utmost bounds of the universe, formulates its laws, reconstructs its past, forecasts its future, and dauntlessly grapples with the varied problems of atoms and stars, matter and force, time and space, eternity and infinity.

The New Smithsonian Astro-Physical Observatory.

We learn from Dr. S. P. Langley, secretary, that there has been established as a department of the Smithsonian Institution a Physical Observatory, which has been furnished with specially designed apparatus for the prosecution of investigations in radiant energy and other departments of telluric and astrophysics. The communication of new memoirs bearing in any way on such researches is requested, and for them it is hoped that proper return can be made in due time.

POSITION OF THE PLANETS IN JULY.

MARS

is evening star until the 30th, and then morning star. He comes to the front on the July annals, for an important epoch in his course occurs during the month. He is in conjunction with the sun on the 30th, at 2 h. 41 m. A. M., being so near the sun as to be hidden in his rays, and also at his greatest distance from the earth. He passes at that time from the eastern to the western side of the sun and commences his course as morning star, slowly increasing in size and slowly approaching the earth, until his career as morning star culminates in the long anticipated opposition of August 4, 1892. Our ruddy neighbor is then nearer than he has been for fifteen years, or than he will be again for seventeen years. Months must pass before Mars becomes visible, but his movement though slow is sure, and the time is none too long to make a study of this interesting planet, the only member of the solar family whose real surface is revealed by the telescope.

The right ascension of Mars on the 1st is 7 h. 20 m., his declination is 23° 15′ north, his diameter is 3″.8, and he is in the constellation Gemini.

Mars sets on the 1st at 8 h. 5 m. P. M. On the 31st he sets at 7 h. 13 m.

MERCURY

is morning star until the 7th, and then evening star. He is in superior conjunction with the sun on the 7th, at 1 h. 18 m. A. M., when the smallest member of the solar brotherhood passes from the western to the eastern side of the sun and commences to oscillate eastward from the sun, in obedience to the law that regulates the movements of the inferior or inner planets. He meets Mars on the way, and the planets are in conjunction on the 11th, at 7 h. P. M., Mercury being 41′ north.

The right ascension of Mercury on the 1st is 6 h. 22 m., his declination is 24° 10′ north, his diameter is 5″.2, and he is in the constellation Gemini.

Mercury rises on the 1st at 4 h. 5 m. A. M. On the 31st he sets at 8 h. 13 m. P. M.

JUPITER

is morning star. He is by far the most distinguished member of the brotherhood on the July list. He passes no important epochs in his course, and he has no meetings or partings with other planets on the celestial road. He is simply a superb star, increasing in size, and rising earlier every evening, at 10 o'clock on the middle of the month and at 9 o'clock when the month closes. Observers who command a view of the southeast horizon should watch for the appearance of this regal planet, as he looms suddenly above the horizon, like a young moon, and shines the brightest of the radiant throng that cluster in the nightly sky.

The moon is in conjunction with Jupiter three days after the full on the 24th, at 2 h. P. M., being 3° 56′ south.

The right ascension of Jupiter on the 1st is 23 h. 18 m., his declination is 5° 53′ south, his diameter is 41″.6, and he is in the constellation Aquarius.

Jupiter rises on the 1st at 10 h. 54 m. P. M. On the 31st he rises at 8 h. 55 m. P. M.

VENUS

is morning star. The movements and position of Venus are in striking contrast with those of Jupiter. She is approaching and he is receding from the sun. She is nearly at her greatest, and he is nearly at his least distance from the earth. She is nearly at the minimum of her size and brilliancy, while he is approaching the culmination of his radiant career. Venus will be greatly missed in the summer evening sky.

The moon makes a close conjunction with Venus on the 4th, the day before her change, at 6 h. 2 m. A. M., being 2° 7′ north.

The right ascension of Venus on the 1st is 5 h. 14 m., her declination is 22° 20′ north, her diameter is 11″.0, and she is in the constellation Taurus.

Venus rises on the 1st at 3 h. 4 m. A. M. On the 31st she rises at 3 h. 49 m. A. M.

SATURN

is evening star. He is on the meridian on the 1st at 4 h. 20 m. P. M., so that he is well advanced on his western way when it is dark enough for him to be visible. He retains his position in regard to Jupiter, being nearly opposite to him, one planet setting as the other rises. The difference is seven minutes on the first of the month, and there is no difference on the last day of the month.

The moon is in conjunction with Saturn when five days old, on the 10th, at 4 h. 31 m. P. M., being 3° 25′ north.

The right ascension of Saturn on the 1st is 10 h. 58 m., his declination is 8° 44′ north, his diameter is 15″.8, and he is in the constellation Leo.

Saturn sets on the 1st at 10 h. 47 m. P. M. On the 31st he sets at 8 h. 55 m. P. M.

URANUS

is evening star. He is in quadrature with the sun on the 20th, at 5 h. A. M., being 90° east.

The right ascension of Uranus on the 1st is 13 h. 42 m., his declination is 10° 1′ south, his diameter is 3″.6, and he is in the constellation Virgo.

Uranus sets on the 1st at 0 h. 25 m. A. M. On the 31st he sets at 10 h. 28 m. P. M.

NEPTUNE

is morning star. His right ascension on the 1st is 4 h. 25 m., his declination is 20° 4′ north, his diameter is 2″.6, and he is in the constellation Taurus.

Neptune rises on the 1st at 2 h. 26 m. A. M. On the 31st he rises at 0 h. 31 m. A. M.

Mars, Mercury, Saturn, and Uranus are evening stars at the close of the month. Venus, Jupiter and Neptune are morning stars.

THE POISONOUS SNAKE OF FLORIDA.

A workman at Oakland, Orange Co., Florida, recently died from the effects of a bite received from a supposed harmless snake. The man had captured a small snake and handled it for ten or fifteen minutes, during which time he received a bite on one hand, giving him no pain at the time. Finally killing the snake, the man returned to his work.

About half an hour later pains came on in his hand and arm, followed by drowsiness and a dull pain in the head. The man quit work, saying he would lie down, and probably be at work again in a short time. He continued to feel drowsy, and a fullness of the eyelids, with a partial loss of control of muscular action of the same, was noticed.

At this point a doctor was called, who did all he could to counteract the effects of the poison, but his every effort proved unsuccessful, and the unfortunate man finally died eighteen hours after receiving the bite.

The snake was called a harmless garter or king snake. It was small and its body was circled with bright-colored bands. But an examination of its mouth disclosed two small fangs in the upper jaw. Our informant says: "Thus it seems this bright-colored, sluggish, meek little snake that we have regarded as harmless as a tadpole is one of the most dangerous of our reptile foes."

From the description received, and a residence of over twelve years in Florida, during which time I devoted much attention to herpetology, I can state positively that the snake in question was the coral snake, *Elaps distans*, also called the "Florida harlequin snake."

Its habitat is the Gulf States and Mexico. It is different from all other North American poisonous snakes in that it has not a well-defined neck, and that its tail tapers to a fine point. All other poisonous snakes in this country have large angular heads and blunt tails. The coral snake also lacks the "poison pit" of the rattlesnake, moccasin, and copperhead—a small orifice about midway between the eye and nostril on either side. This "pit" is connected with the poison sac, but its use has never been satisfactorily explained. As in the case of the coral snake, all poisonous snakes do not have the "pit," but every snake possessing it is armed with deadly fangs.

The color of the coral snake is varied with bright bands of black, white or yellowish white, and coppery red. It is rarely over eighteen inches in length (usually much less), and one-half or three-fourths of an inch in diameter. It is not common in Florida or the Gulf States.

There is another quite common snake in Florida which very closely resembles the coral snake, both in color and size. It is marked with brilliant bands of red, yellow, and black. It is called a garter snake, band snake, etc., by the natives, and by some it is thought to be poisonous. It is entirely harmless, however, and without fangs, as repeated examinations by myself and others clearly proved.

S. Weir Mitchell, in an article on "The Poison of Serpents," appearing in the *Century Magazine* of August, 1889, incidentally refers to the coral snake as "the beautiful coral snake, the little *Elaps* of Florida, too small with us to be dangerous to man."

That it *is* dangerous, under certain circumstances, the above instance—one of two or three cases known in which the coral snake of the United States has destroyed human life—proves beyond dispute. Owing to its scarcity, however, it is seldom met with, and its small size prevents it from inflicting a wound after the usual manner, but if one exposes bare feet and ankles or hands within striking distance, especially after irritating it, a hypodermatic injection of its venom is quite apt to be received, and is as much to be dreaded as a bite from the rattlesnake. CHARLES H. COE.

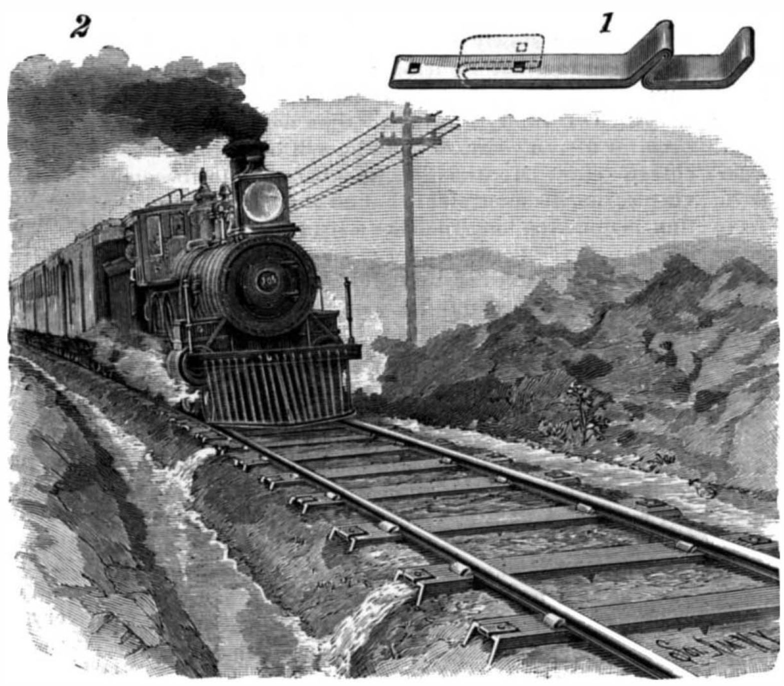
Banana Flour.

Referring to an article in the SCIENTIFIC AMERICAN of June 6, a correspondent says: The flour is made from green bananas—not ripe ones. They are peeled, sliced, and sundried, afterward pounded in a mortar and passed through a coarse sieve.

To preserve the ripe bananas they are dipped in lye and dried in the sun, shriveling up under this operation, and tasting somewhat like figs. The color of the banana flour is dirty gray, like ashes.

A METALLIC TIE AND RAIL FASTENING.

The illustration represents the use of a hollow metal tie, designed to be self-ballasted, or form a gutter for the escape of water when desired, and also a rail fastening for employment therewith, the construction being simple and cheap, and the tie possessing a necessary amount of elasticity. The tie and fastening form the subject of two patents issued to Mr. Bridges Smith, of Macon, Ga. The tie is formed from a sheet metal blank, bent down at right angles on its parallel sides, and cut inward diagonally at its lower edges to form points for anchoring the tie in place, a portion also being bent inward horizontally between the points, thus forming a mainly rectangular body. When the hollow tie thus formed is put in place, it may be filled with earth, clay, or other suitable ballast, or, if laid where water is liable to seek a passage across the railroad bed, the filling is omitted and a plate is inserted adapted to cover the bottom of the hollow space of the tie, which is thus made to serve as a passageway for the water. To fasten the rail to the tie, a flat plate of malleable metal is employed, bent at one end to form two flanges, as shown in Fig. 1. These flanges are passed upward through slots formed for the purpose in the upper surface of the tie, one of the flanges being adapted to rest upon the top of the rail base at one side, while the other flange is bent backward to clasp the rail base on its other side. The outer end of the fastening plate is also doubled over to lie flat upon the top of the tie, to which it is firmly secured by a bolt passed through the tie and two sections of the plate, the bolt hole in the tie having a slightly elongated form to allow for the expansion and contraction of the fastening plate.



SMITH'S RAILROAD TIE AND RAIL FASTENING.

Mines and Mining—Bituminous Coal in Pennsylvania.

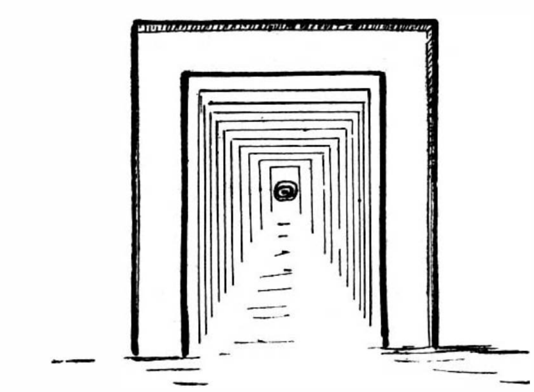
Mr. Robert P. Porter, Superintendent of Census, states in Census Bulletin No. 67, relating to bituminous coal in the State of Pennsylvania, which was prepared by Mr. John H. Jones, special agent, under the supervision of Dr. David T. Day, special agent in charge of the Division of Mines and Mining of the Census Office, that the output of the bituminous regions in the State was 36,174,089 short tons in 1889. The total value of the output is given as $27,953,215, or an average of 77·2 cents per short ton at the mines. The average number of persons employed in 1889 was 53,780, the amount paid for wages being $21,142,051. The output of small local banks and farmers' diggings is reported at 820,197 short tons. No report of this product has heretofore been attempted. The collection of this data was intrusted to resident special agents familiar with the territory under their charge, and the product of this important element of the coal industry in Pennsylvania is authentically given. The quantity sold to the local trade and to employes by regular establishments, together with this neighborhood mining, amounts to 1,590,651 short tons, or 4·40 per cent of the entire production. The amount of coal manufactured into coke during the year 1889 was 10,190,588 short tons, or 28·17 per cent of the total production. Altogether, the report shows a remarkable increase in the bituminous operations throughout the State.

The bituminous coal deposits of Pennsylvania form the northern extremity of the great Appalachian coal fields, and to a greater or less extent underlie all the territory of the State lying west of the crest of the Allegheny Mountains. The counties of Bradford, Tioga, Potter, Warren, Crawford, Venango, Forest, Elk, Cameron, Clinton, and Lycoming, in the northern portion of the State, exhibit only detached basins of the lower measures, which, however, are extensively mined, and the product finds ready markets for manufacturing purposes and for steam. The remaining counties, bounded by the western and southern State lines and a line drawn northward along the eastern boundaries of Fulton, Huntingdon, and Center counties, thence westwardly along the northern boundaries of Clearfield, Jefferson, Clarion, and Mercer, embrace an almost unbroken area of one or more of the important beds belonging to the carboniferous measures.

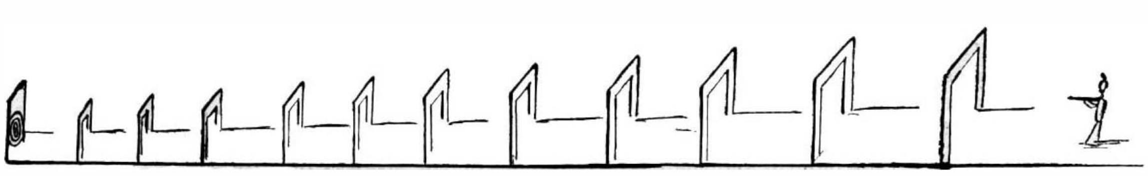
The counties of Allegheny, Westmoreland, Washington, Greene, and Fayette, situated in the southwestern corner of the State, contain the upper productive measures, at the bottom of which lies the notable Pittsburg bed, yielding in the vicinity of Pittsburg a gas coal of the highest quality; to the eastward the coking coals from which the celebrated Connellsville coke is made, and to the southward the Cumberland steam coals of Maryland. Small areas of this bed also occur in Indiana, Somerset, and Beaver counties. The remaining counties referred to contain only the lower productive measures, ranging from the isolated areas of the Pittsburg bed to the Brookville bed, the lowest in the lower productive series, and the Mercer, Quakertown, and Sharon beds in the conglomerate series. The product from this territory, as well as that from the southwestern counties wherever the lower measures are being mined, is classed in the trade as semi-bituminous, containing, as it does, less than 18 per cent of volatile combustible matter. While an excellent quality of coke is produced from coals mined in some localities from these lower measures, the distinctive advantages consist in their superiority as steam and rolling mill fuels, being much sought after for locomotive and steamship uses. In the Freeport and Kittanning beds of the lower productive series, cannel coal of good quality has been found to overlie the seam for considerable areas in certain localities, but on account of the veins being thin and troublesome to separate in mining it is not deemed of much commercial value.

RIFLE RANGE.

Target practice is a *sine qua non* where a regiment of soldiers, volunteer or regular, is to be efficiently maintained or worked into serviceable condition; and the possibility of keeping up, or starting, a good shooting range is at present, in many places, a source of much consideration and thought, the dilemma that some localities find themselves in being aggravated in an enlarged proportion as the population multiplies and the land increases in value in that locality.



Rifle practice is a source of much pleasure and healthful recreation, also creating a spirit of rivalry and emulation among the various members of a corps to such an extent that degrees of perfection are reached that would not otherwise be obtained. It also stimulates the young men, especially, to take an interest in the other duties devolving on a volunteer that, under other circumstances, would become tedious and irksome, but which are necessary to the successful and proper development of a well drilled and disciplined soldier.



A NOVEL FORM OF GUARDS FOR RIFLE RANGES.

There are many places that have sufficient space within their garrison inclosure for short ranges, and others that have in their immediate locality large commons of sufficient area for all distance shooting. The rifle is, however, such a formidable weapon, and the regular as well as the volunteer service supply so many of the *raw recruit* class that the unwary traveler jeopardizes his life and limb should he find it necessary to pass within a radius of some hundreds of yards of the shooter on practice day. The direction of the butt of the rifle could, doubtless, be excepted, and considered a safe course in which to steer during even the novitiate of the future veteran of the musket.

The accompanying diagram illustrates a method of adapting a limited space to a serviceable and safe shooting range.

As the range need not in any respect be different from those at present in use, the bullet guards only require explanation. The guards should be of sheet iron, or other bullet proof substance, and so arranged as to present a broad surface all around the target, when looking toward the latter from the firing point, as represented in the small figure. The width of the surface of the guards would depend on the distance they are placed apart. Standing at the shooting box the full outline of the target is seen, but no open space, the surrounding iron of the target overlapping all open space not covered by the guards in front, so that, after passing through all the guards in its course to the target, the bullet, no matter how badly directed, could not get over nor on either side of the target to the open country beyond. In like manner, should the bullet take an eccentric direction, after passing all guards but the last, that one would save it from traveling into space, and similarly back to the first guard, which would stay the bullet of the most erratic marksman on the ground.

The widths and heights of the guards would have to be made to suit the range. Their distance apart would allow of wider or narrower surface, and the length of range would affect the height to allow of altitude of bullet in its proper course. A flange on the outer edge of each guard is desirable.

Toronto, May 19, 1891. A. C. PAULL.

The Phosphorescence of Diamonds.

In the New York *Sun*, Mr. G. F. Kunz, the well known expert in gems, has recently called attention to a property of the diamond which may serve as a means of distinguishing it from other substances. Referring to the paper of Robert Boyle "On a Remarkable Diamond that Shines in the Dark," published in the Transactions of the Royal Society in 1663, Mr. Kunz remarks that this paper has been indirectly alluded to by a number of authors, but never read. Among a quantity of facts Boyle mentions one diamond that phosphoresced simply by the heat of the hand, absorbed light by being held near a candle, and emitted light on being rubbed. He stated that many diamonds emitted light by being rubbed in the dark. The experiments made by Mr. Kunz show conclusively not only that Boyle's statement that some diamonds phosphoresce in the dark after exposure to the sunlight or an arc of electric light is true, but also that all diamonds emit light by rubbing them on wood, cloth, or metal, a property which will probably prove of great value in distinguishing between the diamond and other hard stones, as well as paste, none of which exhibit this phenomenon, and will be welcomed by the general public who do not possess the experience of the dealer in diamonds. The property is evidently not electric, or it would not be visible on being rubbed on metal.

Yet Room for Inventions.

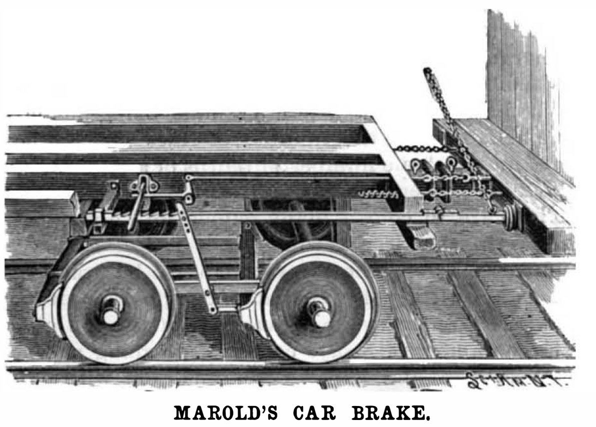
Of all the sack-tying devices, none has proved of practical utility to the extent, at least, of supplanting the old fashioned way of tying with a string. A good sack tie would take wonderfully.

The man who invents a slow-moving feeding device for roller mills that will feed any sort of material, coarse or fine, heavy or light, will have a fortune. Of course it is claimed that there are several on the market, but there are not. Saying nothing disparaging of the many excellent machines for the purpose, they either do not do the work on soft stuff or else they run so fast that they are defective as to long life in good condition. The inventor can get up a slow-moving, perfect feed-regulating machine will have a fortune.

In building a mill it is the case too often that not enough attention is given to the height according to the breadth. This is sure to result in too many elevations and too many choking spouts. All of which means a hard mill to run, a mill that reduces stock, improperly, by elevator and conveyor friction, and a fuel consumer to no advantageous purpose.—*The St. Louis Miller.*

AN IMPROVED CAR BRAKE.

The illustration represents a brake attachment designed to apply the brakes when the cars of a train are brought together and made to engage one with the other, releasing them when the train moves forward



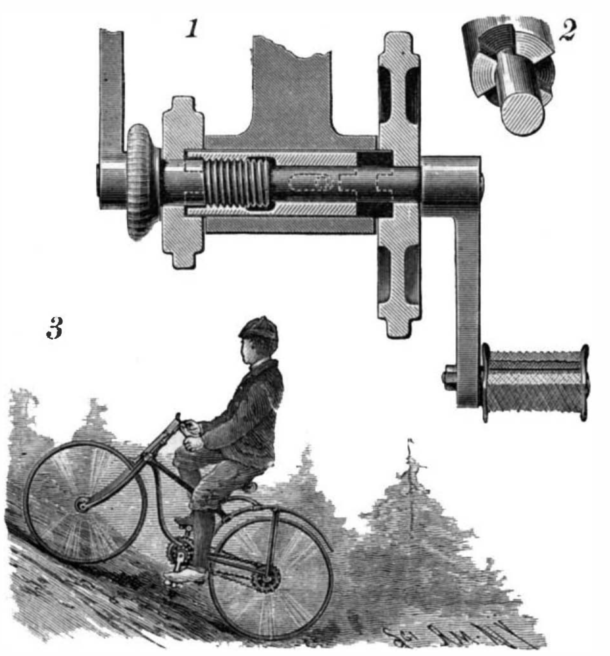
MAROLD'S CAR BRAKE.

or the cars are moved apart. It has been patented by Mr. John Marold, of New Decatur, Ala. At one side of the drawhead, and extending further outward, is a rack bar adapted to slide in the frout sill and on a rear guide beam, the outer end of the bar consisting of a hinged section which may be lifted out of horizontal position when desired. The outer end of the hinged section has a flat head adapted to engage a wear plate of an opposed car, and the bar near its inner end has a series of teeth engaged by a dog pivoted at one end to one of the beams of the car bed, the dog being also connected with a lever fulcrumed on one of the beams, and connected to a rod which extends through an aperture in the front beam of the car, where it is attached to a length of chain connecting it by a hook with the sill of an opposing car. The rack bar is connected with a lever fulcrumed upon a beam of the truck, the lever being connected with the brake beams, and both the rack bar and the lever have a series of holes through which their connection is effected by a registering bolt, for the purpose of regulating the degree of tension to be exerted upon the brakes through the movement of the rack bar. When it is desired to apply the brakes, the coming together of the ends of the cars, pushing the rack bar inward, causes the lever connected with the latter to put on the brakes, which are held thus applied by the engagement of the dog with the rack bar until the cars are moved apart, when the dog is moved out of engagement by means of the rod and chain connecting it with the opposing car, and the release of the brakes is thus effected.

When the cars are to be shunted or backed, the hinged outer end of the rack bar is drawn up and held out of horizontal position by means of a short chain. As a provision against the breaking of the coupling pin, bolts are arranged to slide in the sills at each side of the drawhead, and each having a bearing against a spring cushion, the bolts of one car being connected by chains with corresponding bolts on another car. The chains are of sufficient length to slightly sag when the cars are coupled in the usual way.

A DIFFERENTIAL GEAR FOR BICYCLES.

A construction by means of which a bicycle gear may be quickly changed, so that the vehicle may be driven rapidly where the road is easy, or less speed with more power may be had where the road is loose or hilly, is shown in the accompanying illustration, and



BIGELOW'S BICYCLE.

forms the subject of a patent issued to Mr. Frank R. Bigelow, of Gloucester City, N. J. Fig. 1 shows the device in section applied to the treadle shaft of a bicycle, the bearing of the shaft being supported by an arm in the usual manner. Mounted loosely on opposite ends of the shaft are different-sized sprocket wheels, each having on its inner side a series of sockets adapted to receive the teeth of a sleeve sliding on the shaft, the sleeve being of the length of the hub. Near the center of the sleeve, as shown in dotted lines, is a slot, through which extends a pin secured to the shaft, causing the sleeve to turn with the shaft. The sleeve has a series of recesses at each end, forming projecting teeth, as shown in Fig. 2, the teeth being adapted to fit the sockets on the inner side of each sprocket wheel, so that by sliding the sleeve one way or the other, either one of the sprocket wheels may be engaged and driven by the shaft. A hollow thumb-screw is mounted loosely on the shaft and extends through one of the sprocket wheels into the end of the sleeve, which is counterbored to receive it. The inner end of the screw is threaded to engage a threaded portion of the sleeve, and the outer end of the screw has a handle disk, by turning which the sleeve is moved to engage one of the sprocket wheels. In connecting this gear with a bicycle wheel, the latter is provided with two sprocket wheels, one on each side, and preferably of different sizes, the larger one connecting with the smaller sprocket wheel on the treadle shaft and the smaller one on the main wheel connecting with the larger of the treadle sprockets. By then shifting the sleeve, which serves as a clutch, either the larger or smaller of the treadle sprockets is engaged, according as the road is easy or difficult.

A MINIATURE ELECTRIC MOTOR.

An interesting little electric motor is the subject of our cut. It is of multipolar type, and by its construction secures a very even speed of rotation and good efficiency. It is a complete miniature of the practical everyday motor, and will, with a single cell of bichromate battery, run a 4½ in. fan and do other light work. It is of interest as marking the tendency of electric toy makers to carry out the correct principles of electric engineering in their models. Other motors of larger size are made by the manufacturers, Messrs. Goodnow & Wightman, 63 Sudbury Street, Boston, Mass., one size being powerful enough to run a sewing machine.

A VISIT TO A FAMILY IN ANNAM.

A sojourn of two days gives the passengers on the Natal ample time to visit the city of Saignon. This European city is very attractive on account of the beautiful and well kept trees that border its streets like the lanes in a park, and the pretty little hotels which line its roads. Large and handsome gardens are within easy reach and add to the pleasure of a visit there.

Thanks to the kindness of some friends who acted as guides, I was able to visit the most curious section of the district, namely, Cholon, the Chinese section, where over 60,000 Chinese and Annamites reside. They live in little picturesque houses, and adorn their shops with various exotic plants full of interest to a stranger. Guided by my friends, we visited a very rich Annamite family, who lived in one of the prettiest streets in Cholon. Unfortunately the father was away and so were the sons, who were studying in Paris.

We were, however, most hospitably received by the two eldest daughters. They were attractive-looking women with beautiful eyes, but their black teeth, which were lacquered, detracted somewhat from their beauty. They were clothed in long black trousers, and with a tunic of white Chinese crepe which entirely enveloped their figures. They wore gold collars and diamond bracelets, while their hair was held in position by a golden pin that clasps their locks in a knot. After the formal presentation, we were conducted through the principal apartments of the house. They were very simple in appearance, with bare white walls, but they were filled with beautiful furniture inlaid with mother-of-pearl, and we noticed some exquisite bric-a-brac, such as chiseled silver vases, jade ornaments, arms, and embroidered silks, worthy of the finest collections. The garden was charming, and the young ladies showed us with pride some ornamental plants that their father had procured for them from Canton.

One of these represented a peacock seated on its perch, another a tiger with enameled eyes. Perhaps the most curious of all were little dolls representing Chinese ladies and mandarins. The head, the hands, and the feet were of enameled porcelain, while the body was made of wire and covered with trailing vines. The vines are planted in such a way that they grow through the feet of the image. The vine grows rapidly, and finally conceals the entire figure except the hands, feet, and head. When the figure is entirely clothed with the foliage, the effect is very fine.

CHINESE FIGURES FROM ANNAM, FORMED BY TRAILING VINES.

In the middle of the garden and surrounded by pools of limpid water is a pagoda of carved wood. The pavement is laid in precious marble, and its columns are of carved wood, while the roof is richly ornamented. At the rear of the pavilion there are three altars, on which are three bronze vases and braziers, in front of large gilt statues of Buddha. Our hostesses invited us to rest in this pavilion. Their mother had erected it in honor of their father during his visit to the exposition at Paris, as a surprise for him upon his return.

After refreshments were served, at our request their servants brought their jewelry, and we had a chance to admire the fine gold work that they showed us, gold bracelets, carved ivory boxes, etc.—*By Albert Tissandier, in La Nature.*

AN IMPROVED ENGINE.

The engine shown in the illustration has a valve arranged at each end of the cylinder, opening previous to

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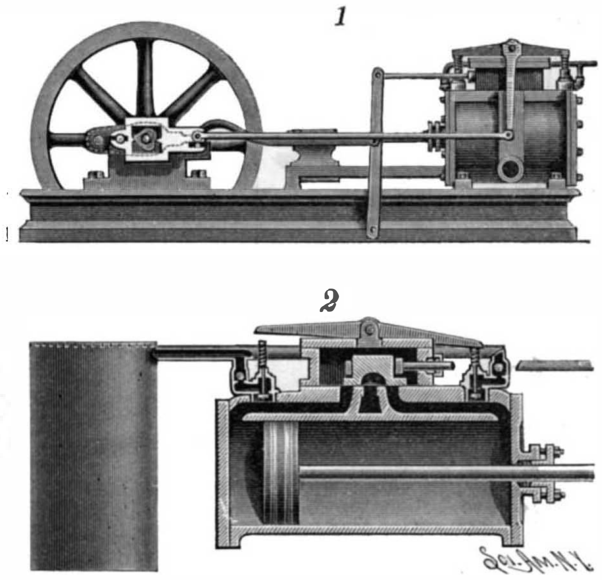


CLARK'S ENGINE.

the opening of the ordinary exhaust and connected with a reservoir for the storage of exhaust steam, whereby it is designed to save a large amount of exhaust steam without causing back pressure on the piston in the cylinder. The valves at the ends of the cylinder are adapted to open inwardly, and in the valve bodies are check valves to prevent a return flow of the exhaust steam from the reservoir to the cylinder. The stems of these valves carry springs to hold the valves normally to their seats, as shown in Fig. 2, their opening being effected by the stems being alternately pressed on by the ends of a lever fulcrumed to the top plate of the steam chest. A depending arm from this lever, as shown in Fig. 1, is pivotally connected by a link with a plate sliding on the frame near the main shaft, the plate having an aperture in which travels a heart-shaped cam secured on the shaft, and adapted to strike on lugs secured on the plate and projecting into the opening. By this construction a quick motion is given to the lever which opens alternately the valves at the cylinder ends, at the time the piston is at or near the end of its stroke, and previous to the opening of the regular exhaust, the latter being effected by the ordinary slide valve operating over the usual inlet ports and the exhaust port. It is designed that the valves at the cylinder ends shall open in sufficient time to permit a large quantity of steam to escape to the storage reservoir, an outlet pipe from the latter carrying off the saved exhaust steam to utilize for other purposes. If desired, also, these valves, instead of opening into the exhaust ports, may be arranged in the heads of the cylinder.

This improvement has been patented by Mr. Andrew J. Clark, of Dayton, Tenn.

THE ASSAYING OF GOLD AND SILVER ORES.

The process of assaying silver ores is based upon the following considerations: Any compound of silver exposed to high heat in the presence of metallic lead or of oxide of lead and of a reducing agent gives up its silver in a metallic state, and in practice an alloy of lead and silver containing all the precious metal of the sample of ore used is obtained.

The ore before being assayed is carefully sampled, so as to represent an exact average, as nearly as possible, of the mine, vein, or heap from which it is taken. It is next pounded in an iron mortar and the process continued until it is very finely pulverized. A sample is thus obtained which is given to the assayer.

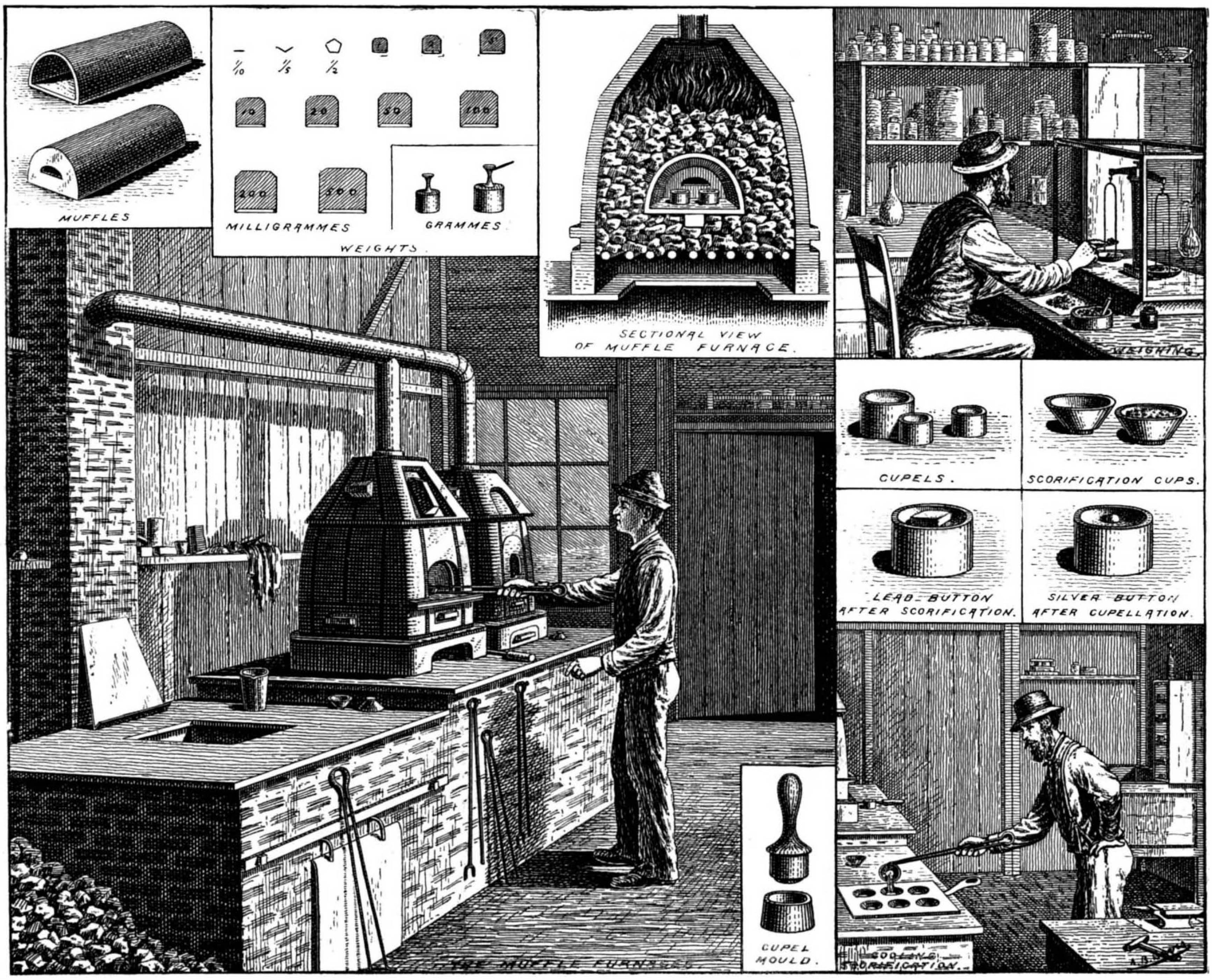
The first operation is to weigh out the powder. This must be done upon a fairly delicate balance. The quantity used for an assay depends upon the richness of the ore; it is very usual to base the weighing upon what is known as the assay ton, a weight of 29·166 grammes. One milligramme bears the same proportion to the assay ton that one troy ounce does to a ton of 2,000 pounds. In weighing, duplicate portions are weighed out representing from a fraction of one to several assay tons, according to the richness of the ore, and the operations are carried on in duplicate throughout. Each sample is mixed with from 8 to 16 parts of very pure, finely granulated lead, called "test lead," and a little borax glass. The fusion is often done directly in a scorifier. These are shallow clay cups about 2 inches and 2¾ inches in width. The weighed portion of ore with the borax glass and lead being placed in one of these cups, the whole is introduced into a hot clay retort known as a muffle, which is heated in a muffle furnace. Muffles and furnaces are shown in the cuts in sections and elevations. The heat is maintained at about 1,600 degrees. The lead in the scorifier melts and the ore floats on top of it, along with the melted borax glass. Gradually the ore disappears, its metallic constituents entering the lead and its earthy constituents forming with the borax glass a fusible slag. As a constant current of air is drawn through the muffle, the lead rapidly oxidizes and its oxide joins the slag, so that after a little while only a small circle of metallic lead appears in the center of the slag. This circle is gradually encroached upon, and eventually the slag covers over the button of metal, which at once sinks to the bottom and the scorifying is ended. After a little more heating the scorifier is withdrawn from the muffle and its melted charge is poured out into a hemispherical depression in an iron pan, in which it rapidly cools. When cold, a few blows of the hammer, the charge resting on an anvil, knocks the slag off. The spheroidal lead button is then pounded into a roughly rectangular shape, and is ready for cupellation.

The cupels are shallow cups of bone ash, about 1½ in. in height, 2¼ in. in width and ⅜ in. in depth. They are made by hammering in a mould, a hammer and piston being used to drive the material down into the cavity of the mould and compact it. The cupel is first heated in a muffle and the rectangular button is placed in it. It at once melts and begins to oxidize. As fast as the oxide of lead is formed, it melts and is absorbed by the porous bone ash of the cupel, as water is absorbed by a sponge. This operation goes on until little more than the silver is left. Just at this point, as the last of the oxide of lead disappears, a sudden flash of rainbow colors passes across the surface of the button, the "brightening" indicating the expulsion of the last of the lead. The silver button is now allowed to cool, is removed by a pair of pincers from the cupel, and when cleaned and brushed free of bone ash is weighed on an exceedingly sensitive balance. Each milligramme of weight represents an ounce or definite portion of an ounce per ton of ore if assay tons have been used. The balance used for this weighing is one of the most sensitive made, and can indicate the twentieth of a milligramme readily.

Should the ore contain gold, this is determined by "parting." The button is fused with one or two times its weight of pure silver. It is then rolled out into a thin sheet, and is treated with nitric acid. This dissolves the silver and leaves behind the gold and any platinum or similar metal which the ore may contain. This residue is weighed and is reported as gold.

The weights used, from the gramme upward, are usually made of brass, of the shape shown. From 500 milligrammes down to 10 milligrammes they are often made of platinum; the smaller weights are of aluminum, the fractions of a milligramme being made of wire bent so that the number of sides in each bent wire indicates the number of tenths of a milligramme which it represents.

There are, of course, many refinements and modifications in the process which it is not necessary to summarize here. The assayer acquires by practice so good a knowledge of ores that he can properly proportion his charge from the appearance of the ore alone. A large number of assays can be kept going at once, the scorifiers and cupels being marked with numbers designating the sample for assaying which it is used.



THE ASSAYING OF GOLD AND SILVER ORES.

American Copyright.

It is a great mistake to suppose that the copyright difficulty with America has been settled. The new American act comes into operation this day month, but we shall then be no better off than we are now. Before the British author can enjoy the benefits of the measure, such as they are, we are expected to give reciprocity to the American author, who is to be placed on exactly the same footing, as regards copyright, as the English writer. That would be fair enough were the conditions equal, but Congress has taken care that they shall be very far from equal. For an English book to obtain copyright in the United States it is essential that it should be printed there. Yet, in face of this, Mr. R. B. Marston appeals to Parliament to grant reciprocity to America. What Parliament ought to do is not to grant a ridiculously one-sided reciprocity, but to pass a measure of retaliation. Let us give copyright to the American author on precisely the same terms that America offers it to the English-man. Nothing can be fairer than that.—*St. James's Gazette.*

THE COLUMBIAN WORLD'S FAIR, 1893.

So great was the strife for the Fair site, and so prolonged the dissensions between the Chicagoans themselves and between them and the National Commissioners after it had been decided that the Fair should be held in Chicago, that it is probable few people are prepared to fully realize the great amount of work which has been already done in practical preparation for the Fair, and the bright prospect at present ahead that the Exhibition will be promptly opened in the spring of 1893. The financial outlook, on which all else mainly depends, has already come down to a solid basis of nearly ten million dollars of appropriations for the Fair, including those from the several States, the city of Chicago, and the General Government—although many States which are certain to make large appropriations have not as yet taken final action. In addition to this sum the managers of the Fair count upon very large prospective resources from the gate receipts, from concessions and privileges, and from salvage. The resources obtainable from the last three sources were estimated on April 1, by Mr. Lyman J. Gage, of the First National Bank of Chicago, and President of the Exposition Company during its first year, as high as eleven million dollars. This showing undoubtedly affords a large financial basis on which to proceed in the erection of buildings and preparing for a great display, and that the time which has thus far elapsed has not been unprofitably occupied by the management is proved by the published plans of buildings and arrangements. These have been so far completed that almost everything in the way of buildings is ready for the contractors' estimates, while contracts for some of the main buildings are already awarded.

The work of preparing the grounds, consisting of some 600 hundred acres of uneven park land, has been virtually completed, except the dredging of the lagoon, the canal, and the basin, which the contracts specify shall be finished early in July. About seventy acres of the grounds were covered by oak trees, which had to be cut down, and the black earth from this tract collected and spread, 85,000 cubic yards being put on and around the site of the natural island, and 120,000 yards on the territory south of the buildings. The ground level or grade of the grounds is 4½ feet above datum, or about 5½ feet above the level of the lake. On the 4½ foot grade are the sites for the liberal arts, fisheries, government, agriculture, machinery, and electricity buildings. The horticulture, transportation, and woman's buildings are on the 6 foot level, the machinery and mines buildings on the 7 foot level, while the administration building is 14 feet above datum, or about 10 feet above the grade of the grounds. About 600 men, 225 teams, and 6 dredges have been at work most of the time since April 1, the dredges being operated night and day, and the earth thrown up by them being used to fill in building sites and uneven areas of the grounds. The basin being excavated will be about 1,500 feet long by 350 feet wide, and will intersect a canal half a mile in length and 150 feet wide. The banks of the canal and basin will be architecturally treated, while the shores of the lagoon will be natural and receive landscape treatment.

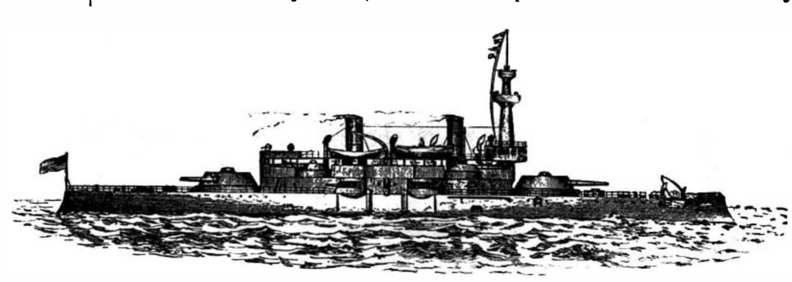
Although nearly all of the Fair buildings will be in Jackson Park, in which the lagoon, canal and basin are located, as shown in our views, Washington Park is also included in the Fair grounds, and the Midway Plaisance, 600 feet wide, connecting the two, in all 1,037 acres. Jackson Park has a frontage of two miles on Lake Michigan, and the two parks are connected with the center of the city and its general park and boulevard system by more than 35 miles of boulevards from 100 to 300 feet in width. The Fair grounds are all within the limits of the city of Chicago, about seven miles south of the City Hall, and it is expected that the transportation facilities, by means of steam roads and horse cars, and by lake steamers, will be of the most ample description.

The trunk lines from every section of the country have their termini but a short distance from the grounds, while the ample lake front will afford abundant room for the accommodation of excursion steamers from every port on the great lakes.

THE MACHINERY HALL.

The fact that the principal buildings are all so near the lake also makes it particularly appropriate that, as a portion of the government exhibit, a full-sized model of one of the new coast-line battle ships be shown here. To all outward appearances it will be a genuine battle ship. It will rest on a foundation of piles, and will be surrounded by water, having the appearance of being moored to a dock. It will be built of brick, covered with concrete. It will serve the double purpose of housing the naval exhibit and showing how our sailors live aboard ship. The dimensions of the structure will be those of the actual battle ship—343 feet long and 69 feet 3 inches wide amidships. It will carry no sails nor spars. It will cost about $100,000, whereas the ships of which it is to be an exact model cost $3,000,000. It will present a complete object lesson, and prove that the sailors of the United States Navy are the best paid, best fed, and best treated sailors in the world.

The structure will have all the fittings that belong to the actual ship, such as guns, turrets, torpedo tubes, torpedo nets and booms, with boats, anchors, chain cables, davits, awnings, deck fittings, etc., together with all appliances for working the same. Officers, seamen, mechanics, and marines will be detailed by the Navy Department during the exposition, and the discipline and mode of life on our naval vessels will be completely shown. The detail of men will not, however, be as great as the complement of the actual ship, the object being mainly to have expert janitors and showmen for the valuable public property. It is expected, however, to give certain drills, especially boat, torpedo and gun drills, as in a vessel of war.

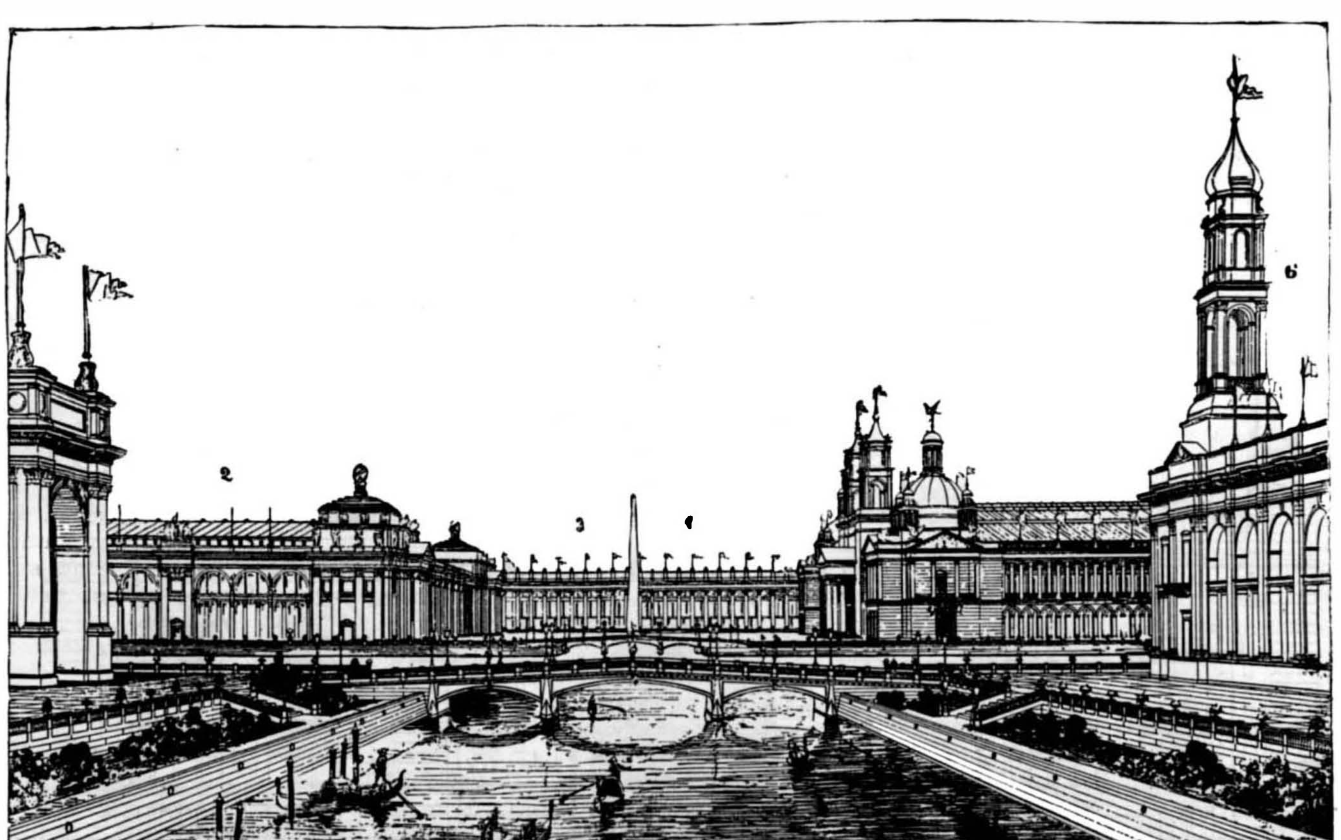


MODEL OF THE BATTLE SHIP ILLINOIS.

The main machinery building, represented in one of our views, and of which Peabody & Stearns, of Boston, are the architects, has received very high praise, which is apparently well deserved. It will be 850 by 500 feet, and cost $450,000. It is located at the extreme south end of the park, midway between the shore of Lake Michigan and the west line of the park. It is just south of the Administration building, and its northwest corner approaches within a few rods of the big transportation loop.

The building is spanned by three arched trusses and the interior will present the appearance of three railroad train houses side by side, surrounded on all of the four exterior sides by a fifty foot gallery. The trusses are to be built separately, so that they can be taken down and sold for use as railroad train houses. In each of these long naves there is to be an elevated traveling crane running from end to end of the building for the purpose of moving machinery. These platforms will be built when the exposition opens, so that the visitors may view from them the exhibitions beneath. Steam power for this building will be supplied from a power house adjoining the south side of the building. The two exterior sides adjoining the grand court are to be rich and palatial in appearance.

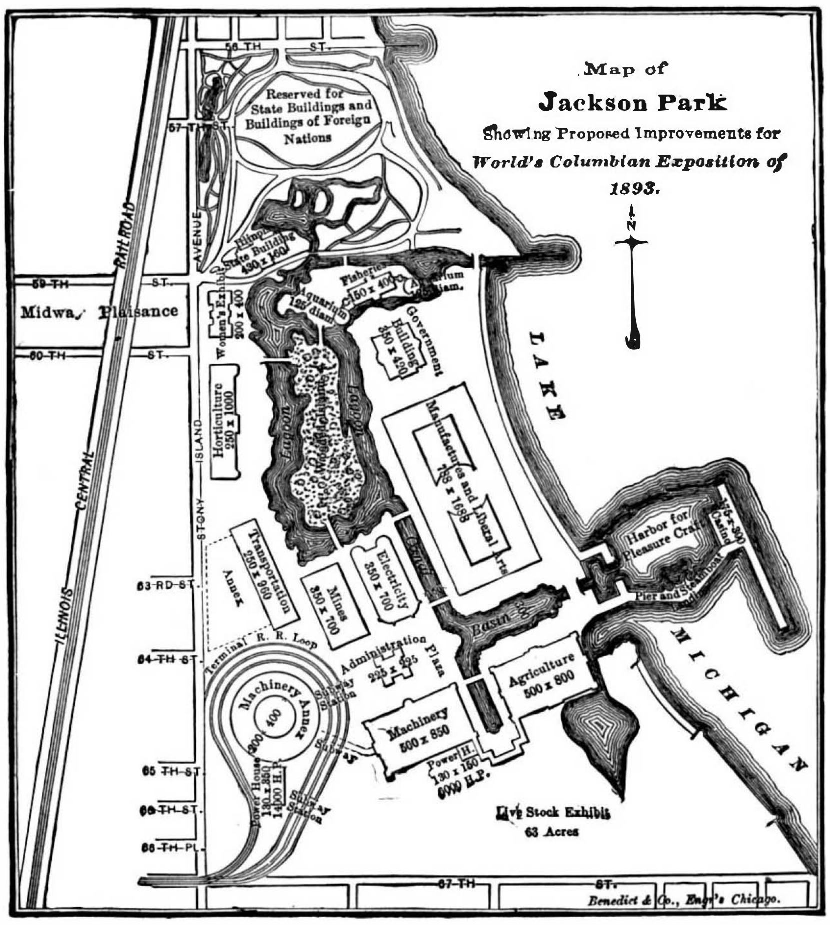
All of the buildings on this grand plaza are designed with a view to making a grand background for displays, and in order to conform to the general richness of the court and add to the festal



VIEW OF LAGOON.

appearance, the two facades of the Machinery Hall on the court are rich with colonnades and other features. The design follows classical models throughout, the details being followed from the renaissance of Seville and other Spanish towns, as being appropriate to a Columbian celebration. An arcade on the first story admits passage around the building under cover, and, as in all the other buildings, the front will be formed of staff colored to an ivory tone; the ceilings will be enriched with strong color. A colonnade with a café at either end forms the length between Machinery and Agricultural halls, and in the center of this colonnade is an archway leading to the cattle exhibit. From this portico there will be a view nearly a mile in length down the lagoon, and an obelisk and fountain in the lagoon will form the southern point of this vista.

The Machinery Annex will stand inside the great transportation loop, west of the Administration Building, unless the plans are changed so that the Electrical Building may occupy that space, as the electricians desire. The annex will cover nearly nine acres. It will be entered by tunnels and bridges from the Machinery Hall and the Administration, Mines, and Transportation buildings. It is to be a simple building, built of wood in an economic manner. Its type is that of a mill or foundry. It is to be annular in form, the diameter being 800 feet. In the inner circle will be a park, in which visitors, fatigued by the hum of machinery, may rest. The annular form chiefly commends itself, because the circle of the electrical elevated railway can run constantly around the entire main nave, and passengers in it can thus see the exposition without leaving the cars. Electrical power will be used in the annex and steam power in the main building.



Attached to this great annex will be the power house, containing the tremendous display of boilers, while in the adjoining portion of the annex building will be established the voluminous plant of engines and dynamos. This will be the largest and most interesting display of electrical power ever made. It is possible that gas may be used beneath the boilers instead of coal for fuel.

The Administration Building is said to be, architecturally, the gem of the Exposition. It will be located at the west end of the great court in the southern part of the site, looking eastward, at the rear of which will be the railroad loop and the great passenger depot. The first object which will attract visitors on reaching the grounds will be the gilded dome of this great building. To the south of the Administration Building will be the Machinery Hall, and across the great court in front will be the Agricultural Building to the south and the Manufacturers' Building to the northeast.

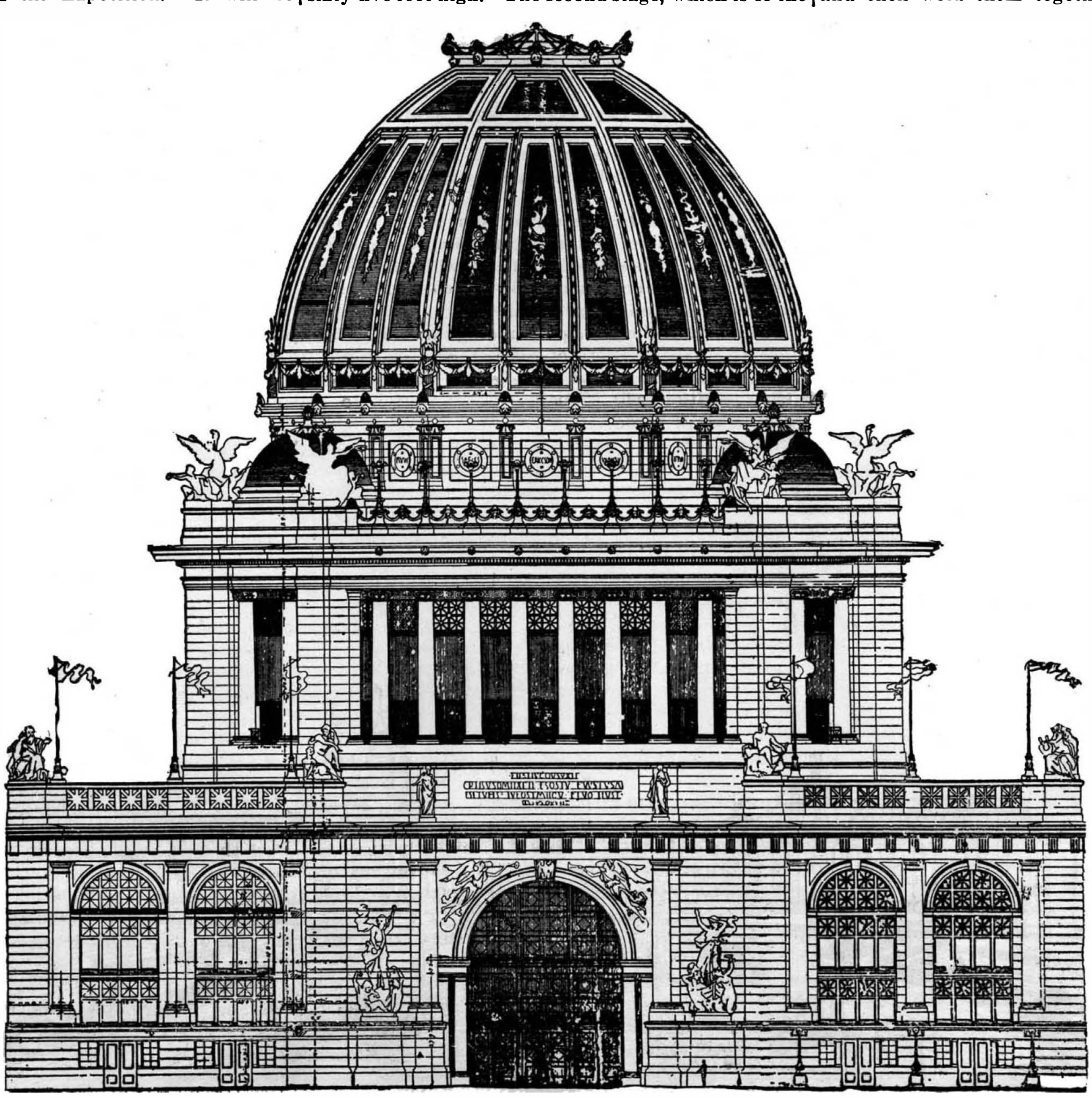
The Administration Building will cost $650,000, and is constructed of material to endure but two years. The architect is Richard M. Hunt, of New York, President of the American Institute of Architects. It will cover an area of 250 feet square and consist of four pavilions, 84 feet square, one at each of the four angles of the square of the plan and connected by a great central dome 120 feet in diameter and 220 feet in height, leaving at the center of each facade a recess 82 feet wide, within which will be one of the grand entrances to the building. The general design is in the style of the French renaissance, and it will be a dignified and beautiful specimen of architecture as befits its position and purpose among the various structures by which it will be surrounded. The first great story will be in the Doric order, of heroic proportions, surrounded by a lofty balustrade and having the great tiers of the angle of each pavilion crowned with sculpture. The second story, with its lofty and spacious colonnade, will be of the Ionic order.

Externally the design may be divided in its height into three principal stages. The first stage consists of the four pavilions, corresponding in height with the various buildings grouped about it, which are about sixty-five feet high. The second stage, which is of the same height, is a continuation of the central rotunda, 175 feet square, surrounded on all sides by an open colonnade of noble proportions, it being 20 feet wide and 40 feet high, with columns 4 feet in diameter. This colonnade is reached by staircases and elevators from the four principal halls and is interrupted at the angles by corner pavilions, crowned with domes and groups of statuary. The third stage consists of the base of the great dome, 30 feet in height, and octagonal in form, and the dome itself, rising in graceful lines, richly ornamented with heavily moulded ribs and sculptural panels and having a large skylight of glass to light the interior. At each angle of the octagonal base are large sculptured eagles, and among the springing lines are panels with rich garlands. The interior features of the building will even exceed in beauty and splendor those of the exterior.

In this building each of the corner pavilions, which are four stories in height, will be divided into offices for the various departments of the administration, and lobbies and toilet rooms. The ground floor contains, in one pavilion, the Fire and Police Departments, with cells for the detention of prisoners; in the second pavilion, the offices of the ambulance service, the physician and pharmacy, the Foreign Department and the Information Bureau; in the third pavilion, the post office and a bank; and in the fourth, the offices of public comfort and a restaurant. The second, third, and fourth stories will contain the board rooms, the committee rooms, the rooms of the director general, of the Department of Publicity and Promotion, and of the United States Columbian Commission.

Small Propeller Screws the Best.

"The small size of the screw," said a boiler maker to a representative of the N. Y. *Tribune*, "is not due to the perception of any inventor of its greater effect as compared with a larger one, but purely to accident. When I first engaged in the machinery business, screws for steamers were made as large as possible, it being the theory that the greater the diameter, the higher the speed. A vessel was placed on Lake Erie with a screw so large that it was deemed best to cast each blade in two parts, and then weld them together. During a storm all these blades of the propeller broke at the welding, reducing the diameter by more than two-thirds. To the surprise of the captain the vessel shot forward at a speed such as had never been attained before. Engineers then experimented with small propellers and discovered that they were much more effective than large ones.



ADMINISTRATION BUILDING.

CUNLIFFE LISTER, one of the new English peers, laid the foundation of his great wealth by mechanical inventions. His first great hit was a wool-combing machine, and his second was a device for utilizing silk waste, which had previously been sold at a cent a pound, in making silk plush. Unlike many of this class of men, he did not begin life a poor boy, but had a father endowed with sense and means, who gave him a mill instead of a university education. Originally it was intended to make a parson of him—the usual destiny of a fourth son of a country gentleman.

The Phosphate Beds of Our Southern States.

BY FRANCIS WYATT, PH.D.

The chemistry of agriculture is that branch of the science which investigates into the nature and properties of soils and plants and which determines the relation of one to the other and the veritable composition of each. If we hand over a grain of wheat to the botanist, he can discern in it nothing but a tiny, yellow opaque, and brittle seed, whereas if we pass it to the chemist, he will discover by analysis that it is composed of a woody fiber, starch, gum, sugar, fat and protein. Again, a geologist may examine the soil,and designate the different ages to which it belongs and the various rocks from which it is derived, but without the chemist, he is unable to determine its actual constituents, and hence, cannot foretell, before any cultivation has been attempted, whether it is destined to be fertile, or of what kind of vegetation it is best able to promote the growth.

The application of chemistry to agriculture is thus naturally indicated. By its aid we obtain from the soil and from plants, at the lowest possible expenditure of time and money, the highest possible quantity of those substances indispensable to our physical well-being.

If production is to be cheap, it must be rapid and plenteous, yet, as we all know the progress of unaided nature is slow and methodical, and so, chemistry, by investigating the laws which govern the development of all living things, and by carefully observing the facts acquired by the practical experience of centuries, has found the means by which the farmer may assist and hasten the natural processes. The work is, of course, still far from complete, but we are at least familiar with the elements essential to plant growth. We know how these elements are distributed, what portion of them is or should be contained in our soils, and what soils are most propitious for different kinds of plants.

Sixty years ago the science of agriculture was unknown. Our grandfathers could not understand why lands once so fertile and productive should show signs of approaching exhaustion. The light only came to us after we had studied how outdoor plants live, whence they obtain their food, of what elements that food is composed, and how it is conveyed and absorbed into their organisms. In point of fact we have discovered that the manner of life in plants is very similar to the manner of life in animals and man. They require certain foods in stated proportions which pass through the process of digestion; they must breathe a certain atmosphere, and they are subject to the influences of heat and cold, light and darkness.

The tissues of their bodies, like ours, are composed of carbon, hydrogen, oxygen, nitrogen, and certain mineral acids and bases, such as phosphoric and sulphuric acids, lime, potash, magnesia, and iron. Since, therefore, it is admittedly necessary for man to constantly absorb a sufficiency of these elements in the form of food, it follows that similar food is required by plants for similar purposes.

Having determined the elementary composition of plants, investigators directed their attention to the analysis of soils, in order to establish comparisons between virgin or uncultivated lands and old varieties which had long been tributaries to every kind of culture.

It was found that in the former there is an abundance of most of the dominating mineral ingredients discovered in plant organisms, whereas in the latter they either exist only in minute proportions or are lacking altogether.

This is a most important stage in our progress! Argument is no longer necessary to prove that if agriculture is to continue to be the basis of national wealth and prosperity, means must be found of restoring to our soils the chief mineral element yearly taken away from them by the crops. This chief mineral element is phosphoric acid; and, since it plays the most important part in the functions of vegetation, it is necessarily the one most liable to be rapidly exhausted.

The following figures, compiled from official reports, will serve to emphasize the argument:

PHOSPHORIC ACID TAKEN FROM THE SOIL PER ACRE AND PER ANNUM.

An average crop of	wheat	takes	30	pounds.
"	maize	"	80	"
"	oats	"	18	"
"	barley	"	18	"
"	rye	"	25	"
"	buckwheat	"	40	"
"	hay	"	15	"
"	turnips	"	45	"
"	potatoes	"	52	"

These are, of course, only a few examples, but they will suffice for present purposes, and it is perhaps hardly necessary to add that if, according to the nature of the crop desired, a sufficient proportion of phosphoric acid be not present in the soil, the plants will languish, various malignant diseases will declare themselves, and death will inevitably ensue before they reach maturity.

Now comes the practical question: How may all this loss be repaired, and whence are we to derive all the phosphoric acid needed to repair it? The equally practical answer is: By hastening to further develop our immense deposits of phosphate of lime!

It was somewhere near the beginning of the present century that the farmers of England began to use crushed bones as a manure. Just why and how they had been brought to do so is shown in an article published in a scientific journal in the year 1830, the writer saying: "As to the earthy matter or phosphate of lime contained in the bones, we may disregard it. It is insoluble and indestructible, and cannot serve as a manure, even in a damp soil and with a combination of circumstances analytically stronger than any of our known chemical processes. . . . . The fact is, that bones, after having undergone a certain internal process of fermentation, ultimately contain about two per cent of gelatine. As this is the only substance to which they can owe any fertilizing activity, they may be practically looked upon as valueless."

These were the opinions of sixty years ago! They were born of ignorance and were fostered by vanity and prejudice. Sixty years hence, what will our own successors think of our knowledge of the same subject? All generations produce some thinking men, and thus, thirteen years after the publication of the article just quoted, that is to say in the year 1843, the light came! The Duke of Richmond was a practical and enthusiastic farmer; he made an exhaustive series of experiments on his soils with fresh and degelatinized bones. His results proved beyond doubt that they both owed their virtue, not to gelatine, or fatty matters, *but to their large percentage of phosphoric acid!* Other investigators—notably Boussingault—having confirmed and elaborated the Duke's conclusions, there was soon such a run upon bones as to exhaust the rather limited supply. Attention was thus drawn to the deposits of mineral phosphates which had been already discovered in several directions, and thence may be dated the development of phosphate mining as an industry, the pursuit of which has proved so remunerative to capital and labor. The mode of occurrence of the best known deposits of phosphate of lime may well be termed eccentric. They have been found in rocks of all ages and of nearly every texture. Sometimes they are very pure, sometimes their combinations are extremely variable. Here they are found in veins, there in pockets, and here again in stratified layers or beds in connection with fossilized *debris* of all kinds deposited by the ancient seas. England, France, Germany, Belgium, Spain, Portugal, Norway, Russia, the West Indies, Canada, etc., all have workable and more or less productive phosphate mines, the commercial value of the products being estimated on the basis of their contents in tricalcium phosphate, the latter ranging from 35 to 95 per cent.

The circumstance that farmers are not in a position to restore to their soils year by year in a natural form all the phosphoric acid taken from them by their crops has caused the demand for phosphatic manures to go on increasing with such steadiness and rapidity that the sources of supply, even for European necessities, have latterly become quite inadequate. Fresh deposits of the material are, therefore, being sought after with industrious care all the world over, and attention has thus been specially directed from abroad as well as from at home to the practically inexhaustible deposits of this country.

Such being the case, a brief outline of the mode of occurrence in our chief centers of production, together with some outlines of the methods of mining, preparation for the market, mining cost, and facilities of transportation, will probably be interesting to a large number of readers.

With the theories which have been formulated from time to time by different authorities as to the true *origin* of all these deposits I shall have nothing to do; but, after describing those which I have personally examined, I shall present my own opinions and conclusions, based on a study of the various exploitations and on the results of my own chemical and physical examinations of samples which I have personally selected.

The Tertiary strata, in which our workable phosphate deposits are found, may be broadly said to hug the coast of the Atlantic Ocean and the Gulf of Mexico from New Jersey to Texas; the phosphate itself, however, according to the present state of our knowledge, being most plentiful in South Carolina and in Florida. The discovery of the South Carolina phosphates dates back as far as 1860; but it was not until some seven or eight years later than this that a mining company could be organized to test the practicability of working them on the commercial scale. Since the eminently successful initiative of this pioneer company, however, the industry has progressed with such leaps and bounds that at the present time some twenty wealthy corporations are actually engaged in it, and have thus raised the status of South Carolina to that of the most productive phosphate region in the world. The geological formation of what is commonly called its phosphate "belt" is made up of quaternary sands and clays. These overlie the beds of Eocene marls, upon whose surface and intermixed with which is found the phosphate deposit. The presumed total area covered by this characteristic formation is 70 miles in length and 30 miles in width, extending from the mouth of Broad River, near Port Royal, in the southeast, to the head waters of the Wando River in the northeast. Its major axis is parallel to the coast, and its greatest width is in the neighborhood of Charleston.

Whether the deposit is continuous or not over the whole of this zone, it certainly varies considerably in depth and thickness. In many places I have seen it 3 feet thick and cropping out at the surface, whereas in others it has dwindled down to a few inches, or was found at depths varying from 3 to 20 feet. These two conditions, thickness of deposit and depth of strata, taken together with the richness of material in phosphoric acid, are the chief points for consideration in the economic working of the Charleston phosphate beds on an industrial scale.

The most approved and generally adopted method of ascertaining the importance and value of the deposits is that of boring and pit sinking. A careful topographical survey is first made of the country. Then commences a systematic series of bore holes from any point that may be arranged, by means of a long steel borer or rod, specially designed for the purpose. The boring rod is worked down through the upper strata until it is arrested by the solid bed of phosphate. Directly the slightest resistance is offered to its passage it is drawn up, and the distance it has traversed is measured with a foot rule. The measurement having been noted, the rod is again let down, is forced through the resisting strata, and is then again withdrawn and measured. The difference between the first and second measurements is taken as representing the thickness of the phosphate bed. These bore holes are practiced at distances of 100 feet apart over the total surface to be examined. The results obtained with the rod are verified and confirmed by a series of exploratory pits—10 feet long by 5 feet wide—which are dug over the course of the bore holes at intervals of 500 feet. The bore holes are driven to a maximum depth of 15 feet, and no pits are at present sunk on those portions of the land where at that distance no phosphate has been encountered. Immediately after removing the overlying strata the phosphate is carefully removed, its depth and thickness measured, and an average sample of the rock and nodules secured and laid aside for analysis.

The practically invariable nature of the superincumbent material, throughout the entire belt, as shown by the digging of a large number of pits under my direction, is represented in the following table, the figures being averages, compiled from my field note book:

	Cainhoy.	Jacksonboro.	Edisto.	Ashley.
	Feet.	Feet.	Feet.	Feet.
Soil very black and acid.	1½	1½	1	2
Mixture of sand and blue clay	2	3½	4	1½
Silicious clay	2½	2½	3½	4
Potters' clay mixed with shells	2	1½	3½	1¼
Sandy, hard conglomerate	traces	½	¾	2½
Phosphate rock or nodules mixed with blue clay	1½	1¼	1½	1¼
Depth of overlying beds.	8	9½	12¾	11¼

So far as I have been able to discover, no systematical investigation has been made of those lands which contain the phosphate deposit at a greater maximum depth than 15 feet, it having been hitherto considered impracticable under present conditions of abundant surface supply, and consequent low mining cost, to conduct a profitable exploitation at any greater depth. A far wider area of lands than those actually classed as mining properties may contain the very same deposit of phosphate, lying under a considerably greater accumulation of the quaternary strata. I am quite disposed to adopt this view as representing the facts, and do not hesitate to predict that means will soon be found of turning them to good account. The phosphate found in the bottoms of all the rivers which flow through the "belt" is of practically the same chemical description as that of the land; having, in fact, been merely washed out from its original beds. It has, however, been worked the more extensively of the two sources, and has proved to be of greater commercial value, since it is obtained by the simple and inexpensive progress of dredging, and is thus raised and washed free from all adhering impurities by one and the same operation.

Both the rock and nodules from these rivers and land deposits occur in very irregular masses or blocks of extremely hard conglomerate of variegated colors, weighing from less than half an ounce to more than a ton. The mean specific gravity of the material is 2·40, and the rock is bored in all directions by very small holes. These holes are the work of innumerable crustaceæ, and are now filled with sands and clays of the overlying strata. Sometimes the rock is quite smooth or even glazed, as if worn by water, at others it is rough and jagged.

Interspersed between the nodules and lumps of conglomerate are the fossilized remains of various species

of fish, and some animals, chiefly belonging to the Eocene, Pliocene, or post-Pliocene ages.

Very careful analysis of a large number of the samples of land rocks taken from the pits above described, made in my laboratory, under my own supervision, gave, after being well dried at 212° F., the following averages:

Moisture, water of combination, and organic matter lost on ignition	8·00
Phosphate of lime	57·63
Carbonate of lime	8·68
Phosphate of iron and alumina	6·60
Carbonate of magnesia	0·78
Sulphuric acid and fluorine	1·80
Sand, siliceous matters and undetermined	10·64
	100·00

These figures suffice to show that the grade of this phosphate is not extremely high, but it is admirably adapted for the purpose of manufacturing commercial fertilizers, and will, therefore, long continue to maintain a leading position as a raw material in the markets of the world.

Before it can be made available for industrial purposes, it is made to pass through three distinct and successive operations: 1. Mining or excavating. 2. Washing it free from sand and other impurities. 3. Kilning, to free it from moisture. Taking these in their order, it is customary to establish a main trunk railroad starting at the river front, or on the bank of some convenient stream, and passing right through the center of the property to be exploited.

Alternate laterals can be run off at right angles from any portion of this main line, at distances of say 500 feet, in conformity with the nature of the ground. Between and parallel to these laterals, a ditch or drain is dug to a depth extending 4 or 5 feet below the phosphate strata. From this main drain the excavators start their lines at right angles to the laterals, commencing at one end of the field and digging trenches 15 feet wide and 500 feet long, the work being so arranged that the men are stationed at intervals of 6 feet. Every man is supposed to dig out, daily, "a pit" 6 feet long, 15 feet wide, and down to the phosphate rock. The overlying material is thrown out to the left hand side of the trench. The phosphate itself is thrown out to the right, and taken in wheelbarrows to the railroad cars which pass at either end of the trench. The water drains from the trenches into the underlying ditch, and is then pumped out by means of a steam pump worked by a locomotive engine. The pump and the engine are secured to connected railway platforms, and run along the railroad track, from one ditch to another, as occasion requires. The cars, loaded with the crude phosphatic material dug out of the pits, are run down to the washing apparatus, constructed at an elevation of some 30 feet from the ground, and generally consisting of a series of semicircular troughs 20 to 30 feet long, set in an iron framework at an incline of some 20 inches rise in their length.

Through every trough passes an octagonal iron-cased shaft, provided with blades so arranged and distributed as to form a screw with a twist of one foot in six, which forces the washed material upward and projects the fragments against each other. The phosphate laden cars are hauled up an incline and their contents dumped into the bottom trough, where the phosphate encounters one or more heavy streams of water, pumped up by a steam pump. This water does not run off at the bottom, but overflows at the higher end near where it enters. When sufficiently washed, the phosphate is pushed out upon a one-half inch mesh screen; the small debris being received on oscillating wire tables below. It is now ready for kilning or drying, and of all the methods hitherto adopted for this important process, that of simple *burning* or *roasting*, in an ordinary kiln, such as is generally used in the manufacture of bricks, has been found at once the most rapid, effective and economical.

The rock is built on layers of pine wood, and owing to its containing a considerable quantity of organic matter, it readily lends itself to combustion and requires but a short time to become quite red hot.

The kilns are made sufficiently large and so arranged as to allow free passage to a train of cars, which, running on the main line of railroad, can be loaded in the kiln, run down to the landing place, and discharged directly into the barges or boats on the river. With a properly constructed plant, regular drainage, and efficient management, the total cost of producing one ton of South Carolina phosphate in clean, dry, marketable condition is about $3.50 per ton, made up as follows:

Mining, at a maximum depth of 15 feet	$1.00
Draining the mine	25
Loading on cars and carrying to washer	60
Washing	30
Drying and handling in kiln	50
Shipping from kiln into vessels on river	25
Interest on capital invested in plant and repairs to same	15
Superintendence and management of mines	20
Towage to Charleston, say	25
Total per ton of 2,240 lb	$3.50

The present selling price for dry phosphate, with an average mean analysis of 57 per cent tribasic or bone phosphate of lime is $7 per ton of 2,240 lb. on wharf at Charleston.

As I have already said, the quantity of phosphate mined and sold in South Carolina during the past few years has been continually increasing until it has now reached the figure of about 500,000 tons per annum. Assuming that the unexploited deposits sti. cover an area of some thirty miles, and that they will yield the present average of 750 tons of phosphate to the acre, we may count upon a reserve of about 14,000,000 tons. With a constantly growing demand for "fertilizer" purposes, it would, therefore, seem as if the mining resources of the State would be exhausted in from fifteen to twenty years.

With a probable appreciation of these figures and facts, the efforts of the wealthiest mining companies now in the field are naturally directed toward the appropriation of all available and readily accessible deposits, and there is no doubt that while acquired on reasonable terms and worked with economy their exploitation will continue to be attended with very profitable results.

The dividends distributed during the past year by some of the companies, whose figures have been published, amounted to a trifle less than $500,000, and it is significant of the rapid intellectual growth and commercial and industrial development of the South that of the total phosphate mined in the State, more than one-fifth is actually used in Charleston for manufacturing purposes. About one-third of the balance is exported to Great Britain and Germany, and the remainder is principally sent coastwise to Richmond, Baltimore, Philadelphia and New York.

When the great benefits accruing to South Carolina and its people from this industry are appreciated, it will not appear strange that active search for phosphate beds of similar value should have been stimulated in the adjoining States, and that the most intense, not to say mad, excitement has manifested itself since the discovery some two years ago of the Florida phosphate deposits.

Note.—The Florida phosphate beds will be fully treated in the following article.

(*To be continued.*)

THE glaze upon enameled cards is made by pressure upon a polished plate or rollers. The composition is chalk, clay, and a little starch. Good work is not possible without elaborate accessories.

RECENTLY PATENTED INVENTIONS.

Engineering.

SYSTEM OF STREET CAR PROPULSION.—Frederick G. Wheeler, Montclair, N. J. Combined with the engine cylinders is a water chamber and a system of circulating pipes, with condensers arranged in the front lower part of the engine and connected with the exhaust ports of the cylinders, an auxiliary condenser being arranged on a higher level, while a pump connects the lower condensers and the water chamber. The construction is such as to cause the water to circulate through a series of tubes back to the water chamber, while the water of condensation is led back to the water chamber, forming a complete circulating system. The invention is an improvement on a former patented invention of the same inventor in that class of motors in which the water is heated in a stationary boiler and supplied to a water chamber on the motor car.

Railway Appliances.

GONDOLA CAR.—Ferdinand E. Canda, New York City. This invention provides for the use of one or more lateral rods on the exterior of each side of the car body, the ends of the rods being provided with screw threads and nuts, the anchorage of the rods being made in the ends of the side boards and through iron castings forming anchor blocks, made in such form as to be completely clamped and held in place by the side boards, thereby being rendered secure against being pulled out. This improved lateral support is wholly outside of the interior surface, and none of the available space of the car is occupied by the rods or fixtures.

Electrical.

BATTERY. — Jacob O. Brinkerhoff, Hackensack, and Milton E. Smith, Rutherford, N. J. Combined with a copper cylinder forming one of the electrodes is an exciting fluid formed of an antimonious chloride and in contact with the inner and outer surfaces of the cylinder. The inventors claim for this battery long life, high voltage, and no creeping or corroding. The exciting agent may be used in liquid or solid form and applied to one or both electrodes, in the common jar battery the electrodes extending into the antimonious chloride, while in the porous cup batteries only one electrode is immersed.

Mechanical Appliances.

BARREL HOOPING MACHINE. — Max Rosenow, Peoria, Ill. This invention provides attachments for the ordinary iron hoop driving or trussing machine, whereby the machine can be readily adapted for the driving of wooden hoops on barrels, providing also suitable means whereby the chine or head hoops can be more effectually placed on the barrel without danger of crushing or breaking them.

WOODEN HOOP LOCKS. — The same inventor has patented a simple and effective machine for cutting the locks in wooden hoops in a quick and positive manner. Combined with a revolving cutter head is a hoop-clamping device arranged at right angles to the rotation of the cutter head, the device being pivotally supported and vertically adjustable in relation to the cutters. The hoops, after having one end cut into a lock, are held by their lock cut to the forked edges of gauges, which set their uncut ends to the proper position for cutting.

OIL CUP. — Thomas McEntee, Jersey City, N. J. This is a lubricating device especially adapted for oiling the crank pin of a marine or other engine, or any moving portion of machinery requiring a constant and reliable oil feed, and where the oil is difficult to apply by the use of the ordinary cup or can. It has a needle valve for adjustment to give the required feed, and the cup is made of sufficient size to supply oil for twenty-four hours, or as long as may be desired, the quantity of oil in the cup being always indicated by a gauge tube.

PLUMB AND LEVEL. — William J. Garner and Thomas Connaughton, Latourell Falls, Oregon. This invention covers a combination device having an extensible support that can be lengthened or shortened, combined with one or more spirit levels and a plumb line and bob, the level being supported by the stock and arranged transversely of and adjacent to the bob, while a suspension device is connected with the bob and extended upwardly, being secured at a point above the level. At one edge of the stock is a spirit level and at the opposite edge is a swinging gravity level.

WATCH MAKER'S ROLLER REMOVER. —Michael L. Sheehan, New York City. This is an improved device for removing and replacing the rollers of watch balance wheel staffs or pivots, the invention providing a simple construction whereby rollers may be disengaged from the staffs or pivots of balance wheels in an expeditious and convenient manner, without disturbing the hair spring or injuring the pivots or ruby pin.

MECHANICAL MOVEMENT. — Israel F. Good, Allentown, Pa. In a suitable frame is mounted a vertical shaft having at its upper end a gear wheel, above which is secured a post supported by radial bars, a gear wheel meshing with the lower gear wheel and connected to the post by a universal joint, with other novel features, the device being designed to furnish a simple means for multiplying speed and transmitting power.

Agricultural.

CORN HARVESTER. — Thomas B. Jones, Radnor, Ohio. Combined with a gathering frame hinged to swing laterally, and having yielding means for holding it normally parallel with the rows of corn, are upper and lower endless belts carried by the frame, and a stalk-cutting mechanism below the lower belts for cutting the stalks as they pass between the belts. The stalks are held in an upright position at the time they are cut, the machine also spreading the butt of the shock prior to its delivery from the harvester.

POTATO DIGGER AND HARVESTER.— Clinton Lanker, St. Joseph, Mo. This invention consists of a plow having a double mould board and discharging on to an inclined elevator provided with raking arms traveling over the grated bottom of the elevator to carry the potatoes upward, a discharge spout being arranged transversely below the elevator. The machine gathers the potatoes, separates them from the soil and weeds, and delivers the cleaned potatoes to bags or other receptacles carried on the machine.

Miscellaneous.

BLEACHING. — Honore Korwin de Pawlowski, Paris, France. This invention provides an apparatus for the bleaching of vegetable and animal matter, and the washing and scouring of wool and other substances, either woven or yarn or fiber, with the avoidance of manipulation. Combined with a series of vats containing liquid, and connected with each other below the level of the liquid, are two vacuum receptacles, placed on a higher level than the vats and connected with them below the level of the liquid, to effect alternately an automatic displacement of the liquid in the vats.

CANE JUICE FILTRATION. — Leon Boyer, New Orleans, La. This is an improved apparatus for treating cane juice by filtration, designed to make the juice so clean that the custom of using lime to neutralize the acid in the juice can be so simplified as to require but little skill or knowledge to carry it out. The invention provides a primary strainer box or filter composed of a series of strainer drawers arranged in sets one below the other, the drawers in each set being of one mesh, but the several sets being of successively finer mesh in a downward direction.

SPRAYING DEVICE.—William J. Ruff, Quincy, Ill. This invention relates to a liquid cooling apparatus more especially designed for spraying beer and ale worts, and adapted to prevent clogging of the device by small particles of hops and other substances liable to pass with the worts to the spraying apparatus. A valve is adapted to pass into the spraying orifice, being held on an adjustable valve stem, while a piston held on the valve stem is adapted to automatically actuate the latter to remove the valve from the orifice when clogged.

MEASURING AND DRAWING INSTRUMENT.—Charles W. James, Philadelphia, Pa. Combined with a forked arm are two arms of unequal length pivoted between the members of the forked arm, the longer arm being of a length equal to that of the forked arm, while a block is adjustably secured to one of the arms. The instrument is simple and durable in construction, and can be readily manipulated to obtain or measure inside or outside angles and obtain the miters of them, or it may be used for calipering, or arranged as a depth and end marking gauge, dividers, compasses, etc.

SPEAKING TUBE AND EARIPHONE. — Frederick Schluchtner, Brooklyn, N. Y. This invention provides a speaking tube having, in addition to the usual mouthpiece, a branch tube with an attached earpiece, the branch tube being located between the whistle and the mouthpiece. The whistle has an operating handle exterior to the tube, and is closed by a spring on the handle.

GOODS EXHIBITOR. — Noah E. Otto, Johnstown, Pa. A strong, compact frame, easily taken apart, carries a series of vertical rollers adapted to receive rolls of fabric, there being also combined with the frame a rack adapted to hold brooms and similar shaped articles. The invention is designed to provide a neat, compact and efficient receptacle for holding and exhibiting rolls of carpets, oilcloths and other bulky and heavy fabrics, so that they may be well displayed and easily handled.

SAVINGS RECEPTACLE. — Charles O. Burns, New York City. This invention relates to boxes used by depositors for collecting their savings from time to time and afterward depositing them in the bank. It provides a safety receptacle in which the box has a slot for entry of the coin, and an opening and closing lid, combined with a lock controlling the lid, a catch mechanism controlling the lock, and two keys, one key being stationary for operating the catch controlling the lock, and the other a movable key to the lock itself, thereby affording increased security.

SCISSORS OR SHEARS.—Julius Langenberg, Ohligs, Germany. Combined with the pivoted blades is a spring-pressed pin protruding through one of the blades so as to impinge upon the other, whereby the two blades are pressed against each other automatically without using any hand pressure during cutting. The construction is also designed to insure the blades cutting the material during the whole cutting movement, from the point where the edges meet toward the ends.

BEE HIVE TONGS. — Crawford D. Holt, Murray, Ky. This is a novel form of tongs for handling the comb frames of bee hives, the tongs having jaws adapted to clasp the tops and sides of the frames, with means for locking the jaws in position. These tongs afford ready means of handling the frames, avoiding the necessity of putting the hands or fingers in the hives and the attendant danger of being stung by the bees.

SASH FASTENER —Charles E. Angell, Salt Lake City, Utah. This is a combined window sash lock and lift, consisting of a positive locking bolt adapted to automatically engage with bolt holes in the window frame, an attached key for operating the bolt, a pivoted thumb piece applied to the outer end of the key to operate the key and serve as a lifter, together with an adjustable dog or catch adapted to engage with the key to prevent the latter from turning to act upon the locking bolt.

THILL COUPLING. — Augustus Beale, Brooklyn, N. Y. This invention provides a shaft coupling designed to be simple, durable and noiseless, whereby the pole may be conveniently connected to or detached from the axle by the most inexperienced helper. It also provides a means whereby the safety straps may be readily connected with or disengaged from the pole or shaft.

LOAD BINDER. — Harry M. Bradley, Canon City, Col. A longitudinally slotted bar with teeth on opposite sides has an aperture in one end for the attachment of a rope, the bar being passed through a slot in a lever, where it is held by a pin and spring-pressed pawls, and there being a rope attached to the lever, the whole forming a simple and convenient device for binding loads upon vehicles in a quick and secure manner. The device may also be used for pulling posts, tightening wire, and as a lifting jack.

WAGON BRAKE. — John W. Herrin, Mount Vernon, Ill. This invention provides a brake which will be automatically applied to the front wheels when the vehicle to which it is attached starts down on an inclined grade, and will be automatically released when a level grade is reached or the vehicle is started up hill. The invention also provides a locking device whereby the brake may be locked either when applied or released, thus taking all strain off the draught animals.

WATERING TROUGH.—John T. Thatcher, Frankfort, Ind. This trough has an apertured end, with a valve arranged to slide past the aperture, in combination with a float hinged to the side of the trough and a rod connected with the valve at its lower end and adjustably connected with the float at its upper end. It is designed that the trough shall always be filled to a definite level, the valve and float working to effect this automatically.

STOVE. — James W. Calta, Castalia, South Dakota. This is a stove of simple and durable construction for heating and cooking purposes, and specially designed for burning hay, straw, trash and rubbish as fuel. All the heat generated is passed around four sides of an oven, and the draught is readily so arranged as to entirely avoid the puffing of the burning fuel.

OIL CAN AND LAMP FILLER.—Charles W. Proctor, Lake Forest, Ill. This is a portable device, secured on a post having a suitable base, the can having a valved outlet at its lower end connected with a delivery tube through which oil is supplied to a lamp without any waste and without the use of pumps. The device is simple and durable, and the oil flows by gravity from the can to the lamp.

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(3113) G. M. says: A question has come up as to whether a piece of iron dropped into water of any given depth would sink to the bottom or would find a point where its density and that of the water would be the same, and consequently remain suspended. Will you kindly answer this and give explanation, also please state the greatest depth of any well or boring in the world? A. The iron will sink to the bottom of the deepest oceans. Every solid substance that is heavier than water sinks to the bottom. The bottoms of the deep oceans are covered with gravel, sand and mud, with shells and vegetable growth of the deep seas. Fish and other living organisms are found at great depths. The pressure of the water is in proportion to the depth, but its density is but very slighty increased, as water can be but very slightly compressed under great pressures. The deepest bored well is about 5,000 feet.

(3114) A. C. R. asks: 1. Is lead a good electrical conductor? A. It has twelve times the resistance of copper. 2. Can you give me a recipe for a good cheap silver polish? A. Use whiting and alcohol. 3. Have the effects of a kaleidoscope ever been shown on the wall like a magic lantern? If so, is the apparatus difficult to make? A. The kaleidoscope can be thus used. It is described in Dolbear's "Art of Projection," $2 by mail.

(3115) M. T. F. asks for the cheapest way of making hydrogen gas. I wish to use it for a balloon in small towns where I can't find the manufactured gas. A. By treatment of iron or zinc scrap with dilute sulphuric acid. This is the usual way on a small scale. On the larger scale it may be made by passing steam over red hot iron scrap.

(3116) J. S. R. asks (1) as to the obelisk (in Central Park, New York), and also the Pyramids of Egypt. Are they not generally considered (by scientific men) a composition, and not blocks of natural stone? A. They are natural stone, not an artificial composition. 2. What was the date of publication of the first number of SCIENTIFIC AMERICAN? Was it a monthly paper, or or magazine, in its youth? A. September, 1845. It was a weekly.

(3117) W. F. B. asks how bird lime is made; it is used to trap birds. A. One receipt is to boil linseed oil until thick and viscid. There is much danger of conflagration in conducting this operation. A better way is to boil the middle bark of the holly for seven or eight hours in water, and put in a heap in a hole in the earth covered with boards or stones for some weeks, until reduced to a mucilaginous mass. It must be rubbed up in a mortar and washed until clean, and put into earthen pots.

(3118) P. B. says A and B have an argument about the motion of a clock's pendulum. A says it never stops in its forward and backward motion. B says it does, or it could not reverse. Who is right? A. B is right. The pendulum must come to a dead stop before it can change or reverse its movement. The time required for the change is very short and not within our perception to measure it.

INDEX OF INVENTIONS

For which Letters Patent of the United States were Granted

June 16, 1891.

AND EACH BEARING THAT DATE.

[See note at end of list about copies of these patents.]

Advertising device, H. G. Rich.... 454,292
Alarm. See Burglar alarm.
Ammonia from sodium nitrate, manufacture of, Baudouin & Delort.... 454,108
Animal tread, J. R. Bevil.... 454,200
Antipyrine and iodine, compound of, E. Ostermayer.... 454,223
Atomizer, R. Lockwood.... 454,055
Axle, adjustable vehicle, D. C. Crawford.... 454,397
Axle journal and journal bearing, A. E. Smith.... 454,075
Axle setting machine, G. W. Hunter.... 454,213
Axles, method of and die for making crank, J. C. Shea.... 454,073
Bag. See Feed bag.
Bag lock, M. V. Mitchell.... 454,058
Barrel rolling implement, Hilton & Monahan.... 454,042
Barrow and truck, combined hand, Martin & Bohn.... 454,174
Basket, fish, C. R. White.... 454,241
Bathing suit, buoyant, R. Wightman, Jr.... 454,193
Battery. See Galvanic battery. Secondary battery.
Bean cutting machine, J. Steudle.... 454,388
Bearing, ball, H. Howard.... 454,049
Bed, folding, H. S. Hale.... 454,121, 454,122
Bed, spring, J. H. Brothers.... 454,027
Bell, W. L. Upson.... 454,190
Bi-telephone, E. J. P. Mercadier.... 454,138
Binding posts, making, E. T. Greenfield.... 454,430
Blinds, friction device for inside, J. B. Hartman.... 454,349
Boiler. See Water tube boiler.
Boiler furnace circulator, C. A. McAllister.... 454,140
Boiler furnace, steam, M. E. Herbert.... 454,350
Boiler tube scraper, H. V. Clynick.... 454,032
Boilers, mechanical stoker for steam, J. Proctor.... 454,379
Book, flat opening blank, P. W. Nelson.... 454,373
Book, flat opening blank, O. W. Smith.... 454,076
Boot drier, E. A. Jones.... 454,050
Boring machines, adjustable stop for, W. P. Kellogg.... 454,051
Box. See Electric resistance box. Letter box.
Brake. See Car brake. Wagon brake.
Brush, A. Hitt.... 454,046
Brush for lithographic stipple work, G. Arnold.... 454,321
Buckle, J. C. & A. M. Hyde.... 454,170
Burglar alarm, portable, C. C. Davis.... 454,033
Burial apparatus, C. M. Chamblin.... 454,331
Burner. See Fuel burner. Hydrocarbon burner. Vapor burner.
Button, J. N. Gotendorf, Jr.... 454,266
Canal rack, F. L. Robinson.... 454,185
Car brake, J. L. Owen.... 454,224
Car coupling, G. Bell.... 454,417
Car coupling, G. W. Dickey.... 454,427
Car coupling, A. Hackman.... 454,133
Car coupling, D. Hirsh.... 454,045
Car coupling, A. C. McCord.... 454,406
Car coupling, H. G. Russell.... 454,385
Car, electric motor, E. M. Bentley.... 454,021
Car, electric railway, E. M. Bentley.... 454,020
Car door, grain, E. A. Hill.... 454,212
Car for underground electric systems, motor, J. J. Miller.... 454,178
Car, railway, W. C. Whitner.... 454,099
Cars, safety guard for sleeping, N. Brown.... 454,202
Cars, sand box for, H. F. Parker.... 454,182
Cars, steam heating system for railway, J. F. McElroy.... 454,286
Card holder, G. K. Kelsea.... 454,277
Card list, J. H. Fezandie.... 454,265
Carding machine, hair, F. J. Mauborgne.... 454,175
Carrier. See Cartridge carrier.
Cart, road, M. Halfpenny.... 454,347
Cart, road, L. M. Smith.... 454,157
Cartridge carrier, L. M. R. Daudeteau.... 454,333
Case. See Pocket case.
Cash recorder, W. H. Thompson.... 454,089
Caster, furniture, H. McDonald.... 454,284
Caster, socket, Crean & Stone.... 454,257
Cattle rack, J. H. Howard.... 454,357
Caustic alkali, etc., manufacture of, A. Kayser.... 454,136
Centrifugal machine, T. Long.... 454,056
Centrifugal separator, H. Stauton.... 454,408
Centrifugal vessels, balancing, P. M. Sharples.... 454,072
Chain link, drive, T. Maxon.... 454,176
Chair. See Convertible chair. Hammock chair.
Chair, J. G. Wilson.... 454,100
Chair and sewing machine top, combined, M. M. Bostick.... 454,251
Check book, W. F. Knowles.... 454,361
Chuck, drill, J. N. Skinner.... 454,074
Cigar bundling machine, Albert & Rathkamp.... 454,246
Cigarmaker's implement, T. Streat.... 454,084
Clock striking mechanism, G. W. Shuman.... 454,299
Closet. See Knockdown closet.
Clutch, friction, C. Hermann.... 454,435
Clutch mechanism, J. A. Dyblie.... 454,261
Clutching and releasing mechanism, E. C. McFarland.... 454,141
Coal separator and cleaner, Smith & Bishop.... 454,148
Cock, gas, Stafford & Hudson.... 454,234
Cofferdam, J. E. Robinson.... 454,383
Coffin cover, L. G. Kregel.... 454,363
Collar or cuff protector, E. J. B. Bowyer.... 454,201
Comb. See Curry comb.
Commode, D. H. Murphy.... 454,128
Compressing rolls, adjusting device for, J. G. Goldthwaite.... 454,402
Condenser, G. H. Simpson.... 454,386
Confectionery, machine for making, P. Knorpp.... 454,278
Convertible chair, L. Jorgensen.... 454,276
Corset, L. Harmon.... 454,167
Corsets, etc., clasp for, H. F. Wyatt.... 454,104
Cotton handling and cleaning apparatus, seed, R. S. Thomas *et al*.... 454,146
Coupling. See Car coupling. Hose coupling. Pipe coupling. Thill coupling.
Cradle, H. Weber.... 454,191
Crank pin, G. W. Rogers.... 454,229
Cultivator, W. C. De Graffenried.... 454,036
Current collecting device, R. M. Hunter.... 454,437
Curry comb, E. C. Hempel.... 454,269
Cutter. See Glass tube cutter.
Cycle saddle, W. A. Hance.... 454,431
Dental engine, W. W. Williamson.... 454,242
Dentures, apparatus for making, R. E. Zellers.... 454,415
Dentures, vulcanizing rubber, G. B. Snow.... 454,079
Desk and document cabinet, combination, C. E. Lucas.... 454,368
Dies, taps, etc., machine for cutting, A. W. Cash.... 454,029
Display rack or case, S. B. Calkins.... 454,164
Distilling apparatus, T. McGowan.... 454,061
Door check, J. Keene.... 454,360
Door hanger, L. Terry.... 454,304
Door mat, metal, E. R. Landon.... 454,439
Door spring, W. C. Smith.... 454,078
Draught equalizer, W. Z. Runkle.... 454,069
Draw bars, manufacture of, J. T. Wilson.... 454,101
Drier. See Boot drier.
Drill. See Rock drill.
Drying line support, J. Pagliughi *et al*.... 454,377
Egg beater, W. H. Dennison.... 454,165
Egg beater, E. Hadley.... 454,345
Egg beater, D. A. Wilkinson.... 454,194
Elastic or corded fabric, woven, W. Lapworth.... 454,366
Elastic washer, C. E. Swan.... 454,085
Electric apparatus for treating deafness, G. F. Webb.... 454,313
Electric conduit, tubular, E. H. Johnson.... 454,275
Electric current indicator, A. B. Herrick.... 454,270
Electric head light, Pattison & Desmond.... 454,184
Electric locked switch, F. Teague.... 454,087
Electric machine, dynamo, R. Eickemeyer.... 454,336
Electric motor, H. H. Blades.... 454,024
Electric resistance box, R. Eickemeyer, Jr.... 454,207
Electric switch, H. T. Clark.... 454,031
Electric systems, conduit for underground or subway, J. J. Miller.... 454,177
Electric wire subway, W. Readman.... 454,155
Electric wires, connector for, E. L. Nash *et al*.... 454,181
Electrical conductors, wall fixture for, Pieper & Watson.... 454,226
Electro deposition and cathode therefor, A. C. Reinfeld.... 454,381
Elevator controlling mechanism, W. O. Wakefield.... 454,095
Elevator safety device, A. Eichert.... 454,263
Embossing works in sheet metal, machine for, S. W. Babbitt.... 454,149
Enameling powders, machinery for distributing, Walters & Smith.... 454,312
Engine. See Dental engine. Pumping engine. Steam engine.
Engine, G. White.... 454,192
Engines, electric pole in gas or vapor explosive, Tremper & Eisenhuth.... 454,238
Engraving machine, J. C. Parmerlee.... 454,063
Envelope, W. E. Thomas.... 454,237
Exhibition rack, H. A. Buckholz.... 454,328
Explosive, Ward & Gregory.... 454,239
Extractor. See Pen extractor. Stump extractor.
Fabric. See Elastic or corded fabric.
Fabric stretching frame, S. Hough.... 454,134
Facing slip and label holder, T. W. Gaines, Jr.... 454,341
Fare register, J. W. Meaker.... 454,370
Feed bag, animal, G. D. Leonard.... 454,054
Feed water regulator, automatic, J. Thomas.... 454,088
Fence making machine, B. Duley.... 454,260
Filter, J. A. Fulton.... 454,340
Fire escape, A. R. Brandt.... 454,325
Fishing reel, P. H. Yawman.... 454,319
Fistula ligatures, device for applying, M. M. Brown.... 454,327
Flanger, rotary, E. P. Caldwell.... 454,110
Fog horn, W. Le Blanc.... 454,280
Fork. See Hay fork.
Frame. See Fabric stretching frame. Photographic printing frame.
Fruit gatherer, A. B. Anderson.... 454,320
Fuel burner, liquid, E. De Beauharnais.... 454,125
Funnel, indicating, A. Whelan.... 454,240
Furnace. See Boiler furnace. Heating, puddling, or boiler furnace. Hot air furnace.
Furnace, E. F. Edgar.... 454,037
Furnace, R. L. Walker.... 454,310
Galvanic battery, W. Macmillan.... 454,057
Game apparatus, S. M. Barnett.... 454,161
Game apparatus, J. D. Jackson.... 454,358
Game or puzzle, J. J. Erin.... 454,147
Gas and oil tank, J. N. Barker.... 454,106
Gas, apparatus for the manufacture of, J. L. Stewart.... 454.409
Gate, W. Brayton.... 454,026
Generator. See Steam generator.
Glass tube cutter, P. Smith.... 454,233
Governor, J. F. Kirby.... 454,218
Grader, road, J. A. Houser.... 454,048
Grain scourer, W. B. Anthony.... 454,159
Grapple, J. H. Dungan.... 454,335
Guard. See Life guard.
Gun, T. Nordenfelt.... 454,374
Gun cotton, making, H. S. Maxim.... 454,281
Gun, recoil-operated machine, A. Odkolek.... 454,403
Gun, spring air, M. F. Stanly.... 454,081
Gunner's arm rest, R. B. Sproul.... 454,300
Hair tonic, S. T. Fraser *et al*.... 454,401
Hame fastener, C. S. Ellis.... 454,400
Hammock chair, J. C. Bach.... 454,248
Ham stuffing machine, boneless, G. N. De Loriea.... 454,112
Hanger. See Door hanger. Picture hanger.
Harrow, W. Hetrick.... 454,352
Harrow and roller, combined, G. M. West.... 454,098
Harrow or cultivator, P. Blaker.... 454,324
Harrow, revolving, S. Sheets.... 454,188
Harvester, J. & W. Paterson.... 454,225
Harvester, corn, J. Wise.... 454,102
Hat and coat hook, C. H. Thurston.... 454,305
Hay fork, H. H. Wright.... 454,103
Heater. See Tire heater.
Heating apparatus, steam, J. F. McElroy.... 454,285
Heating, puddling, or boiler furnace, J. James.... 454,359
Hedge trimmer, R. H. Elliott.... 454,337
Heel shaping or compressing machine, C. W. Glidden.... 454,428
Hinge, S. P. Gibson.... 454,343
Holder. See Card holder. Jar holder. Map or chart holder. Sash holder.
Hook. See Check hook. Hat and coat hook. Snap hook. Whiffletree hook.
Hose coupling, J. F. McElroy.... 454,287
Hose or other pipes, device for stopping leakage in, J. Lawrence.... 454,279
Hot air furnace, J. Evans.... 454,264
Hot air register, T. G. Wanless.... 454,096
Hydrocarbon burner, C. E. Cookerly.... 454,332
Incrustation preventive, J. F. Stephenson.... 454,083
Indicator. See Electric current indicator.
Inhaler, C. A. Simpson.... 454,142
Inkstand, J. A. Macmeikan.... 454,173
Insecticide distributer, H. Myers.... 454,117
Insulated electric conductor, E. D. McCracken.... 454,060
Interfering straps, rubber pad for, M. Haughey.... 454,210
Iron, melting, H. J. Graf.... 454,209
Jack. See Lifting jack.
Jar holder, fruit, O. R. Cooke.... 454,396
Journal bearings, composition for, P. H. Holmes.... 454,354
Key fastener, W. Bishman.... 454,419
Knife for turning irregular forms, T. W. Gardiner 454,041
Knitting machines, needle cylinder for, E. R. Branson.... 454,163
Knockdown closet, H. Pattberg.... 454,123
Lace fastener, shoe, W. Wellock.... 454,314
Lacing hooks, machine for setting, W. Halkyard.... 454,114
Lamp, Argand, Atwood & Tobey.... 454,247
Lamp, blow, G. E. Moody.... 454,139
Lamp controller, incandescent electric, J. J. Fanning.... 454,038
Lamp, electric arc, P. Clarke.... 454,253
Lamp, electric arc, J. E. McAuley.... 454,443
Lamp, electric arc, S. W. Rushmore.... 454,294, 454,295
Lamp filament, incandescent, T. A. Edison.... 454,262
Lamp fixture, suspension, J. E. Bohner.... 454,420
Lamps, mast arm for electric, T. Dillon.... 454,166
Lantern, vehicle, T. B. Jefferey.... 454,171
Latch, C. Koegel.... 454,053
Lawn sprinkler, I. W. McGaffey.... 454,288
Letter box, E. Franke.... 454,127
Letter box, W. Shempp.... 454,298
Letter feeding and separating apparatus, G. W. Hey.... 454,405
Life guard, T. L. Johnson.... 454,214
Lifting jack, L. Meeker.... 454,441
Lifting jack, Sutphen & Bray.... 454,302
Light. See Electric head light. Ship's side light.
Liniment, B. E. Donham.... 454,334
Lithmetalography, C. L. Kling.... 454,438
Lock. See Bag lock. Nut lock.
Lock, W. C. Smith.... 454,077
Loom for weaving tufted pile fabrics, H. Wyman 454,414
Loom shedding and shuttle box operating mechanism, G. F. Hutchins.... 454,135
Loom shedding mechanism, J. Cashman.... 454,252
Loom, terry, F. Leake.... 454.367
Lumber for veneers, etc., compound, F. Koskul.... 454,362
Mail bag catcher, H. & C. Soggs.... 454,387
Map or chart holder, adjustable, A. L. Eilar.... 454,126
Mat. See Door mat.
Matrix making machines, type die for, C. L. Redfield.... 454,066
Meat tenderer, O. L. Cady.... 454,330
Metal slitting machines, scrap cutter for, A. P. Hine.... 454,353
Metals from quartz or other gangue, liquid for separating, J. S. Lurie.... 454,116
Milk, vessel for sterilizing and transporting, Gronwald & Oehlmann.... 454,267
Mine shafts, electric signal for, F. W. Bacorn.... 454,018
Miter cramp, D. Foster.... 454,039
Mop wringer, A. M. Burnham.... 454,203
Motor. See Electric motor.
Necktie fastener, J. Walter.... 454,311
Nets, machine for making, W. J. Hooper *et al*.... 454,355
Nut for securing pinions on shafts, differential, N. C. Bassett.... 454,019
Nut lock, M. Kroell.... 454,364
Oil for general painting, J. C. Decker.... 454,035
Ore sampling device, D. W. Brunton.... 454,120
Ores, grading and concentrating, H. Scovell.... 454,071
Overshoe, W. H. Sprague.... 454,143
Packing, piston rod, G. W. Rogers.... 454,384
Packing, rod, Udstad & Ryan.... 454,093
Painter's overshoe, A. S. Olson.... 454,375
Paper calendering rolls, A. S. Bacon.... 454,322
Paper fixture, toilet, S. Wheeler.... 454,317
Paper roll, wrapping and toilet, S. Wheeler.... 454,316
Paper shells, machine for making, G. B. Farrington.... 454,113
Paper tube winding machine, M. C. Stone.... 454,145
Pawl and ratchet mechanism, J. M. W. Long.... 454,440
Pen attachment, writing, D. Lubin.... 454,221
Pen extractor, F. C. Pfeiffer.... 454,064
Pen, ruling, H. H. Love.... 454,220
Photographic printing frame, adjustable, H. B. Hennemann.... 454,433
Pianoforte, G. Caddick.... 454,204
Picker. See Slate picker.

Picture hanger, J. F. Coupe ... 454,111
Piling, making tight joints in sheet, J. E. Robinson ... 454,382
Pin. See Crank pin. Scarf pin.
Pipe coupling, G. Westinghouse, Jr ... 454,129
Pipes, stop box for water or gas, E. G. Crawford .. 454,398
Planter, J. A. Handeland ... 454,348
Planter, T. C. Patterson ... 454,183
Planter, corn, J. R. Payne ... 454,378
Planter, seed, E. S. Keeler ... 454,216, 454,217
Planters, check row attachment for corn, C. S. Bean ... 454,150
Plow, steam gang, N. L. Darling ... 454,206
Pocket case, F. C. Avery ... 454,160
Printers' forms, lock-up mechanism for, Horning & Clapp ... 454,047
Printers' leads, machine for shaving, Damon & Peets ... 454,153
Printing from collotype or photo-gelatine plates, machine for, W. C. Hawkins ... 454,268
Printing presses, perforating attachment for, G. H. Slocum ... 454,231
Printing presses, perforating attachment for, Slocum & Gamble ... 454,232
Propeller, D. W. Horton ... 454,272
Propulsion of vessels, hydraulic, Bowring & Newcomb ... 454,151
Protector. See Collar or cuff protector.
Pulley, split, D. G. Reitz ... 454,227
Pulleys, universal joint and support for, T. S. Brown ... 454,422
Pump, W. McLennan ... 454,180
Pump, steam vacuum, G. E. Nye ... 454,062
Pumping engine, direct-acting, Mumford & Anthony ... 454,059
Punch, check, R. L. Rogers ... 454,156
Quarter-beating machine, C. W. Glidden ... 454,429
Rack. See Canal rack. Cattle rack. Display rack. Exhibition rack.
Rack attachment for theater or other chairs or seats, G. Hermann ... 454,351
Railway and vehicle for railway transportation, E. G. Tobey ... 454,306, 454,307
Railway, electric, F. O. Blackwell ... 454,023
Railway grip, cable, J. C. H. Stut ... 454,235
Railway, pneumatic, H. W. Wiley ... 454,318
Railway switch, R. Paskel ... 454,290
Railways, conduit for electric, E. M. Bentley ... 454,022
Railways, electric block system for, A. H. R. Guiley ... 454,344
Rails, machine for making point, E. H. Johnston. 454,274
Recorder. See Cash recorder, Speed recorder.
Reel. See Fishing reel.
Register. See Fare register. Hot air register.
Regulator. See Feed water regulator.
Reversing gear, C. Hermann ... 454,434
Riveting machine, M. Arnold ... 454,199
Rock drill, E. A. Rix ... 454,228
Rolling mills, girder rail roll for, Wood & Watson 454,244
Rubber goods, production of waste, N. C. Mitchell ... 454,442
Saddle, riding, D. Heermance ... 454,211
Safes, etc., making shells or casings for, J. Baum. 454,162
Safety switch, automatic, G. M. Howe ... 454,169
Sash holder, J. Blocher ... 454,025
Sawing machine, hand, Troeger & Schneider ... 454,308
Sawing machine turntable, J. A. Campbell ... 454,426
Scale for railway cars, hydraulic weighing, C. R. Bache ... 454,249
Scale, spring weighing, P. Kiltz ... 454,052
Scalping machine, J. Pye ... 454,065
Scarf pin, Z. Rabby ... 454,380
Scourer. See Grain scourer.
Screw thread cutting machine, E. & H. L. Ament. 454,197
Seamer, roofing, O. P. Talley ... 454,303
Secondary battery, J. S. Sellon ... 454,187
Secondary battery, Tommasi & Theryc ... 454,091
Seeding machine, R. D. Berry ... 454,418
Seeding machine, broadcast, V. Swanfeldt ... 454,158
Separator. See Centrifugal separator. Coal separator.
Sewing carpets, apparatus for, F. Ames ... 454,404
Sewing machine binding attachment, H. H. Barnard ... 454,250
Sewing machine feeding mechanism, C. M. Hine, 454,043, 454,044
Shaking screen support, W. D. Gray ... 454,130 to 454,132
Shelving, J. L. Daniels ... 454,259
Shelving, portable, P. Rink ... 454,293
Shingles or other flat articles, device for coloring, Horton & Lee ... 454,356
Ship's side light, T. Andreasen ... 454,198
Shoe, J. W. Packard ... 454,376
Shot canister, J. H. Reid ... 454,124
Shutter worker, A. Merz ... 454,371
Sieve and mixer, combined, A. M. Binau ... 454,323
Sign, price card, etc., C. H. Buxton ... 454,424
Signal indicating apparatus, J. O. Ziegler ... 454,245
Skate, J. D. Freese ... 454,040
Slate picker, Bartl & Bowman ... 454,393
Snap hook, W. R. Davis ... 454,034
Snow plow flanger, E. P. Caldwell ... 454,109
Soda alum, making, F. M. Spence *et al* ... 454,189
Sodium aluminate, making, A. Kayser ... 454,137
Sole beating-out machine, Cutcheon & Johnson .. 454,258
Speaking tube, H. A. Cutmore ... 454,399
Speed recorder and register, E. Verstraete ... 454,391
Spinning and twisting machines, spindle support for, T. Mayor ... 454,282
Spring. See Door spring.
Sprinkler. See Lawn sprinkler.
Stamps, approval sheet for, R. F. Albrecht ... 454,416
Steam engine, O. Tackman ... 454,086
Steam generator, J. I. Thornycroft ... 454,390
Steamboat smokestack, J. B. Brolaski ... 454,326
Stitching and barring machine, buttonhole, J. H. Reed ... 454,067, 454,068
Stone, artificial, G. E. Hagerman ... 454,346
Stove polish, Sargent & Gallup ... 454,296
Street sweeper, W. H. Sterling ... 454,144
Striking machine, coin-controlled, H. Cooper ... 454,256
Stump extractor, C. E. Bassett ... 454,107
Supporter. See Surgical foot supporter.
Surgical foot supporter, A. G. Gefvert ... 454,342
Suspensory bandage, T. W. Heinemann ... 454,168
Switch. See Electric switch. Electric locked switch. Railway switch. Safety switch.
Tag and parcel tier, W. H. Anderson ... 454,105
Tank. See Gas and oil tank.
Telegraphic apparatus, electric, S. V. Essick ... 454,338
Thill coupling, A. Burger ... 454,329
Thill coupling, D. E. Russell ... 454,118
Thill coupling, C. Tahash ... 454,236
Thill coupling, H. L. Witham ... 454,243
Thrasher, E. F. Sanford ... 454,230
Thrashing machines, grain pan for, F. F. Landis .. 454,365
Tire heater, N. H. Cook ... 454,205
Tire rubber, J. A. Turner ... 454,092
Tire, wheel, T. B. Jeffery ... 454,115
Tobacco, hanging, F. R. Warren ... 454,097
Tool, combination, S. G. Arnold ... 454,017
Tooth, artificial, T. H. Schmitz ... 454,297
Toy, M. Cohn ... 454,254
Toy, C. A. Mahle ... 454,369
Traction roads, rail and road bed for, J. J. Miller .. 454,179
Transformer, E. Thomson ... 454,090
Traps, method of and apparatus for making lead pipe S, W. W. Rosenfield ... 454,186
Trimmer. See Hedge trimmer.
Triturating straw, etc., for cattle, apparatus for, L. Vigreux ... 454,094
Trousers, M. Falk ... 454,208
Truck, car, C. W. Hunt ... 454,273
Truss, M. R. Fletcher ... 454,339
Tube. See Speaking tube.
Tube forming machine, seamless, E. W. Clark ... 454,030
Typewriting machine, C. Spiro ... 454,080
Typewriting machines, type holding device for, C. L. Hibbard ... 454,271
Umbrella attachment, H. Blassberg ... 454,395
Valve gear, A. M. Sykes ... 454,411
Valve, governor, F. N. Burt ... 454,423
Valve mechanism for hydraulic elevators, A. Sundh ... 454,410
Vapor burner, W. A. Schaner ... 454,119
Velocipede, R. Schweers ... 454,070
Velocipede saddle, T. B. Jeffery ... 454,172
Vending apparatus, W. Cahoon, Jr ... 454,425
Vending machine, F. W. Silkman ... 454,407
Vending machine, newspaper, Starr & Hollingsworth ... 454,301
Ventilating railway and other carriages, apparatus for, J. Anderson ... 454,392
Ventilator, P. Abrahamson ... 454,195
Veterinary file, F. K. Hesse ... 454,436
Wagon brake, N. E. Thompson ... 454,389
Washer. See Elastic washer.
Washer, A. F. W. Partz ... 454,289
Washing compound, W. G. Eckstein ... 454,154
Washing machine, J. W. Butler ... 454,028
Washing machine, M. Van Auken ... 454,309
Watch cases, etc., machine for ornamenting, C. F. Morrill ... 454,283
Watch, repeating, E. Perrin ... 454,291
Water tube boiler, J. B. Johnston ... 454,215
Weather strip for car doors, J. W. Brown ... 454,421
Weighing beam, H. G. Beuckmann ... 454,394
Well sinking tool, J. D. Stephenson ... 454,082
Wells, means for and method of blowing off fluids from oil or gas, J. Heed ... 454,432
Wheel, D. S. West ... 454,315
Whiffletree hook, L. E. Waterman ... 454,413
Whiting, composition of matter for, G. A. Casselman ... 454,152
Windmill, J. Q. Adams ... 454,196
Windmill, R. Monday ... 454,372
Windmill, power, C. O. Sylvester ... 454,412
Wrench, H. H. Love ... 454,219
Wrench, J. A. Miller ... 454,222
Wringer. See Mop wringer.
Yarn dressing machines, tension device for, T. H. Connor ... 454,255

TRADE MARKS.

Aerated spring water and ginger ale, L. T. Foss ... 19,731
Ale and porter, Ind, Coope & Co ... 19,718
Baking powder, Star Manufacturing Company ... 19,735
Belting, Boston Woven Hose Company ... 19,695
Billiard cloth, Peltzer & Son ... 19,733
Boards made of compressed wood and straw pulp, American Straw Board Company ... 19,734
Boots and shoes, Brennan & White ... 19,694
Brushes and combs, F. A. Maurey-Deschamps ... 19,704
Button fasteners, J. K. Krieg & Co ... 19,737
Cheese, J. S. Martin & Co ... 19,732
Cigars, Fernandez, Corral & Co ... 19,697, 19,698
Cooking vessels, sheet metal, Bronson Supply Company ... 19,706
Corsets, Worcester Corset Company ... 19,707
Corsets and trimmings therefor, I. Newman & Sons ... 19,713
Fish, cut and boneless, S. Gorton & Co ... 19,720
Gloves, kid, Wertheimer & Co ... 19,708
Homeopathic remedies for family use, C. W. Karsner ... 19,711
Knit goods, such as hosiery, underwear, and athletic goods, S. P. Curtis ... 19,719
Leads and chalk for use in pencils and crayons, J. J. Mitchell Company ... 19,723
Meats, antiseptic coloring compound for use upon cured, J. Horner ... 19,730
Medicinal preparations, certain, A. C. Meyer ... 19,703
Metal polish, Johnson Brothers ... 19,710
Nose bags for animals, G. D. Leonard ... 19,712
Perfumery and soap, S. Palmer ... 19,721
Perfumery, dentifrice, restoratives for the hair, and soap, Scottish Drug Depot ... 19,714
Pills, Carter Medicine Company ... 19,729
Remedies for gout and rheumatism, W. Whann ... 19,717
Remedy for epilepsy and other nervous diseases, S. A. Richmond ... 19,722
Remedy for gonorrhœa, R. T. Kelleam ... 19,702
Ribbons, Gartner & Friedenheit ... 19,699
Shears, scissors, and table, pocket, and shaving cutlery, A. J. Jordan ... 19,701
Shoes, men's, E. T. Harvell & Co ... 19,709
Sirup, sodawater, W. E. Bosshard ... 19,728
Soap, Procter & Gamble Company ... 19,724, 19,725
Soap, family, N. K. Fairbank & Company ... 19,696
Soldering flux, Baltimore Chemical Company ... 19,693
Spoons, forks, and tableware, solid and plated, G. E. Shaw ... 19,736
Tanning leather, compound for, F. E. Atteaux & Co ... 19,726, 19,727
Thread, cotton, C. G. Hubert ... 19,700
Tin plate in sheets, Beaufort Tin Plate Company. 19,715, 19,716
Whisky, J. E. Pepper & Co ... 19,705

DESIGNS.

Bottle, W. B. Lillard ... 20,833
Bottle, druggist's show, F. M. Underhill ... 20,836
Lace pin, W. C. Finck ... 20,837
Padlock, J. S. Peacock ... 20,834
Photograph mount, G. F. E. Pearsall ... 20,840
Sign, Z. Marx ... 20,839
Spoon, etc., J. H. & W. H. Bullard ... 20,841
Spoon, etc., G. L. Crowell, Jr ... 20,842
Spoon, etc., A. F. Jackson ... 20,835, 20,838
Spoon, etc., F. Schwatka ... 20,832
Spoon, fork, etc., H. G. Peirsons ... 20,843
Stove, open front, L. Kahn ... 20,831

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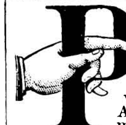

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INDEX.

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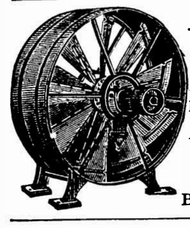

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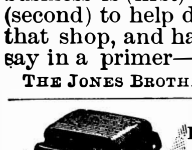

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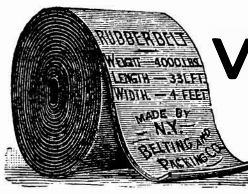

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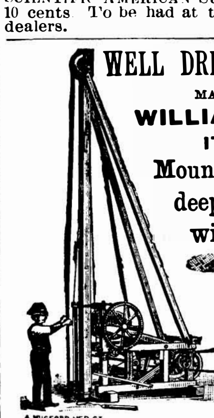

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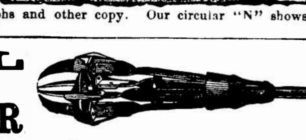

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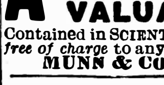

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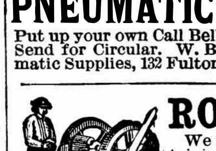

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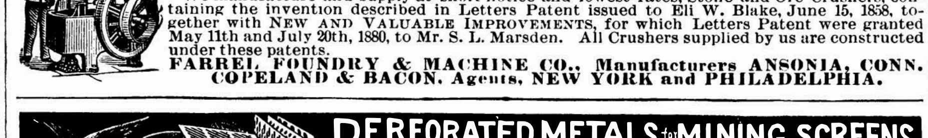

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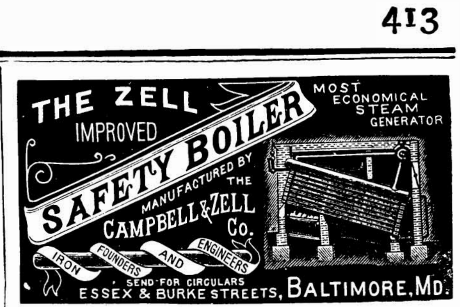

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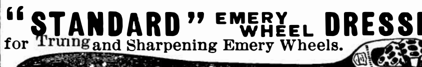

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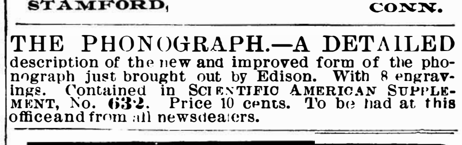

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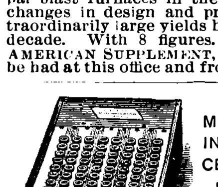

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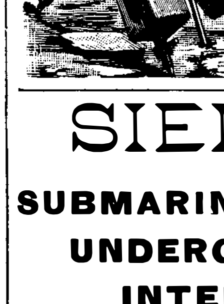

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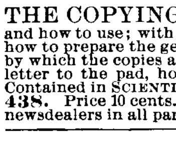

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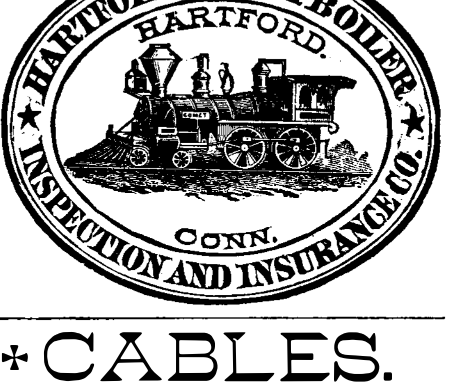

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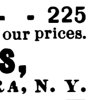

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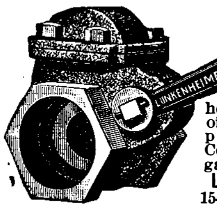

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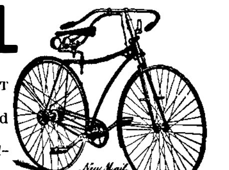

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