The Wonderful Progress of the Nineteenth Century.

By Colonel John P. Irish.

AFTER the close of this year, 18 will be written no more at the beginning of the century's date line until the centuries are far up in the thousands. The action and events of the nineteenth century are practically recorded, and its achievements are history. Those achievements have been largely in the advance made by science and its application to man's material interests and progress. It is true that science has not stopped with the material, but has gone with investigating vision into ineffable fields, and has found there testimony bearing upon man's physical origin and upon the beginning of animal species, as well as the beginning of this solid world itself. The vast universe around us has been studied, and the composition of distant stars has been analyzed. The principles of light, heat, sound and of all the phenomena by which the physical universe is cognized by man have been developed. During the nineteenth century, therefore, it has come to pass that man has discovered and has lived in a larger world, has known a greater universe, than before. This has caused a change in his intellectual direction, in the channels whereto mind goes to manifest activity. The realm of the known has been so enlarged, and that of the unknown has been so enshrouded, that literature has been affected, and even poetry, which shares with worship the highest exercise of the imagination, has turned to the ponderable and measurable, and less to the mythical and mysterious.

The earliest use of the inventive faculty was in literature. The great manifestations of nature in the visible universe by day and by night enlisted man's attention and inspired in him gratitude or terror, as they ministered to his existence or threatened his destruction. His inventive genius, unaided by science, created causes for what was not understood and put its uses under the direction of personalities of his own creation. The Greek, Norse and other mythologies arose in that use of invention, and they remain attractive monuments to the ingenuity of men addressed to searching for a cause of that which was unknowable. As the area of the known was enlarged the purpose of invention was changed. It seized upon the principles of mechanics, and used the conclusions of science to add to the material store of man. So the nineteenth century has witnessed the wide application of the steam engine, the development of machinery. Electricity had a development that transcends the old idea of magic. Used as a wire-conducted current, it was made to carry messages under the oceans and around the world. It was made a transmitter of the human voice. It was made to illuminate cities, houses, and mines and moving cars. It distributed power to run cars, mills and factories. It was introduced as the agent of chemical change in fluids. This force, that was a terror and mystery until past the middle of the eighteenth and was hidden in laboratory experiments until near the middle of the nineteenth century, by the close thereof had become one of the most commonly used elements, and had become a necessity of civilization. To crown all that man had wrought came Marconi's discovery of wireless telegraphy, which, using the atmosphere as a medium, sends thought through the uncolumned air. This century developed the cotton gin and the spinning machinery, which increased and cheapened the clothing of the world.

Lieutenant Maury's charts of ocean winds and currents and of great circle sailing and the compound steam engine reduced by more than half the cost of commerce by sea. The discovery of Bessemer steel and invention of the air brake and automatic coupling reduced by more than half the cost of transportation by land, which the railway system before had cheapened to what seemed the minimum.

At the meeting of the British Association for the Advancement of Science in 1888 Sir Frederick Bramwell predicted that those who should attend the centenary of the association in 1931 "would see the present steam engines in museums, treated as things to be respected and of antiquarian interest by the engineers of those days, such as are the open topped steam cylinders of Newcomer and of Smeaton to ourselves, and that the heat engine of the future will probably become independent of the vapor of water."

Since then the engine has undergone great improvement. Most people have forgotten that prior to 1875 steamships were not competitors with sail ships in the freight trade, because with the old style marine engine the tonnage was exhausted in carrying coal to propel the ship. A 3000-ton steamer on a long voyage had to carry so much coal that only room was left for 500 tons of freight. With the compound and expansion engines now in use the proportions are reversed and 500 tons of coal will carry twenty-two hundred tons of freight and the ship. Sir Lyon Playfair says that "a cake of coal which would pass through a ring the size of an English shilling when burned in the compound engine of a modern steamer would drive a ton of food and its proportion of the ship two miles."

The London Engineer says that half a sheet of note paper will develop sufficient power when burned under a triple expansion engine to carry a ton a mile on an Atlantic steamer. It needs no mathematical deduction to show how wonderfully such consertation of the coal or of the heat used under boilers has cheapened transportation by water.

This has been pre-eminently the century in which mechanical power has substituted former modes of locomotion and transportation. It was estimated by Poor's Manual for 1887 that the railroads of the United States carried 60,061,068,996 tons of freight one mile, which was equivalent to carrying a thousand tons one mile for every inhabitant of this country, or one ton a thousand miles for each. The average cost of this service was $10 per annum for each individual in our population. Had it been performed by horse-power its cost would have been $200 for each inhabitant, or a sum greater than the value of the entire product of the country. This means that the entire value of all that the people of the United States produced in one year would not have paid the cost of one year's transportation in this country if done by the old methods.

A proper study of these statements will reveal the heavy handicap that is upon any people who have not these modern methods of transportation by land and sea. It brings before the mind the great transformation scene that will occur in any of the hermit nations when they take to themselves this use of mechanical power, which has been the agent in the world's vast increase of production and distribution.

Sir Frederick Bramwell predicted that engines operated independently of the expansive force of steam would largely supplant the vapor of water. He pointed to the gas engine then in use up to an energy of forty horsepower and to the electric dynamo as a means of distributing hydraulic energy, and foresaw in the more volatile products of petroleum the possibilities of a true vapor which by recondensation could be used again indefinitely, with but little loss.

It is now demonstrated that in land transportation all other methods must find in electricity, generated by hydraulic power, a formidable competitor, and that as its use spreads there will appear a further cheapening of the service in response to a decrease in its cost.

The substitution of machinery for the manual operation in all lines of manufacture is another stupendous result of nineteenth century invention.

Taking wheat bread as the unit in food supply under existing mechanical methods, the labor of four men for one year produces as much flour as a thousand men consume in bread. This transfer of power from the hand to machinery and improved tools has wrought equivalent changes throughout the whole field of food production.

Turning to the creation of the other essentials of modern civilization, the manufacture of common brass pins may stand as an illustration. Adam Smith wrote his "Origin of the Wealth of Nations" in 1776. In that work, to illustrate the division of labor required in the manual production of a single article, he had to say: "To take an example, therefore, from a very trifling manufacture but one in which the division of labor has been very often taken notice of — the trade of the pinmaker. A workman not educated to this business nor acquainted with the machinery employed in it could scarce, perhaps with his utmost industry make one pin a day and certainly could not make twenty. But in the way this business is now carried on, not only the whole work is a peculiar trade, but it is divided into numerous branches of which the greater part are also peculiar trades. One man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top to receive the head. To make the head requires three distinct operations, to put it on is a peculiar business, to whiten the pin is another. It is even a trade by itself to put the pins in paper, and the important business of making a pin is thus divided into eighteen distinct operations and each is a trade. In a manufactory where ten men were employed, and where consequently some of them performed two or three distinct operations, they could by exerting themselves make among them twelve pounds of pins a day. There are in a pound 4000 pins. Those ten persons, therefore, could make among them upward of 48,000 pins in a day." Contrasting this with pin-making to-day, a coil of wire is put in its proper place, the end is fastened and the machine does the rest, making 180 pins complete in a minute, its daily output being 108,000 pins.

In a factory three men tend seventy of these machines and their daily output is 7,500,000 pins.

This increase in the potential power of man by labor-aiding mechanism extends throughout the metal and fabric manufacture. It, like the development of the steam engine and of the use of electricity, has come about by nineteenth century ingenuity seizing upon the results of scientific discovery and investigation and combining them, harnessing them, for the use of man. The most of this has been done within the last fifty years. There has been equal progress in the operations of finance and business. A merchant in San Francisco goes to his office in the morning, orders a cargo in Melbourne, Bombay or Calcutta, pays for it in London exchange, has it insured, and by the time he goes to lunch the smart stevedores are putting it on board, and the transaction has occupied less time than a lady requires to buy an Easter hat.

It is no longer necessary to accumulate great stocks of merchandise produced at a distance. The India wharf and warehouses in Boston are obsoleted. The ocean cables and system of exchange make the handling of goods from the antipodes as little difficult as ordering meat for dinner by telephone from the market stall ten blocks away.

This has enabled high commercial organization and has easily put it in the power of the business men of the world to avert anywhere on the planet the fluctuation in prices formerly caused by glut or famine. It has raised the intellectual plane of all occupations. At the beginning of the century the farmer was everywhere a peasant, with no horizon beyond his landmarks. At its close the farmer is an international merchant. He knows how the products that compete with his are growing in every country. He is aware daily of the condition of wheat on the Rio de la Plata, in the valley of the Euphrates, on the Black Sea; of cotton on the Nile, cane in Penang, tobacco in Cuba, raisin grapes in Valencia and the Ionian Isles, and wine grapes in Burgundy, Dijon, Bingen, Nassau and Rheims. He knows the wool clip in Australian paddocks and the Scotch highlands. To him the world in every zone is more familiar than were the resources of his farm a hundred years ago. Then the chemistry of soils was a laboratory secret. He knew not why some land was fruitful and some barren. Now he can know the exact proportion of lime, phosphoric acid or other elements that may be lacking or present in excess, and can add or subtract them by applying the knowledge that science has put within his reach. For his benefit botany has been rewritten. The scientific discoveries of Darwin demonstrated the influence of sex in all flora. He had had from the time of Jacob some comprehension of prenatal influence upon animals and had applied the principle of heredity to develop individual qualities into separate strains or breeds of the same race. The new botany in the hands of the hybridizer has made it possible to combine in required proportions the flavors, the edible principle, the desirable qualities of economic plants, to secure exactly the same mingling in them of the vital principle as is secured in the cross-breeding of animals and to the same end, the securing of greater excellence. Up to this employment of botany in the interest of the farmer man had depended for this differentiation of species and the effect of change in environment upon vagrant insects, animals and birds, which respectively fertilized or hybridized, or by the transportation of seeds changed the habitat of plants and modified them by the new environment. But now science breeds plants out of the torrid into the temperate zone, inbreeds new qualities, creates new varieties, and thereby enriches the catalogue of crops out of which the energy of man increases the supply of his wants and swells the gains of his labor. In the beginning of the nineteenth century man stood helpless in the presence of many forms of fungi that destroyed his crops and of insects that preyed upon his fields and orchards. But now science has taught him the use of fungicides, and that, in nature's great plan, for every destructive insect there is an insect destroyer that feeds upon it. Formerly it was understood that the ravages of rats and mice might be restrained by breeding cats and ferrets to prey upon them, and dogs were trained to protect the flocks at night against wolves. Now colonies of beneficial insects are bred to be turned loose in defense of grain and fruit against other insects, and the certainty of crops has been correspondingly increased. California has not only had a great interest in this practical application of botany and entomology, but has furnished a field nowhere else as available for experiments. Here hybridizing and the development of "sports" in plants into new sorts are ministered to by a climate and a precocity of vegetable growth not found elsewhere on the planet, and here Burbank, the king of experimenters, and others have produced results that have shown how far the subordination of nature to the purpose of man may be carried by those who are wise in her ways. Along with these marvelous changes in the economic conditions of man and the extension of his knowledge of nature and of the conversion of her forces to his use has of necessity gone great progress in pedagogics. The classical has had to surrender standing room to the practical education, metaphysics has lost in importance and physics has gained. At the same time the training is for equipment in the activities of real life upon which the student must enter. Practically it is the renaissance of the methods of Aristotle applied to the immeasurable riches which have been smelted by investigation out of the ores which science had been accumulating for centuries. So modern methods of education have moved forward as a part of that great mobilization of the mind which has made the last half of the century the most stirring time the world has known. That profound economic disturbance has resulted from this change in the direction and purpose of education and this conversion of natural forces into the hewers of wood and drawers of water is true. The pessimistic view of this disturbance has been illustrated by a writer on economic subjects with an Oriental legend of magic. A certain man having by great learning obtained knowledge of an incantation whereby he could compel inanimate objects to work for him, commanded a stick to bring him water. But when water sufficient for his necessities had been brought and there was threatened danger of an oversupply, he desired the stick to stop working. Having, however, omitted to learn the words for revoking the incantation, the stick refused to obey. Thereupon the magician in anger caught up an ax and, with a view to destroy or diminish the power of the stick to perform work, chopped it into several pieces; whereupon each piece immediately began to bring as much water as one had formerly done, and in the end not only the magician but the whole world was deluged and destroyed.

This represents the views of some upon the subject of applying science to the increase of production. But there is another side to it. In 1798, only five score and one years ago, the philosopher Malthus foresaw the obliteration of the human race by failure of the food supply. It is an iron law of nature that everywhere all the various forms of life rise and multiply and fall and cease, in harmony with the fluctuations in the production of whatever supports life. Malthus, aware of this law, discovered that the human race increased in a geometrical ratio, while the food supply of man increased in an arithmetrical ratio. It is the fashion to sneer at Malthus, but, given a continuance of the conditions under which man existed at the time he wrote, only a century ago, by this time the race would have been overtaken by a famine and its effacement would now be in operation, to continue down to the equilibrium between population and food supply. But science has disturbed the relation of the ratios, and has approximated the food supply to the mouths that hunger, in ways that neither Adam Smith nor Malthus foresaw. The many ways in which this has been done make up the sum of man's control of the forces of nature, which are the peculiar glory of the nineteenth century.

Now the pessimist who sneers at Malthus sees the reverse of the danger which that philosopher saw a century ago. Man having set inanimate objects at work to supply him with the necessaries of life finds that the sticks that toil for him cannot be stopped. Toward the end of the nineteenth century bread was more plentiful and cheaper than Malthus had ever seen it, and now the pessimists are appalled because the sticks that toil for man seem to them to be in danger of so overwhelming him with a supply of his physical wants that the race, instead of dying of famine, will perish of surfeit.

Bacteriology and antisepsis have so extended the healing art in all its branches, including sanitation and surgery, as to increase the persistence of the race. Medicine no longer stands powerless in the presence of smallpox, cholera and the plague, and is rapidly moving to the conquest of those scourges of the flesh—cancer and consumption.

In corresponding progress in pedagogics and all means of human enlightenment, the nineteenth century salutes the twentieth and challenges competition with what it has wrought.

Our Powerful New Explosive.

The War Department's adoption of thorite is the military event of the year. Uncle Sam will see to it that no foreign power learns a jot as to its secret manufacture. These precautions alone attest that it is precious stuff. Its mysteries have been confided to only a handful of high military officers pledged to solemn secrecy. Thorite has solved vexed problems racking the brains of our most skilful ordnance experts for five years or more. Uncle Sam durning this time has scoured the earth for a man able to furnish him a highly explosive shell capable of accomplishing two things, viz.: First, alighting from a high-power gun without danger of explosion from the shock in the breech of the weapon, second, striking its mark without exploding from the force of impact, but at any desired time after impact. It was during last summer that Dr. Hiram P. Tuttle, a wizard from the far Western city of Tacoma, Wash., journeyed to the national capital and made the proposition to the army's board of ordnance and fortifications that he prove his ability to furnish the desired article. Shortly afterward General Miles issued an order enforcing to the letter an old rule barring admittance to Government tests. A few weeks later the mysterious wizard of the West did wondrous things up at Sandy Hook. The official adoption of thorite recently is the result. That thorite could be fired with perfect safety and without possible danger to gun or gunner was readily demonstrated by numerous tests. It was fired by guns of various sizes by both black and smokeless powder. That intense heat brought in direct contact with it could not affect it in any way was proved by the inventor in a striking test. He heated a poker red-hot and thrust it into a two-pound can of the explosive without any perceptible result. Other tests demonstrated that not even the pressure of the heaviest siege guns—40,000 pounds to the square inch—could affect it. A 12-inch service shell charged with thirty-nine pounds of thorite was fired from a huge sea coast rifle. No fuse was fixed. The explosive shell withstood the enormous pressure caused by the explosion of 450 pounds of brown powder at its base and went out to sea without uttering a sound or suffering any destruction. Had this shell been fused it would have been exploded exactly when it struck the water, and the force of the explosion would have been sufficient to sink any heavily armored battle-ship in the vicinity.

Tests of the safety of other high explosives during the firing process have resulted disastrously at our various proving grounds. Several years ago a dynamite shell, fired from an experimental Dudley gun, burst the breech of the weapon and hurled its fragments in every direction. General Miles and a delegation of officers that day had the narrowest escape of their lives, and it was regarded as a miracle that they were not all killed. During a test at the Indian Head proving ground a 13-inch gun was badly damaged by the explosion in its breech of 315 pounds of gun-cotton. At another time a gun loaded with a 15-inch shell containing 230 pounds of the high explosive, emmensite, burst to splinterseens. Such experiments with high explosives were discouraged for a while by an accident in 1897, when a Gathman shell burst in the breech of a very valuable gun, badly damaging the weapon and the expensive hydraulic mount. The explosion tore up the railroad tracks at the proving ground, destroyed one of the heavy bomb-proofs used in the experiment and damaged property in the neighborhood. Fragments of the shell hurled a mile away fell into the river a short distance from a tug carrying experts witnessing the trial.

That this new element of warfare would not explode from the shock of impact but would reap its hellish harvest of death at any other moment desired by the gunner was proven in a more fascinating series of secret tests. Ten-inch shells filled with it were left without fuses necessary to its explosion and were fired entirely through huge chunks of Harveyized steel armor-plate 4½ inches thick. Regardless of the terrific shock and tremendous friction these shells did not explode. In another trial a large iron shell of 132 pounds weight and 7 inches in diameter was loaded with only 4 pounds of the new explosive and placed inside a square enclosure strongly built of steel. Connection was made by wire between the shell and an electric circuit. The purpose of the steel enclosure was to collect the flying pieces of the shell—in other words, to test its "fragmentary power." This power is necessarily an important consideration. The explosive capable of bursting its shell into the most pieces is the most destructive in warfare, since it endangers the greatest number of lives. An electric button was touched and after the explosion several men were delegated to gather the scraps of iron within the enclosure. They counted 20,000 visible fragments. To determine destructive power shells which had been fused were fired from a 2½-inch Sims-Dudley gun down the beach at Sandy Hook. Great "craters" left in the sand were sufficient proof that thorite is as powerful as the strongest blasting gelatine.

Thorite shells cannot possibly explode save by aid of a certain time fuse or detonator devised by the inventor. Indeed, this was the all-important fact brought out by the tests, in other words it can be hammered and battered around during transportation and subjected to various temperatures, loaded in either cans or shells. No accident can occur unless the detonator is attached and set. The new explosive, furthermore, needs no particular make of shell, but can be put in any. Another advantage is that its power does not weaken during long storage. Unlike any other high explosive it will last for an indefinite period.

The Philippine insurgents will be the first to suffer from the effects of thorite. Dr. Tuttle will be busy this winter at Sandy Hook. There he will erect a laboratory and manufacture his compound. This workshop will be shrouded in deeper mystery than were those of the alchemists of old. He will be aided by his son and Lieutenant Charles F. Parker of the Second Artillery, both pledged not to disclose the secret formula. The Ordnance Department has already shipped to the doctor sufficient raw materials to manufacture several thousand pounds of the explosive within the next two months. What these materials are will not be disclosed. The finished product will be placed in shells of 3.2-inch caliber for the light artillery guns, and other sizes are required. The shells will be shot from guns charged with gunpowder, smokeless or black. The War Department has just purchased a dozen Maxim mountain guns of the same type as used by the British in the Khartoum, Omdurman and Transvaal campaigns. These will soon arrive in Manila and shells for them will be supplied, although the department has ordered 5000 rounds of ammunition such as is used with them in Europe. A few weeks ago Lieutenant Buckley of the artillery was ordered to inspect the principal arsenals of Europe, investigate their organizations of mountain batteries and report.

Introduction of Electricity in Constantinople.

Till recently the employment of electricity in any shape or form in Constantinople was strictly forbidden. For an unfortunate official to mention the word "electricity" in the hearing of the Sultan was as much as his place, if not his head, was worth. Incredible as it may seem his Serene Highness naively imagined that a dynamo must have something to do with the manufacture of dynamite. So much is there in a name. The final triumph over the prejudice of the Sultan is said to have been due to a Spaniard and the cinematograph. This Spaniard, Don Ramirez by name, started a circus in Constantinople, and in order to be up to date, imported a cinematograph. But the city authorities would not allow him to set his new instrument in operation, because it had to be driven by the condemned electricity. In his difficulty he applied to his Embassador, who promised to do his best for him. During the next audience which he had with the Sultan, the wily diplomat took occasion to enlarge on the wonders of the cinematograph, and interested the Sultan so much that Don Ramirez was ordered to bring his instrument to the palace. Moving scenes from the leading capitals of Europe were thrown upon the screen for the delectation of the Sultan, who no doubt enjoyed them all the more since he is not, like his friend the German Kaiser, a great traveler. Among the direct results of this exhibition was that the Sultan became convinced that electricity, though produced by a dynamo or a battery, had no connection with dangerous explosives; the lucky Don got kudos and wealth, and permission was granted to him to install in his circus the first electric-lighting plant in Constantinople.

Color healing is practiced in certain quarters of India. It consists in administering water in glasses of different colors, from which color the draught is supposed to obtain properties magical in their effect. Water in a red glass will "cure" epilepsy, insomnia, nervous diseases, the plague, fevers and ague and half a score of other diseases which mortal flesh is heir to. Water in a blue glass is a sovereign remedy for the palsy, for falling sickness, for typhoid and for numerous other allied and non-related complaints. If put in a green glass it is a specific for other troubles, and when in a yellow glass, strange to say, exercises curative properties in liver disorders. If the patient is endowed with faith the cure is prompt.