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.

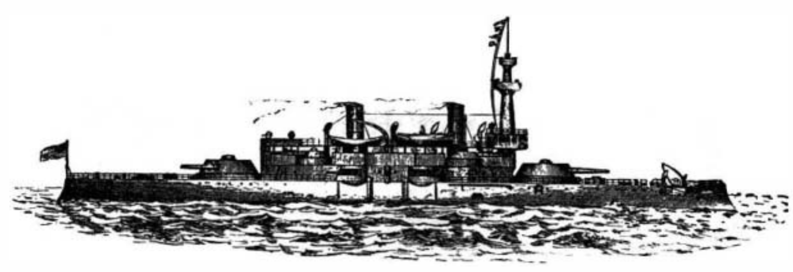
Although nearly all of the Fair buildings will be in Jackson Park, in which the lagoon, canal and basin are located, as shown in our views, Washington Park is also included in the Fair grounds, and the Midway Plaisance, 600 feet wide, connecting the two, in all 1,037 acres. Jackson Park has a frontage 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 MACHINERY HALL.

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 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.

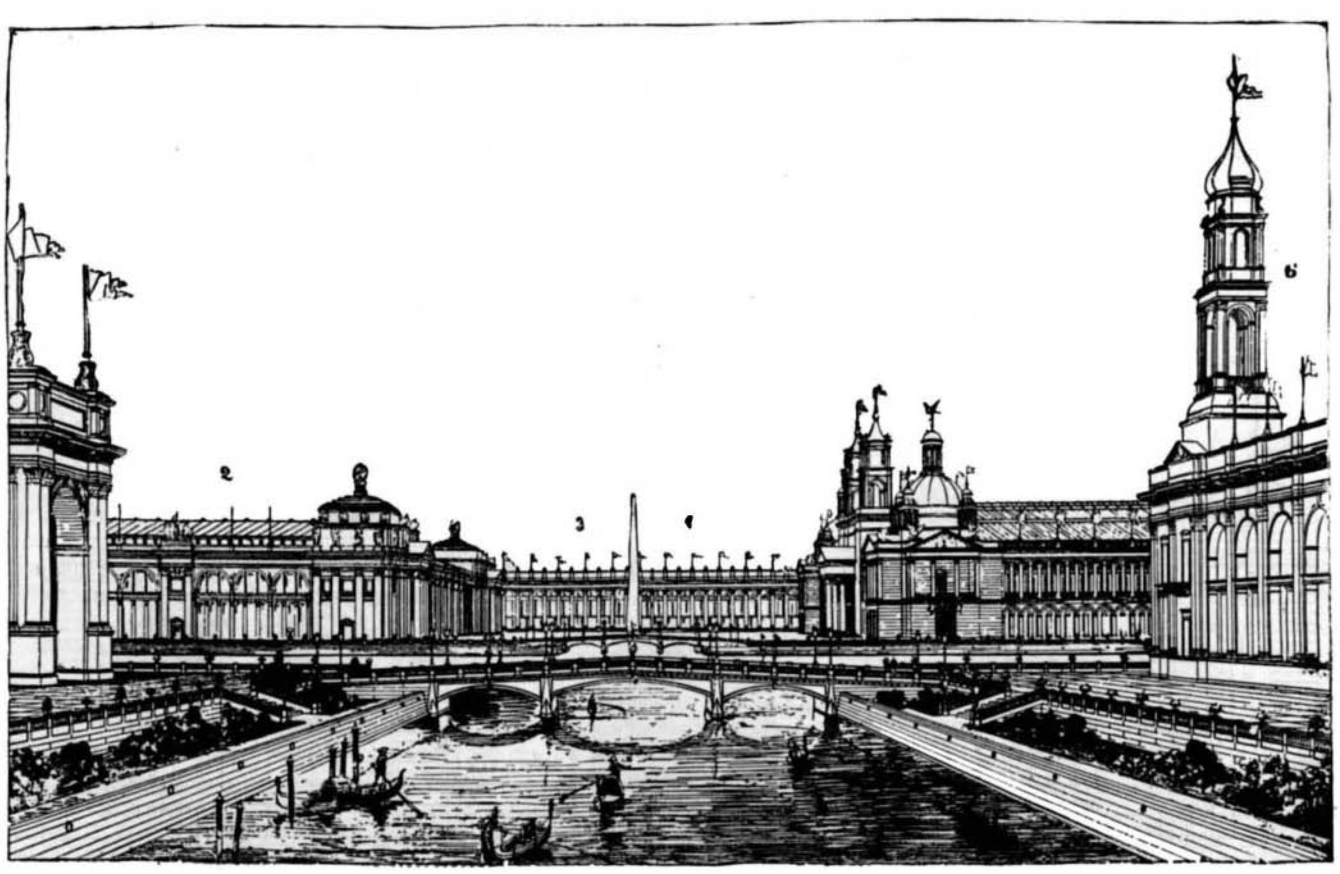


MODEL OF THE BATTLE SHIP ILLINOIS.

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 north west 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.

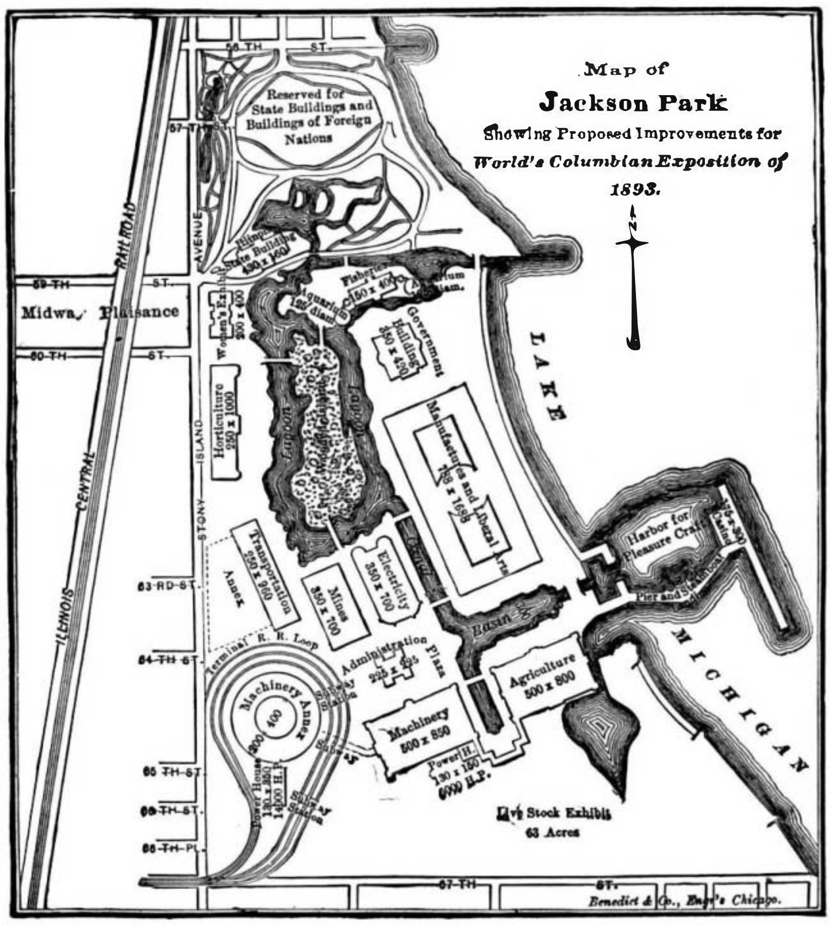
All of the buildings on this grand plaza are designed with a view to making a grand background for displays, and in order to conform to the general richness of the court and add to the festal



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.



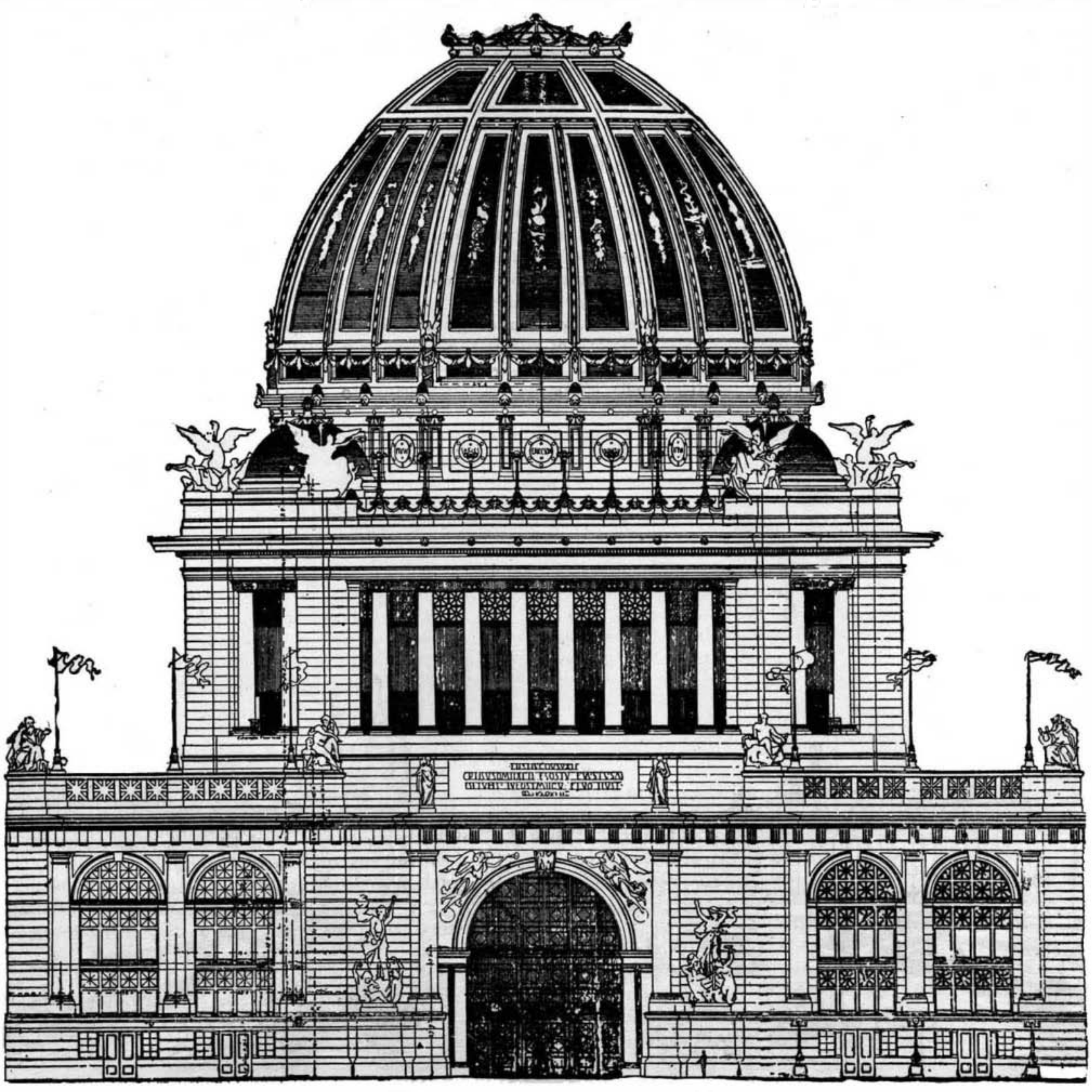
Attached to this great annex will be the power house, containing the tremendous display of boilers, while in the adjoining portion of the annex building will be established the voluminous plant of engines and dynamos. This will be the largest and most interesting display of electrical power ever made. 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.



ADMINISTRATION BUILDING.

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.

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	57·68
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 thence 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