the result was that on November 10, 1894, diplomatic relations were broken off, and since this time a French army has been attempting to make the French protectorate of the island effective. The French have had considerable liberty of action in Madagascar on account of existing agreements which protect her from any foreign interference. The Hovas works, near Tamatave, were bombarded by French cruisers on April 4, 1895, and on May 2 the Hovas suffered disastrous defeats at Marovoay and Ampiharama. General Duchesne, who was appointed to the chief command, arrived from France at Majunga May 6, and immediately begun marching on Antananarivo, meeting with considerable opposition.

Our engraving shows the landing of live stock for the French army.

An English military officer, lately employed by the Hova government as commander-in-chief, writes to the London Times as follows:

In the 150 miles of country already covered by General Duchesne's force it is but fair to admit that great difficulties have been overcome, but now they have to deal with mountain ranges and to pass through the fever-stricken district of Vonizongo. Up to the present the French troops have had to make roads at an altitude of 1,500 ft. at the most, but they have yet to scale the heights of Fihonana, 35 miles from the capital, and the chief town of the Vonizongo district of Imerina, at an altitude of at least 6,000 ft. above sea level. After leaving Andriba, their present position according to the latest telegrams, the expedition will cross a large and well populated valley about six miles in extent to Mangasoavina, from which point right up to the capital they will have to proceed along the top of mountain ridges and through deep valleys and ravines, cutting their way as they go along a track flanked with positions which can be defended with the greatest ease—a route involving, from what I have seen, the greatest engineering difficulties possible.

During the last war with France the intention of the Hovas, in the event of a French advance on the capital (which, of course, never took place), was to mass the whole of the population some 15 or 20 miles from the capital, where the queen herself would have been present to encourage her troops and where the high Hova officials would have been gathered. These were the Hova tactics, and doubtless they are the Hova tactics now.

Asked to explain the attitude of the Hovas toward the French, the late Malagasy commander-in-chief remarked:

"There is a strong party in the capital in favor of the French—composed of members of the cabinet and other high officials. Apart from this section, the Hova people are most inimical to the French, and I do not for a moment suppose they would agree to any terms unless they saw their case to be hopeless. They are, on the contrary, much more likely to sweep away the French party and insist upon proper steps being taken to keep the French out. The Hova officers are one of the great drawbacks. They are greedy and grasping men, who rob the soldiers and think only of their own aggrandizement, and, instead of feeding the troops, steal the ration money.

"Both the queen and prime minister are thoroughly loyal to their country, but are deceived by designing persons. As far as arms and ammunition are concerned, the Hovas have all that can be desired. Their artillery and machine guns are of the latest and most approved patterns, and, numerically, are far superior to those accompanying the French expedition. Their small arms are Sniders and Remingtons, which, if properly handled, are good enough for the purpose required.

"The Hova is a splendid soldier behind earthworks, but incapable of meeting European troops in the open. With regard to the strength of the Malagasy army, while it would be impolitic to go into details, I may say that there are at least 50,000 men armed with breech-loading rifles, and with a splendid artillery, and certainly not less than 150,000 more or less trained men available, but indifferently armed. On the red flag being run up at the palace the whole population who are liable to service would assemble in a few hours and be dispatched to their various stations. A large number of the officers have already had considerable experience in fighting the French, and both they and their men have been for years well versed in military tactics."

On the political future of Madagascar Colonel Sherinton, in conclusion, said:

"The present misrule and the tyranny of the governing classes is such that even French rule would be an improvement. Madagascar has a great future before her with proper European administration. I do not believe the French mean to seize the country, but I think they will be satisfied with the establishment of an effective protectorate. The difficulties of occupying the island as a possession are enormous, and it will probably be administered by Hovas under French official supervision."

LONG RANGE RIFLE PRACTICE.

By A. G. HOLCOMBE.

RIFLE practice at long range is accompanied by an irksome tax on the mind, to relieve which any device is welcome.

It is absolutely necessary to carefully clean the rifle after each shot; to watch the light and calculate the strength and direction of the wind, and note the effect it will have on the ball.

The adjustment of the sights under the same atmospheric conditions varies with the distance to be shot over.

To relieve the mind and simplify calculation, I formulated the diagrams published herewith and pasted them in the front page of my score book. By the use of them I was enabled to make some remarkably good scores after very little practice, and I have no doubt they will prove a valuable aid to others.

The regulation targets for long range shooting are six feet in height and twelve feet broad. A square six feet on the sides occupies the middle. Inside this square is the center ring, four and one-half feet across, with its bull's eye three feet in diameter. The space, three feet by six, on either side of the square is called the outer.

The distance to be shot over for this target is five

hundred, eight hundred, nine hundred and one thousand yards.

The rifle is provided with front and rear sights, which are (when the rear sight is on the heel of the rifle) about four feet apart, the front sight being attached to the movable wind gage. The scale by which the wind gage is regulated is divided by lines one-fortieth of an inch apart. The rear sight of the rifle is a sliding eyepiece on the Vernier scale for elevation, the points representing the one one-hundredth part of an inch.

To lay out a diagram for the one thousand yard range (or any other distance), a drawing is first to be made of the target, on a scale say of three-eighths of an inch to the foot. On this diagram two heavy black

THE STANDARD TARGET.

lines are to be drawn, one a perpendicular line passing through the center of the bull's eye from top to bottom of the target and the other a horizontal line passing through the center of the bull's eye and extending to the sides of the target. These lines are the starting points from which to count, right or left from the perpendicular line, for the points on the wind gage, and above and below the horizontal line for the point of elevation, the entire target being divided into spaces by fine red lines, those for the elevation and wind gage being calculated separately.

To lay out on the one thousand yard range diagram the spaces for the elevation, the distance between the butts and the target, i. e., three thousand feet, is to be taken, and divided by the distance between the front and rear sights on the rifle, which we will assume to be four feet. This gives 750 parts. This sum, multi-

plied by one space of the rear sight, namely, one one-hundredth of an inch, gives 7.5 inches for the height of each space on the target, which, when reduced to scale and set off on the diagram above and below the horizontal line, give four spaces on each side of it, with part of a space remaining above and below.

To lay out on the same one thousand yard diagram the spaces for the wind gage the same rule is to be followed. The three thousand feet divided by four gives 750 parts, which multiplied by one-fortieth of an inch—one space on the wind gage—gives eighteen and three-fourths inches for each of the spaces on the target. These spaces reduced to scale are set off right and left from the perpendicular line running through the center of the diagram, three of them on each side

of it and part of a space remaining on either outer side. The diagram, which is now completed, may be pasted in the score book.

If when shooting over the one thousand yard range the rifleman should see that his ball has struck on the extreme upper right hand corner of the target, he could, by referring to his diagram and counting on it the number of spaces between the horizontal line and where his shot struck, see that his rear sight would

have to be lowered five points to bring him level with the center of the bull's eye; and his wind gage (the wind and other conditions remaining the same as at the time of the previous shot) would have to be moved four points to the right to bring him in line with the bull's eye center.

To lay out on the diagram the elevation spaces for the midrange or 500 yard target, the same rule must be

500 YARD DIAGRAM.

followed, the size of the target being six feet by six, with a 22 inch bull's eye.

The distance, 1,500 feet, is divided by 4, and this sum, 375, multiplied by $\frac{1}{100}$ of an inch, gives 3.75 inches for each space on the target, and this when reduced to scale gives on the diagram nine spaces and part of a space above the horizontal line, and nine spaces and part of a space below it. To lay out on the same diagram the spaces for the wind gage, the 1,500 feet is divided by 4, giving the same 375; this multiplied by $\frac{1}{40}$ of an inch gives 9.375 inches for the target spaces, which, when reduced to scale on the diagram, gives three spaces and part of a space for each side of the perpendicular line.

By following the same rule in laying out the spaces on the 800 yard diagram, for the elevation, the distance 2,400 feet is divided by 4, which gives 600, this multi-

800 YARD DIAGRAM.

plied by 0.01 of an inch gives 6 inches. In each of the 3 feet (36 inches) between the horizontal line and the upper and lower edges of the target there will be six equal spaces of 6 inches each. To lay out on this 800 yard diagram the spaces for the wind gage, the 2,400 feet, divided by 4, gives 600. This multiplied by $\frac{1}{40}$ gives target spaces of 15 inches each. These when reduced to scale give 4 spaces and $\frac{3}{4}$ of a space on either side of the perpendicular center line of the diagram.

We present with this the diagrams for the 500, 800 and 1,000 yard ranges, drawn to a scale of three-eighths of an inch to the foot. The distances usually shot over being 500, 800, 900 and 1,000 yards. These diagrams will be found sufficiently correct for practical use.

Here it may be well to remind the reader that in constructing diagrams a separate calculation must be

1,000 YARD DIAGRAM.

made for the different distances shot over, and for the distance the sights on the rifle are apart, also the number of spaces to the inch that the scales of the sights are graduated to. The rule is this: Divide the distance between the butts and the target by the distance between the front and rear sights on the rifle, and multiply the quotient by the distance represented by one point on the scale of the movable sights. This gives the size of the space on the target covered by one

of it and part of a space remaining on either outer side. The diagram, which is now completed, may be pasted in the score book.

of it and part of a space remaining on either outer side. The diagram, which is now completed, may be pasted in the score book.

space of the gage. This is then to be reduced to the scale adopted for the diagram.—The Amateur Sportsman.

THE RELATION OF ENGINEERING TO ECONOMICS.*

By WILLIAM KENT.

IN the first page of Mr. J. R. McCullough's "Introductory Discourse" (published in 1828) to his edition of Dr. Adam Smith's great work, "An Inquiry into the Nature and Causes of the Wealth of Nations," he gives one of the best definitions we have of the science of political economy. "Its object," he says, "is to point out the means by which the industry of man may be rendered most productive of those necessities, comforts and enjoyments which constitute wealth; to ascertain the proportion in which this wealth is divided among the different classes of the community and the mode in which it may be most advantageously consumed."

The definition of engineering given by Telford and incorporated into the charter of the British Institution of Civil Engineers, is "The art of directing the great sources of power in nature for the use and convenience of man." Rankine says: "The engineer is he who by art and science makes the mechanical properties of matter serve the ends of man."

Mr. George S. Morison, president of the American Society of Civil Engineers, in his address at the convention of the society in June of this year, says:

"Every engineering work is built for a special ulterior end; it is a tool to accomplish some specific purpose. Engine is but another name for tool. The highest development of a tool is an engine which manufactures power."

Comparing the above definitions of political economy and of engineering, we find they are closely related. Political economy, according to McCullough, points out the means by which the industry of man may be rendered most productive of wealth. If we asked the merest tyro in knowledge of human industry by what means industry might be rendered most productive, he would naturally answer "By the use of tools." The engineer is the tool builder. His best work is the building of an engine which manufactures power, makes industry most productive and manufactures commodities which are the elements of wealth. Political economy, which points out the means by which industry may be made most productive, should, therefore, point out tools and engines. But, strange to say, the writers on political economy have almost entirely neglected to point out those means. Their "dismal science," as it is called, generally points out everything but tools and engines. It treats of buying and selling, of supply and demand, of rents, interest and wages, of tariffs, of money and currency, of land values, taxes, and what not; but, with rare exceptions, does not mention engineering, which is the most potent force in the economics of the nineteenth century.

Adam Smith, the first great English writer on political economy, writing in 1776, when he was, of course, not to be blamed for knowing nothing of the engineering of this century, said: "The greatest improvement in the productive power of labor, and the greater part of the skill, dexterity and judgment with which it is anywhere directed or applied, seem to have been the effects of the division of labor." He gives a famous instance of division of labor in the manufacture of pins. One man, he said, might with difficulty make one pin a day, and certainly could not make twenty. But as the manufacture was carried on in his day, by division of labor one man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head, and so on, dividing the labor up among ten men and eighteen different operations.

Those ten men thus made between them 48,000 pins per day. Most writers on political economy have followed Adam Smith, and given division of labor the credit for making the greatest improvement in production, and neglected the still more important improvement, the introduction of machinery, by which the labor of the ten men was all done by a machine with one man tending it. But I find that Robert Ellis Thompson in his work on political economy (1875) mentions the case of the pin industry in its modern phase. He says: "An inventive mechanic has put together a machine that only needs to be fed with wire, well oiled and supplied with steam power, to turn out complete pins, sorts them and even thrusts them into the papers in the right numbers and in straight rows."

The example of the pin industry may be taken as representative of what has taken place in every branch of productive industry. By the use of the steam engine and of other machinery the productive power of human labor has been increased a thousandfold, and engineering thus becomes the most important force which has caused an industrial and economic revolution throughout the civilized world, and the one subject of all others which should be discussed by a political economist.

Political economy being broadly the science of wealth, and since wealth is property, and property, according to some writers of the socialistic school, is robbery, it may be well to get our bearings here, and see whether wealth is a thing to be desired or not. I quote here the words of Mr. McCullough in his "Introductory Discourse," above mentioned, and without further argument may say that I agree with him entirely.

"The acquisition of wealth is not desirable merely as the means of procuring immediate and direct gratification, but as being indispensably necessary to the advancement of society in civilization and refinement. Without the tranquillity and leisure afforded by the possession of accumulated wealth, those speculative and elegant studies which expand and enlarge our views, purify our taste and lift us higher in the scale of beings, can never be successfully prosecuted. It is certain, indeed, that the comparative barbarism and refinement of nations depend more upon the comparative amount of their wealth than on any other circumstance. It is impossible to name a single nation which has made any distinguished figure either in

philosophy or the fine arts without having been at the same time celebrated for its wealth."

Having thus settled the question of the desirability of wealth, let us consider what is the engineer's share in its production. The great forces of nature which the engineer utilizes for the production of wealth are the forces of wind and of running water, and the stored energy of fuel in the forests, peat bogs, coal mines, and gas and oil wells. By far the greatest of these forms of stored energy is that of coal. Let us compare for a moment the work that can be done by a ton of coal with the muscular power of men. One man digging coal from the side of a hill can easily dig two tons, say 4,000 lb. of coal, in a day. Another man running a boiler and engine can burn these same two tons under a boiler, and if the engine is a moderately good non-condensing engine using 3 lb. of coal per indicated horse power per hour, it will develop from the two tons of coal 133 horse power for 10 hours, equivalent to the physical labor that could be done by 1,300 men. Thus a man's labor by means of coal and a steam engine can be multiplied 650 times. But if we use a large high-grade triple expansion, condensing engine, it will require only half as much coal per horse power, and then if we set the engine to work to mine the coal itself, through the agency of mining machinery, and to feed its own coal to the boiler by means of automatic stokers, we see that the effectiveness of man's labor can be still more vastly increased.

Let us consider some of the results which the engineer has been able to accomplish by the utilization of coal.

In my study of the subject of this address, while I have failed to find it properly treated in any of the standard works on political economy to which I have had access, I have found it discussed in a more or less fragmentary manner in writings and addresses of numerous engineers, statisticians and other specialists, and since it is more convenient to quote largely from their writings than to write anything original, I will now trouble you with some quotations.

I first quote from a recent lecture by Mr. Edward Orton, State Geologist of Ohio, before the Ohio Mining Institute:

"All the great applications of the stored power of the world belong to the nineteenth century, and the most important of them belong to the last fifty years. What has been done within this century constitutes by far the most important chapter in the economic history of the race. Fossil power lies at the root and center of this unparalleled advance. In Great Britain alone coal does the work of more than 100,000,000 men. It adds to the wealth of these fortunate islands on this basis.

"The great powers, those that are making over the world, are steam and electricity. The steam engine lies at the bottom of by far the greatest industrial and economic revolution through which the race has ever passed, and steam is now being reinforced by the new motor, from which we justly expect so much.

"We note some further consequences of the discovery and use of fossil power on the large scale. We shall find the most striking characteristics of our day and age, so far as the material side of life is concerned, centering around this one element. What are these characteristics of the nineteenth century? There are no more distinctive features of our time than the two following—viz., the remarkable growth of cities throughout the civilized world and the unparalleled increase of the wealth of men. Both take their rise in coal; both are conditioned by its use in all their phases and stages. All modern manufactures are absolutely dependent on the stored force of coal. Machinery driven by this power is everywhere replacing the skilled labor of the olden time. Cities grow largely by massing the ruder labor that our modern factories can utilize.

"With this growth of cities in the modern world, a group of problems arises, all of which are new and of which we are obliged to work out the solutions. No other problems of equal gravity and urgency confront the statesman, philosopher or philanthropist of our day. All of them have their root in coal."

Mr. John Birkinbine, Past President of the American Institute of Mining Engineers, estimates that if only one per cent. of the consumption of fuel of all kinds in the United States, including coal, wood, oil and gas, were saved, it would be equal to 2,300,000 tons of coal per year. It is the work of the engineer to devise ways and means to accomplish this saving and more.

Mr. Chas. H. Loring, Past President of the American Society of Mechanical Engineers, in his presidential address in 1892 thus spoke of the influence of the steam engine upon civilization:

"The civilizations of antiquity were limited to a few cities, and were based upon a slave labor, the slaves being drained from other places, which were thus doomed to deepening barbarism.

"The disgrace of the ancient civilization was its utter want of humanity. Justice, benevolence and mercy held but little sway; force, fraud and cruelty supplanted them. Nor could anything better be expected of an organization based upon the worst system of slavery that ever shocked the sensibilities of man. As long as human slavery was the origin and support of civilization, the latter had to be brutal, for the stream could not rise higher than its source. Such a civilization, after a rapid culmination, had to decay, and history, though vague, shows its lapse into a barbarism as dark as that from which it had emerged.

"Modern civilization also has at its base a toiling slave, but one differing widely from his predecessor of the ancients. He is without nerves and he does not know fatigue. There is no intermission in his work, and he performs in a small compass more than the labor of nations of human slaves. He is not only vastly stronger, but vastly cheaper than they. He works interminably, and he works at everything; from the finest to the coarsest he is equally applicable. He produces all things in such abundance that man, relieved from the greater part of his servile toil, realizes for the first time his title of Lord of Creation. The products of all the great arts of our civilization, the use of cheap and rapid transportation on land and water, and of printing, density of population everywhere, the instruments of peace and war, the acquisition of knowledge of all kinds, are made the possibility and the possession of all by the labor of this obedient slave, which we call Steam Engine.

"We who were born under this benign influence but vaguely appreciate its value, and rarely recognize our obligations to it; existing civilizations would be impossible without it, and if human ingenuity finds no substitute for it, they will perish with it.

"The steam engine is a machine which has been the prolific parent of other machines. It has caused the invention and construction of the immense plant of ingenious power tools employed in its own fabrication; it has caused the improvement of metallurgy as a science and of the various methods of metal manufacture as an art; it may be said to have created whole branches of important manufacture, and to have been the occasion of the invention of the immense mass of highly diversified machinery by means of which these manufactures are practiced; and, last and greatest, it has stimulated and directed the human intellect as nothing else ever has, and has done more to advance human nature to a higher plane than all which statesmen, generals, monarchs, philosophers, priests and artists have ever accomplished in the vast interval which separates original man from the man of to-day. It has raised man from an animal to something approaching what a great intelligence should be by simply placing in his hands a limitless physical power capable of application in every conceivable direction and to every conceivable purpose."

The value of the invention of Bessemer steel to the human race is discussed as follows in an address by Mr. Abram S. Hewitt in 1890 ("Trans. Amer. Inst. Mining Engineers," Vol. XIX, p. 518):

"The Bessemer invention takes its rank with the great events which have changed the face of society since the middle ages. The invention of printing, the construction of the magnetic compass, the discovery of America and the introduction of the steam engine are the only capital events in modern history which belong to the same category as the Bessemer process. They are all examples of the law of progress, which evolves moral and social results from material development. The face of society has been transformed by these discoveries and inventions.

"Steel is now produced at a cost less than that of common iron. This has led to an enormous extension in its use and to a great reduction in the cost of the machinery which carries on the operations of society. The effect has been most marked in three particulars: First, the cost of constructing railways has been so greatly lessened as to permit of their extension into sparsely inhabited regions, and the consequent occupation of distant territory otherwise beyond the reach of settlement; second, the cost of transportation has been reduced to so low a point as to bring into the markets of the world crude products which formerly would not bear removal, and were thus excluded from the exchanges of commerce; third, the practical result of these two causes has been to reduce the value of food products throughout the civilized world, and, inasmuch as cheap food is the basis of all industrial development and the necessary condition for the amelioration of humanity, the present generation has witnessed a general rise in the wages of labor, accompanied by a fall in price of the food which it consumes. . . . These are material results, but they are accompanied with the slow but sure elevation of the great mass of society to a higher plane of intelligence and aspiration."

The increase of working power of the United States is thus shown by Mr. M. G. Mulhall, the great statistician, in the North American Review for June, 1895. The working power of an able-bodied male adult is 300 foot tons daily; that of a horse, 3,000; and of steam horse power, 4,000. On this basis the working power of the United States was at various dates approximately as follows, in millions of foot tons daily:

Year.	Hand.	Horse.	Steam.	Total.	Foot tons daily per inhabitant.
1820	753	3,300	240	4,293	446
1840	1,406	12,900	3,040	17,346	1,020
1860	2,805	22,200	14,000	39,005	1,240
1880	4,450	36,600	36,340	77,390	1,545
1895	6,400	55,200	67,700	129,300	1,940
Great Britain, 1895	3,210	6,100	46,800	56,110	1,470
Germany, 1895.	4,280	11,500	29,800	45,580	902
France, 1895.	3,380	9,600	21,600	34,580	910
Austria, 1895.	3,410	9,900	9,200	22,510	560

Notice from this table how vastly the power of man is increased by the use of the steam engine, and in the United States how great was the increase in the last 15 years.

The wealth of the American people, says Mr. Mulhall, surpasses that of any other nation past or present. The physical and mechanical power which has enabled a community of wood cutters and farmers to become, in less than 100 years, the greatest nation in the world, is the aggregate of the strong arms of men and women, aided by horse power, machinery and steam power applied to the useful arts and services of everyday life. The accumulation of wealth in the United States averages \$7,000,000 daily.

The increase of wealth in the United States is shown as follows, according to Mulhall:

Year.	Total wealth, millions of dollars.	Wealth per capita.
1820	1,960	\$205
1840	3,910	230
1860	16,160	514
1880	43,642	870
1890	65,037	1,039

Wealth per capita in different countries in 1890:

Great Britain	\$1,260
France	1,130
Holland	1,089
United States	1,039
Belgium	840
Germany	730
Sweden	630
Italy	480
Austria	475

Average yearly wages per operative in the United States:

1860	\$289
1870	302
1880	347
1890	485

* Vice-presidential address delivered before Section D, Mechanical Science and Engineering, of the American Association for Advancement of Science, at Springfield, Mass., August 29, 1895.