

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 213° F., the following averages:

Moisture, water of combination, and organic matter lost on ignition.....	8.00
Phosphate of lime.....	57.66
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 still 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 EARPHONE.—Frederick Schluchter, 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.

THRILL COUPLING.—Augustus Beale, Brooklyn, N. Y. This invention provides a shaft

