tain amount of lateral motion, as well as of elevation, may be given to the gun. The breech is composed of a block, containing the mechanism and closed at the rear end by a cover, shown in Fig 2, which is fixed by two set screws, so that it may be easily removed and ready access thus afforded to the interior portions.

Beginning our explanation with the revolving mechanism, B, in Fig. 3, is a pin wheel keyed inside the breech to the end of the shaft, A, and carrying six studs upon its rear face, arranged parallel to each other. C is a worm wheel which is mounted on a shaft at right angles to shaft A, that is, transverse the breech. The left hand end of the worm shaft turns in a bearing within the breech, while its other extremity passes through the latter, and is actuated by the crank, the motion of which operates the whole system, as will be seen further on. The worm wheel, C, the grooves in which receive the studs on B and so rotate shaft A, is of peculiar construction, and is so designed that, at the instant of firing. the barrels may be motionless. To this end the directing groove is composed of two inclined parts connected by a straight portion which covers half of the section of the cylinder, so that, while a pin of the pin wheel, B, is in this straight part, no movement of the barrels during half a revolution of the wheel takes place. But as soon as the worm wheel has revolved so far that the inclined part acts upon a pin, the wheel, B, and with it the barrels, will be revolved. Of course, during the time the pin is traversing the straight portion of the groove, the firing takes place.

From Figs. 3, 4, and 5, the loading mechanism will be readily followed. The left hand end of the worm shaft, Fig. 3, i will be noticed, passes through its bearing within the breech, and terminates in a crank arm, D. The extremity of the latter carries a pin which works in the slotted piece. E, Fig. 4, so that, as the crank arm revolves, it gives a to-and-fro motion to said slotted piece. which carries with it a rack, F Above, and engaging with this rack, is a small pinion, the teeth of which also mesh with those of a second rack, G, so that, as the rack, F, is carried forward, the rack, G, moves back, and *vice versâ* H is a cylindrical piston connected with the rack, G, by a pin which travels through a slot in the bottom of the conducting trough, so that piston and rack work together I, Fig. 3 is the feed trough in which the cartridges are placed, as shown, and in the bottom of which is a little door, J, Fig. 5. When the piston is sufficiently retracted. this door falls open and a cartridge drops into the conducting trough by its own gravity. Subsequently, as the piston moves forward, in the manner described further on, to drive the charge into the barrel, a stud upon its upper side pushes the door shut, and thus holds it until the proper time for the reception of another cartridge arrives.

As shown in Fig. 4, the crank arm. D, is horizontal. It arrives at this position just as a pin upon the wheel, B, enters the straight part of the worm; and of course the racks, as depicted in the last mentioned figure, are drawn respectively forward and backward to their fullest extent. As above noted, the little door, J, is now free to open, and hence a cartridge drops in before the piston. The racks also, in the position shown, remain at rest for a moment and this is effected by giving the slot in E, Fig. 4, a circular shape, concentric to the shaft of the crank. The object of this is that at this moment. the barrels arriving at the end of their motion, a spent cartridge in one becomes engaged with the large double hook, K Fig. 4, of the extractor, which is secured to the lower rack, F, and hence, if the motion of the racks were not thus interrupted, time would not be afforded to complete the engagement.

The crank arm, D, we will suppose, continuing its revolution, passes the circular portion of the slotted piece, E, and, consequently moving the latter, starts the racks in opposite directions. Rack, F, pulling on the extractor, drags the cartridge shell out of the lower barrel and to the rear, until it meets an ejector, L, Fig. 5, against which the cylinder strikes, is detached and falls to the ground through the opening shown in the breech block. Rack G, moving forward and carrying with it the piston, during the next half revolution of the worm wheel introduces the cartridge into its barrel; the latter, it will be remembered, necessarily stands still. The cartridge is, however, not driven in all the way, but its head is in view of an inclined plane, M. Fig. 5, which is cut into the metal of the breech, on which it slides when carried around by the movement of the barrels. This completes the introduction of the charge.

The firing apparatus is omitted in Fig. 3, in order to render other parts more clearly shown, but it is represented very plainly in Fig. 2. N is a cam secured on the worm shaft and to the right of the worm wheel. It will be remembered that we have supposed the cartridge to be inserted and the barrels to be revolving; hence, this cam will now also be turning, and in such a manner as to be in the act of pushing back the long arm, O, which connects with the firing pin, P. The action of the spiral spring, shown at Q, keeps the arm, O, pressed against the cam so that, as the pin is forced back, it compresses the spring and, in fact, cocks the piece. The barrel, with its charge. now arrives opposite the end of the pin, the head of the cartridge being at this moment in face of a steel plate fixed in the breech block, R, Fig. 2. The shoulder of the cam now slips from under the arm, the pin, P, is driven forward by the spiral spring, strikes the primer of the cartridge, and explodes the charge. The object of the steel plate, R, is to receive the shock, and we are informed that, on becoming worn or deranged by repeated firing, it may be readily changed.

We understand the caliber of the barrels to be 1·57 inches, and their length 38 1 inches. The total length of the gun is about 4 89 feet, and its weight, inclusive of saddle, 968 lbs.

Figs 6 and 7 represent, respectively, the form of fixed ammunition used and the percussion fuse. The total weight of the charged cartridge and shell is 26 3 ounces, and of the charge alone, 2 8 ounces, and the length is 7·2 inches, The fuse, Fig 7, consists of a case which, in its under part contains a lead plunger, S, with a brass envelope. The plunger holds the fulminate, and has a little powder chamber at T. It is fastened by a safety plug of lead in the under hole of the fuse, and it is closed by a plug which has the point against which the plunger drops at a sudden stop of of the projectile.

The elevating screw of the gun is so made that the head is connected to a bearing, movable on an axis near the trunnions, and so annexed as to provide for a lateral system of pointing. The nut of the screw is a conical gear wheel, and receives the movement from another wheel moved by a crank placed on the right side of the trail. The end of the latter is formed into a large friction plate, and the wheels are placed on shoes so that motion of the carriage by recoil is prevented. Approximate pointing is effected in the same way, by the trail, and nicer range is obtained by the mechanism under the gun.

We notice that a report of recent experiments with the cannon at Garve, France, by the French Marine Department, states that 500 rounds were fired with perfect success. Forty shots were fired in 30 seconds at targets 5,760 feet distant; and from the explosion of the forty projectiles, two hundred hits were obtained At Turin, further trials are to be made by the Italian Government. We learn that the gun has already been fired sixty shots in 55, and afterwards in 48, seconds.

The weapon is the device of Mr. B. B. Hotchkiss, of 27 Rue de Cooiseul, Paris, France, a gentleman already well known for his rifle projectiles and other military inventions For further information address, care of C. C. Dawson, office Congress and Empire Spring Company, 94 Chambers street, New York city.

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Contents:

(Illustrated articles are marked with an asterisk.)

NEW PATENT CONVENTIONS.

Messrs. Thacher, Hill, and Blake, Committee of the Vienna International Patent Congress, have, in accordance with their official authority, issued a call, addressed to all who are interested in the effort to secure better patent protection for Americans in foreign countries, for a Convention, to be held in the city of Washington. The Committee say that: "Our friends abroad greatly need the information and aid which we can readily furnish, *for we are the foremost nation in the world in the liberality and success of our patent system.*"

This characteristic assemblage of American Patent Saints is called for January 15, 1874, for the purpose of discussing this topic, so says the call, and if thought desirable, of organizing a United States Patent Association. We hope the attendance will be full, the proceedings harmonious, and the results practical. This Convention is to have the aid of an other Convention, recently organized at Boston, called the New England Association of Inventors and Patent Owners. The objects of this association, so far as we can gather from the reports of the proceedings, are to render mutual aid and benefit to the members in the management of their patents, to secure the extension of their several patent monopolies, compel the payment of fair prices for patents by railway companies, and in other ways "to promote the general prosperity of the country."

Among the prominent members of this new association is Mr. Hamilton A. Hill, who also figures as one of the Committee of the Vienna Congress, and as one of the callers of the Washington Convention. He offered a couple of resolutions, one of which was that the association should be represented at Washington by delegates; the other: "That this Convention heartily endorses the action of the Congress lately held at Vienna on the subject of patents." Both resolutions were adopted. We congratulate Mr Hill in having thus succeeded in getting himself endorsed by the New England Association. Possibly he may have equally good luck before the Washington Convention.

It is well known to our readers that the resolutions adopted at the Vienna Patent Congress contained hardly a single point or suggestion for change in the existing laws of the leading continental governments, except this, namely: That the laws ought to provide that the inventor shall be compelled to sell his invention and rights under the patent, at such prices as government officers shall dictate. This is not the exact wording of the resolution, which was framed in the German idiom, but we give its real meaning, translated into plain English. Most of the Americans who were present objected to the passage of the resolution and argued against it strongly. Mr. Hill himself spoke against it, and Mr. R. W. Raymond, who was present, has publicly stated that the resolution would have been defeated had the American delegates all continued to protest against it with united voice. But between night and morning a defection in their ranks took place; Mr. Hill and some others went back on their comrades, and next day voted for the resolution, which they had previously opposed. Now if the New England Association or the Washington Convention supposes that the endorsement of Mr. Hill's obnoxious resolution at Vienna is likely to promote the interests of American inventors in foreign countries, we can assure them that they are mistaken. The very thing that our inventors most need, in foreign countries, is to be freed from government interference. What our people want is the right to control their foreign patents. in the same untrammeled manner as their home patents. Nothing less than this will satisfy them. On this point the Convention should take a firm stand, pledging itself to its advocacy, and seeking for its adoption throughout Europe. But to start off the Convention by resolutions approvatory of the absurd project, first opposed and then supported by Mr. Hill, will be likely to impair the usefulness of the Convention, and prevent our countrymen from taking interest in its proceedings.

THE PRIME MOVERS AND THEIR RECENT PROGRESS.

The prime movers are those machines from which we obtain power through their adaptation to the transformation of some available natural force into kind of effort which develops mechanical power. These sources of power are generally classified, according to the form of energy which they yield or which the machines are fitted to utilize, as muscular power, the weight and movement of fluids, electricity, and heat. Thus, men and animals are prime movers, utilizing muscular power; water wheels and wind mills utilize the fluids water and air; electrical engines make useful the power of the voltaic battery; and gas, air, and steam engines —heat engines, as they are collectively called—transform the force of heat motion into mechanical force. All of these prime movers have received a certain degree of development; and some of them, as the heat engines generally, and particularly the steam engine, have occupied the attention of man for many centuries and have afforded a field for the display of his highest scientific attainments, inventive genius, and mechanical skill; and they today are doing by far the greater part of the unintellectual work of civilization. Indeed, they indirectly assist, to a wonderful and inestimable extent, even intellectual progress, by furnishing the material aids essential to its existence and continuance.

Muscular power has its origin in heat developed by combustion, probably, as truly as does the power obtained from the generally termed heat engines; and the animal system is simply a machine or apparatus in which a certain quantity of oxydizable material is consumed and a certain quantity of power is developed by its consumption. The animal system is compelled to furnish heat sufficient to keep its several parts in working order, and to furnish supplies also to that strange and wonderful organ the brain. It is, therefore, impossible to state how efficient the animal system is as a prime mover, simply, but it is supposed to be far more efficient than any machine yet constructed by man. Man can do little to improve the efficiency of the animal mechanism, but he can do something. Whether the organism to be used as a prime mover be that of a man or of a beast, the proper treatment by which to obtain maximum efficiency is that by which the natural strength of *physique* and constitution is cherished and increased. Abundance of plain, wholesome, nutritious food, regular work, never exceeding but always approaching the maximum that can be attained without more than moderate fatigue, comfortable housing and general care will give the animal system its most complete development and its greatest effectiveness. It is generally believed that working one third of a day, at one third the maximum speed attainable without load, and with a load equal to one third the maximum force which can be exerted, gives the best conditions and highest efficiency.

Having effected so much for the prime mover, the next point to which attention should be turned is the simplicity and effectiveness of the machine through which the work is done, whether a wagon, a treadmill, or a so-called horse power. Probably not less than twenty per cent of the power of the animal is generally lost here, in some of the best designs of these forms of apparatus, and usually occurs through friction. Invention and mechanical skill have not deserted this field, however, and we hope yet to be able to chronicle some useful improvements.

The power of falling water and of the winds is utilized by the various forms of water wheels and wind mills. Not many years ago, awkward and costly vertical water wheels, with their slow motion and expensive systems of transmitting machinery, were thought the only proper and economical forms of water engines. They still remain, as a class, unexcelled in economical efficiency, but they have found rivals in the smaller, quickly working, and far cheaper and more satisfactory turbines, and have been almost completely driven from the field.

The power of prime movers is measured by horse power. Watt found that the strongest London draft horses were capable of doing work equivalent to raising 33,000 pounds one foot high per minute, and he took this as the unit of power for the steam engine. The horse is not usually capable of doing so great a quantity of work. Rankine gave 26,000 foot pounds as the figure for a mean of several experiments, and it is probable that 25,000 foot pounds is a fair minute's average work for a good animal. It would require five or six men to do the work of a strong horse. Watt's estimate has become, by general consent among engineers, the standard of power measurement for all purposes.

The weight of water flowing per minute, over a weir or dam, being multiplied by the hight of available fall, gives a product in foot pounds per minute, which, divided by 33,000, gives the horse power of the stream. Of this power, a certain proportion is always lost through the inefficiency of the machinery of the prime mover which is intended to utilize it. The best overshot and high breast water wheels yield as a maximum but little over seventy-five horse power where the available power of the fall is one hundred. The best turbines have about the same efficiency as the vertical wheels when precisely proportioned to their work. In all wheels, a loss greater than twenty per cent is met with when running on "part gate." There is, therefore, room for improvement in water wheels to the extent of twenty per cent or more. These losses are to be lessened by more skillfully proportioning the wheels, and especially by some arrangement which will allow them to work efficiently with varying gate. The prime defects at present exist in the method of adjusting the wheel to do its work with different loads. Hardly less important is the problem of effectively connecting the governor to the wheel gate. Much has been done in these directions, but much remains to be done. Some wheels will do nearly as good work at part gate as at full gate, but usually this efficiency is attained by the sacrifice of simplicity and of maximum economy. A wheel which will invariably yield seventy-five per cent of the power of the fall under which it works, and do this under all loads, is yet to be brought into the market. The high tide of progress has culminated in the successful competition of the small, lively, and cheap turbine with the older forms of wheel, which are now nearly driven out of use. By far the most important work in cheapening the construction of turbine wheels and in making them efficient has been done by American mechanics.

The windmill is largely used on our western prairies and to a considerable extent elsewhere. The improvements lately made on this motor have been principally in the structure and arrangement of the vanes, making them self-regulating, and in so constructing the apparatus that it shall keep itself pointed toward the wind. Abroad, nothing seems to have been done, but our own inventors have accomplished some good work in this field, the extent and importance of which are not generally appreciated. We have but little information as to the efficiency of windmills. They are probably less effective than water wheels, and their improvement remains a promising task for ingenious mechanics.

The force derivable from electricity has long engaged the attention of most active minds, but we cannot yet chronicle any really well settled and important advance towards its utilization. Indeed we can hardly anticipate its employment to any considerable extent until new methods of generating the force itself are discovered. The available power to be obtained by the consumption of zinc, which is the metal consumed in the voltaic battery, is estimated, by various authorities, at from one half to one sixth that derivable from an equal weight of coal, and the great difference in price between zinc and coal, pound for pound, makes the difference in cost of power vastly in favor of coal. A quarter of a century or more ago, many attempts were made, some upon a large scale, to utilize electric force in the production of mechanical power, but with no success. Our countryman Page, who in 1850 obtained power from a small engine at a cost, as he stated, of about a cent per horse power per hour was the most successful; but even he finally failed, and no one has since been more successful. Attempts are still made and are almost daily brought to our notice; and occasionally a charlatan or a self-deceiver deludes credulous listeners, by the claim of wonderful results. We hope that we may find such a claim well founded, in some time to come, but we fear that it will be very far in the future, unless some fortunate man shall discover a method of evolving electricity, in place of heat, from the oxidation of coal. That done, the problem would be far less difficult of solution, and we should look hopefully for a splendid development of this field, which would have then become most promising.

PROGRESS OF THE CENTENNIAL.

With the object of enlisting the coöperation and interest of the people of New York in the coming Centennial, a delegation from the Board of Finance of that enterprise recently met with the members of the Chamber of Commerce of this city. The Philadelphia committee deprecated any feeling of sectional rivalry and urged, with much earnestness, the view that the exhibition was a national affair, and that it deserved the hearty support of the whole country. The New York merchants replied in similar strain, cordial expressions of coöperation were exchanged, and a committee of seven was appointed to solicit aid from the people of the State. As regards progress, we find it stated that the Board of Finance has confined its operations principally to Pennsylvania, in which State $3,500,000 have been subscribed by citizens and corporations. California has promised her full quota, and efforts have been begun in order to raise funds in Delaware and Maryland. The work of construction is to be rapidly pushed during the coming spring. A temporary building covering from 35 to 40 acres is to be erected, and the permanent structure will be commenced at the same time. The former edifice is to cost from two to three million dollars, and the latter, half a million. The machinery, horticultural, and agricultural halls, are each to cost $500,000, and it is believed that the preparation of the ground, sewage, etc., will use up the remainder of the $10,000,000 required.

The prospects of foreign participation are very encouraging. At the assembling of the German Parliament, Prince Bismarck recommended the acceptance of the invitations and also urged the appointment of a plenipotentiary to reside in Philadelphia during the Exposition, and of a commissioner for each State of the empire. Belgium has promptly signified her intention to contribute, and the republic of Ecuador has made an appropriation for the purpose, and already has a resident commissioner in Philadelphia. Official notifications of intended participation have also been received, by the Government, from Mexico and Hayti. Professor W. P. Blake, special agent for the centennial at the late Vienna exhibition, says in his report that he has received assurances of friendly interest from the Emperor of Austria and other high officials. He has already obtained contributions for a permanent museum, consisting of Swedish iron ores, and a valuable collection of terra cotta work, samples of ozokerit, etc. China and Japan, it is considered, will be well represented, and the Turkish merchants are to erect a grand bazar, coffee houses, bath, and, in some convenient portion of the grounds, a complete Turkish village.

We hope capitalists, merchants, manufacturers, inventors, and every other class of our citizens will take an active interest in promoting the success of this great patriotic Centennial exhibition.

EXPERT ENGINEERING.

We are constantly in receipt of inquiries as to what are the requisite qualifications for an engineer. This word as it is frequently employed is somewhat of a misnomer. An engineer, in the broadest signification of the term, is an expert in engineering, one who is practically acquainted with the construction and management of heat engines: who is thoroughly versed in the physical laws which relate to the formation and use of steam and other motive powers: who can design machinery, and adapt it to the various purposes for which it is intended. But in common parlance, every one who has control of an engine or boiler is known as an engineer. From this fact, much misunderstanding frequently results. The proprietor of a factory, for instance, sees no difference between the person who takes care of his engine and the consulting engineer who offers his services in expert cases, except, perhaps, that he looks upon the former as a practical man, and therefore one who is always certain to think and act correctly, while he considers the latter a theoretical engineer, whose opinions are entirely too visionary to be of any value. We think we have not overstated the comparison that is usually made between what are known as practical and theoretical men. But it may be worth while to look into the matter a little, and see whether the popular estimate is a just one. The purely practical man, as we understand it, is one who knows nothing but what he has acquired by actual practice; and things that he has not seen and handled, as it were, he will not believe. Now the engineer who is understood to be theoretical has ordinarily enjoyed quite as much practice as the other, but he has labored more understandingly, investigating the principles of the work in which he is engaged, and endeavoring by the application of these principles to effect changes and improvements. There is little doubt that the intellect of man is his most valuable possession, and that the cultivation of this faculty will give him greater rewards than he can hope to acquire by manual labor. It is true, however, that his theories, if unsupported by facts, are little better than idle dreams, so far as their value to the community is concerned. James Watt, in making his splendid inventions relating to the steam engine, carried theory and practice hand in hand. Starting with a rude model, he determined practically what it would do, and reasoned out what it ought to do if it were a perfect machine, and then turned his attention to making it fulfil the conditions called for by his theoretical investigation. Surely the result justified all his experiments and hypothesis.

Professor Rankine, lately deceased, and perhaps the most remarkable engineer that the world has ever known, united, in a most happy degree, the use of theory and practice. The result of his labors, cut short by an early death, can hardly be appreciated as yet; but in giving to the world the first accurate theory of the action of heat engines, he has enabled future experimenters and inventors to work with a clear knowledge of the nature of the problems which they wish to solve.

We hope we have succeeded in demonstrating to our readers that theory and practice are not naturally antagonistic, and that the professions of engineer and engine driver, both honorable ones, are quite distinct, the former comprising all that is contained in the latter, and embracing additional details.

If we have induced the owner of steam power to alter his opinion of the expert engineer, perhaps we may persuade him that he can occasionally employ the services of this expert with profit to himself. If every time that steam was raised in his boiler a large quantity continually escaped through some opening that was plainly visible, he would not hesitate a moment to have the leak repaired. We are able to state, from our own knowledge, that this state of affairs practically exists in many places where steam power is used, with the important exception that the leak is not visible to the ordinary observer. To find this leak is the task of the engineer, and surely the owner will be amply repaid if he succeeds, for a trifling amount, in having repairs made which will save him thousands of dollars yearly. The Royal Agricultural Society of England, at their yearly exhibitions, are accustomed to test the engines that are entered for competition. An investigation of the results obtained from year to year shows a most extraordinary improvement in the engines, as regards economy and workmanship, and there is little doubt that the effect of these tests has been most beneficial to the users of steam power. In this country, comparatively few reports of tests have been made public, and we are lamentably ignorant in regard to the performance of machinery made even by our best manufacturers. This is a matter in which every user of steam power is directly interested, and we hazard little in saying that all owners of steam engines would find it profitable to have tests made by reliable experts at least once a year. From examinations that we are continually making in the city, and by letters that we frequently receive from abroad, we are convinced that there are many steam engines which stand in need of professional assistance. The steam engine indicator has been likened to the stethoscope of the physician, but it should be remembered that either, in unskillful hands, will be productive of but little benefit. There are many cases, besides, in which other tests than those made with the indicator are called for; but so far as our experience goes, the skillful engineer is generally able to find the trouble and devise a remedy, when his services are called into requisition. Those who are accustomed to read that portion of our paper devoted to questions and answers have doubtless noticed that we receive many letters in relation to the power that can be transmitted by a belt. It is a very common practice in letting power to calculate the amount furnished from the width and speed of the driving belt. But this is a very uncertain estimate, as in some cases the belt will transmit more and in others less than the rated power. If a few tests were made of the bulk of a pound of sugar, and the article were ever afterwards sold by guess work, the bulk furnished being based, by the seller's eye, on the amount previously determined by experiment, we venture to assert that neither dealer nor purchaser would be satisfied. And yet this is just the course pursued in circumstances where the amount of power can be as accurately determined as the quantity of sugar to be furnished for a pound. Cases have come to our knowledge in which the amount of power actually furnished varied as much as two hundred per cent from that given by calculation.

Some years ago, we heard of a bridge contract being let, in which it was stipulated that none of the material was to be strained, when subjected to the maximum load, to more than one sixth of its ultimate strength. When the structure was completed, a simple calculation showed that the maximum load brought a strain equal to one third of the ultimate resistance. The bridge commissioners performed a simple sum in arithmetic for the benefit of the constructor, worked somewhat in this manner: If a tun of iron costs D dollars, and it would require W pounds to give a factor of safety of six, and the price of the bridge is to be P dollars, if constructed according to specifications, what should its price be if it contains only half as much iron, so as to give a factor of three? Payment for the bridge was made according to the solution of this question, to the intense disgust of the contractor. A similar sum might be worked out with considerable profit to the purchasers of many steam engines and boilers, who find that their machines fall far short of the power at which they were rated by their makers.

This article has already extended beyond our proposed limits, and we have merely touched upon the benefits that users of steam power can obtain from reliable expert assistance.

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