SCIENTIFIC AMERICAN

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THE WATERTOWN ARSENAL TESTING MACHINE.

The great testing machine at the United States Arsenal at Watertown, Mass., in the environs of Boston, is properly considered one of the engineering triumphs of its day. A machine which will break by tension a five inch bar requiring 350 tons stress, and immediately after the strain and shock of recoil due to this performance will break a horse hair, and indicate perfectly the required rupturing tension of one pound, must be mechanically perfect. It is told of the Emperor William of Germany that, when visiting Krupp's works, he placed his watch on the anvil under the great hammer. The attendant brought the hundred ton ram down on the piece without injuring it. The watch was thereupon presented to him. The same class of test has been applied to the Watertown machine. A compression of 1,000,000 lb. was first produced, and immediately afterward eggs and nuts were cracked and violin strings stretched. By the very peculiar construction of the indicating apparatus, friction in that part seems to have been almost entirely done away with. The single resistance left, as regards its registration, is the molecular friction or stiffness of very thin metal plates, which have only to yield to an infinitesimally small extent of motion or flexure.

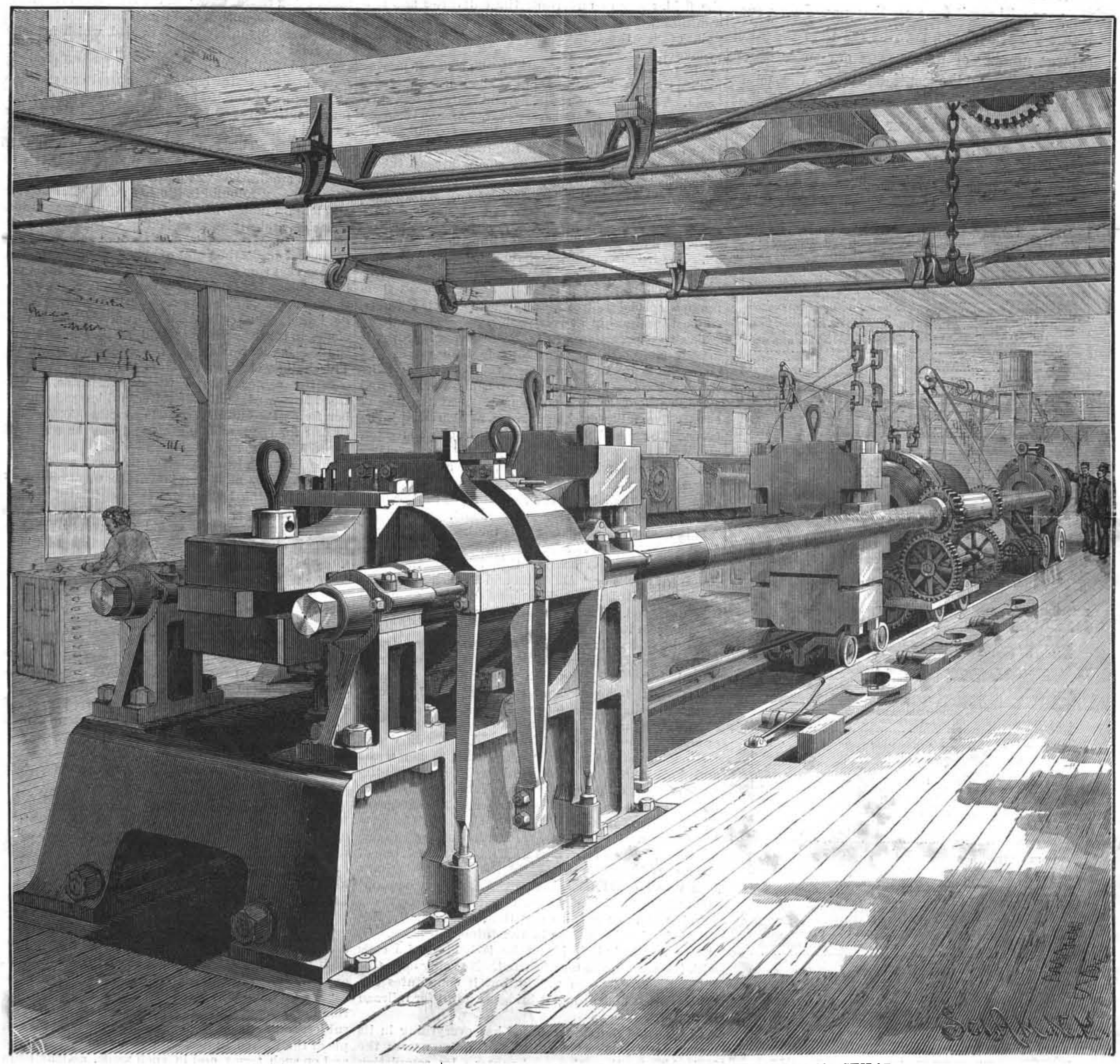
The machine was designed according to the ideas and inventions of Mr. Albert H. Emery. It was built at the works of the Ames Manufacturing Company, of Chicopee, Mass. The principal castings, embracing 80,000 lb. of gun iron, were made at the South Boston Iron Works. The forgings in steel and iron were produced at the Nashua Iron and Steel Works. The finished metal work includes bronze, cast and wrought iron, and steel. The largest casting weighs 14,000 lb., while of some pieces a great number would be required to weigh a single ounce. The cost to the United States government is stated as follows:

Machine, with pump and accumulator	$31,500 00
Erection	4,000 00
Foundation and accumulator pit	4,083 77
Traveling crane	2,981 23
Steam pipes for heating building	439 52
	$43,004 52

It was completed in 1879, and is said to have cost the contractors more than double the above amount.

The machine works by hydraulic pressure for heavy strains, while for light ones, and especially for such as require a very large range for stretching or contracting, screw power can be effectively applied. The apparatus in general is thus arranged: A line of rails carries a traveling ram, which produces the stresses. This is mounted on wheels that fit the track. To move it, screws that run parallel with the track are provided. These are held by an immensely strong abutment at one end of the machine and by simple uprights at the other. The traveling ram is provided with nuts on each side, through which the screws pass. By turning these nuts the ram is moved backward or forward. At one end, where the abutments are situated, and attached to them, are the weighing platforms. These act upon four cylinders and pistons forming rams, but of very slight play. The axes of these cylinders are horizontal. The space between piston and cylinder

(*Continued on p.* 407.)



THE UNITED STATES TESTING MACHINE AT THE WATERTOWN ARSENAL.

with the exception of a little common salt. The pollution of the river is thus averted. The cake of fatty matter and dirt is next turned to profitable account. It is placed in what are called the filter beds, and then pressed in a machine press until the fatty matter is extracted. The oil thus obtained is next made into brown soap, exactly similar to that which is used in the process of washing the raw silk. The soap is again used for washing purposes, and is found to answer quite as well as in its first application. Only 5 per cent of the original weight of soap is lost in the reclaiming process. The value of the invention is proved by the fact that the firm has been offered £20 per ton by wholesale dealers for the reclaimed soap.—*Chem. and Drug.*

THE WATERTOWN ARSENAL TESTING MACHINE.

(*Continued from first page.*)

head is filled with glycerine and alcohol. When a piece of metal is tried in tension, it is clamped to the ram and also to the weighing platform. Then the hydraulic pressure is turned into the pressure cylinder. The amount brought to bear at any moment is ascertained, not, as would normally be done, by noting the gauge connected to the pump cylinder, but by noting the pressure produced within the four cylinders between the weighing platforms. The motion of the pistons and cylinders is infinitesimal. They have no packing. The pistons are held concentric, and without touching the cylinders, by brass diaphragms. Being without sensible motion and without friction, the pressure within them indicates the exact stress to which the trial sample is subjected. When a piece is to be subjected to compression, the clamping is dispensed with, and the opposite end of the weighing mechanism is acted on, so that compression is still produced within its cylinders. In other words, a traveling ram is arranged for the adjustments of length, and this ram, when in action, is secured in place and made to work against a highly sensitive hydraulic dynamometer.

Pressure is produced by a steam pump working into an accumulator. The pressure in the weighing cylinders is communicated by reducing levers and hydraulic cylinders to an elaborate weighing mechanism. For certain classes of light strains of extended longitudinal range, as in Manila rope testing, the screws alone are used to produce the stress.

By it a stress of 1,068,000 lb. in compression or 801,100 in tension can be produced. In normal working pieces 30 feet long can be received; but by a special arrangement, pieces 31 feet long for compression, and 31 feet 3 inches for tension, can be introduced.

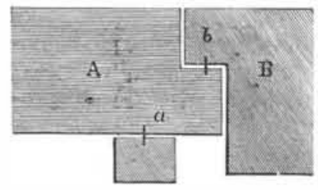
The ram or straining cylinder has an internal diameter of twenty inches and a stroke of twenty-four inches. The piston and rod are on one piece, turned up from a single forging. The cylinder is lined with rolled copper, to prevent the sperm oil used as filling from penetrating into the pores of the iron. Cup leather packings are used to prevent leakage.

The screws that hold the ram in place, and which receive the full strain and transfer it to the weighing platforms, are eight and one-half inches in diameter, measured to the outside of the thread. They are threaded with a truncated V thread, two to the inch, and are forty-eight feet long. They are horizontal, and parallel with the rails, are 50 inches apart and 47 inches above the floor. Their diameter from end to end calibrates within one thousandth of an inch. Intermediate supports are provided, which can be swung up, so as to secure them from vibration or bending.

On each side of the ram are the nuts which work on the screws and move it. These nuts are rotated by a "live head" bolted down to the foundation at the further end between the tracks. This resembles in general appearance a lathe head, and is worked by a straight or crossed belt, according to the direction of motion that may be required. It turns a long shaft, which can be seen running between the tracks close to the ground, and which is as long as the track. A groove is made in the shaft extending along its entire length. By a feathered wheel and connecting gear carried by the ram, the nuts are rotated so as to move it back and forth. The nuts are allowed a play on the screws of $\frac{1}{100}$ inch. They are made of bronze.

The ram is carried by a truck moving upon a track. The latter is made of cast iron, laid in sulphur, and bolted to the foundation.

At the end nearest the front of the picture are shown the scale platforms and abutments. In them the screws are held. A space is seen between the two platforms. Within this space are placed the four weighing cylinders. When the stress comes upon the sample, the screws are drawn or thrust, as the case may be, and the weighing platforms are pressed together. This tends to compress the weighing cylinders with their pistons. The free space between the cylinders and pistons is filled with a diaphragm of brass $\frac{6}{1000}$ inch thick. This keeps the piston centered and acts as packing. The extreme range of motion is $\frac{15}{1000}$ inch. The interior of the cylinders connects by a copper pipe $\frac{1}{10}$ inch internal and $\frac{18}{100}$ inch external diameter, with another smaller cylinder and piston, placed with its axis vertical within the scale box, and to one side of the machine. This pipe and smaller cylinder are also completely filled with the glycerine and alcohol mixture. The piston of the small cylinder actuates a lever, which, in its turn, connects with the scale beam on which the weighing is executed. This portion embodies in its general arrangement the principles that obtain in platform scales, with one distinguishing point of difference from ordinary practice. No knife edges are used. In their place thin strips of steel, called fulcrum plates, are employed. These vary in thickness from $\frac{8}{100}$ down to $\frac{5}{1000}$ inch. They are either set into or clamped fast to both members of the system.



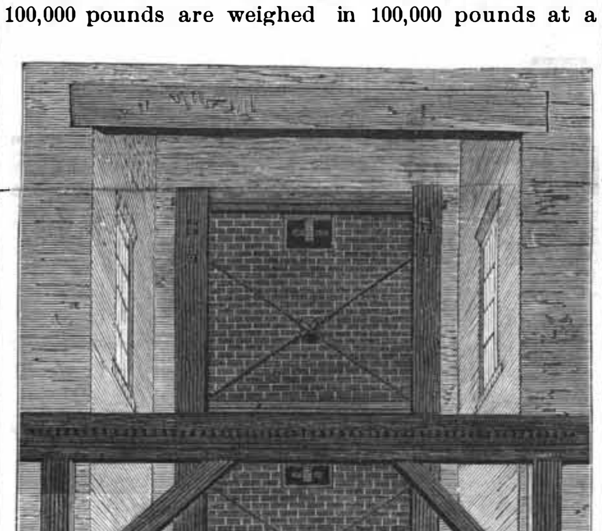
FULCRUM PLATES.

To illustrate this method, the first lever connections are shown in the cut. A represents the end of the lever. At *a* is a fulcrum plate which transmits the thrust from the smaller cylinder and piston just spoken of. Connected to the stationary abutment, B, a second fulcrum plate, at *b*, is provided. In ordinary practice knife edges would be used in both these places. These particular plates are $\frac{8}{100}$ inch thick, and are bedded $\frac{8}{100}$ inch in the metal.

As the large lever is pressed upward it communicates the pressure, reduced proportionately to the ratio of the length of its arms, to the scale beam by a vertical rod.

It will be seen that the infinitesimal movements of the pistons and original weighing cylinders are increased progressively. Above the scale beam is placed a long index beam which still further multiplies the extent of motion, so that a range 420,000 times greater than that of the pistons between the weighing platforms is obtained.

From the scale beam four rods depend, also suspended by fulcrum plates. By handles worked from outside the scale beam case, weights are added to or removed from these rods. On one rod from 700,000 to 100,000 pounds are weighed in 100,000 pounds at a



THE ACCUMULATOR OF THE TESTING MACHINE.

time; on the next, from 100,000 to 10,000 pounds are weighed by 10,000 pounds increments; on the next, from 10,000 to 1,000 pounds are weighed by 1,000 pounds increments; and on the fourth rod, from 1,000 to 100 pounds are weighed by 100 pounds increments. A rider is provided that slides along the scale beam and weighs by single pounds up to 100 pounds. This gives a maximum of less than the full capacity. To obtain this a large counterpoise is removed, which adds at once 200,000 pounds to the effectual weights.

The extreme range of play of the index need not exceed a fraction of an inch, so that the movement of the weighing cylinders and pistons is quite inappreciable. As Mr. Holley, in his graphic paper, puts it, a motion of $\frac{1}{100}$ of an inch at the end of the index under the influence of a strain of one pound would indicate a motion of $\frac{1}{42000000}$ inch of the weighing pistons. The flexure of the fulcrum plates is also very slight. The accuracy of the machine hinges on these points, as by this absence of extended motion the resistance due to rigidity of fulcrum plates and diaphragms is done away with practically. There is no friction, properly speaking, in the system.

The scale beams are finished in the best manner, and all their principal parts are nickel plated or gilded. They are inclosed in a glass case.

The original power is derived from a steam pump. The steam cylinder is of the Knowles pattern, but has the piston rod extended through the back cylinder head. One end of the rod works a pump of 1½ inches diameter, the other a pump of ⅞ inch diameter. Cocks are so arranged that either the small pump alone may be used as the source of power for high pressure or both together may be employed, giving a lower pressure equal to that due to the larger one. Both pumps are of brass, and are double-acting.

The pumps force sperm oil into the working cylinder, an accumulator being used to secure steady action. This structure is of the usual type. It has two concentric rams, one of 10 in., the other of 5⅛ in. diameter. Either can be made the efficient one. It carries a central square wooden beam, to which the weights, composed of brick and mortar masonry, are keyed. These weights are in three parts, and can be used singly or combined. By utilizing the combinations of rams and weights, a pressure varying from 300 to 3,400 pounds per square inch can be secured, covering a range of total pressure of 119,400 to 1,068,000 pounds on the large or compressing face of the piston of the straining cylinder, and of 89,500 to 801,100 pounds on the small or tension face. The small face is the one reduced in effective area by the piston rod. The accumulator is provided with a safety valve to prevent any possibility of the rams being driven out of the cylinder of the accumulator.

The clamps for holding samples that are to be strained in tension are hydraulic. Their jaws are forced together by the pressure of the accumulator. Gauges are provided for showing the pressure they exert.

Owing to its great size and power, this machine can be used for large samples. Examples of its utility in this direction may be cited. A link of iron, 5 inches in diameter, was broken at a total pressure of 722,800 pounds, giving away with a loud report. Its diameter at the breaking surface was slightly diminished. This reduced to a breaking strain of 36,000 pounds to the square inch. Yet the piece was supposed to have a tensile strength of 60,000 pounds. Another piece of iron, turned down to 3⅝ inches diameter, broke at a tension of 37,000 pounds to the square inch. The same metal in a 1 inch bar had stood a 50,000 pound strain. At the beginning of the present year 14,000 specimens, principally for government work, had been tested. These ran from the finest wire up to full sized members of engineering structures. From 1 to 800,000 pound stresses were applied. Some specimens were less than 1 inch in length. Upward of 320,000 pounds of material had been tested to destruction. Brick piers and wooden posts have been among the objects tested.

Elaborate sets of calipers and all necessary accessories are supplied for testing elongation under stress, and other factors and data.

The absence of friction in the weighing apparatus is shown strikingly in the case of small strains. A horse hair producing a strain of one pound will affect the index. Yet to do this the weighing platforms and other mechanism theoretically have to move. The weight of metal put in motion thus by so slight an agent is 24,000 pounds. A paper by the late Alexander H. Holley, giving a general description of the machine, is printed in the Transactions of the American Institute of Mining Engineers for 1879; and a technical description, with outline drawings in projection, is given in the Annual Report of the Chief of Ordnance, U. S. A., for 1883.

Proposed Utilization of the Rhine Falls.

Some twenty miles below the point where it issues from the Lake of Constance the Rhine, with a width of 350 feet and an average depth of about 21 feet, plunges over a barrier of rocks, varying in height from 45 feet on the right bank to about 60 feet on the left. Including the rapids, the total fall within a distance of a little over a third of a mile is estimated at 150 feet. The volume of water passing over the falls per second varies from a minimum of 118 cubic meters in February to a maximum of 502 cubic meters in July, when, in consequence of the melting of the snows in the mountains and the rise in all the tributary streams and brooks, the Rhine reaches its highest point.

In this practical age of inventions and progress very few will be surprised to hear that an application has been made for a concession to utilize these magnificent falls, so familiar to travelers, for the manufacture of aluminum. The applicants are J. G. Nethers, Son & Co., Schaffhausen, iron workers, who ask for the privilege of constructing a dam from Laufen Mill to the railroad bridges, a length sufficient to furnish them with a volume of 75 cubic meters per second. If this is granted, a foreign contemporary says, they propose to establish works for the manufacture of aluminum, furnishing employment at first to 500 workmen and later to double that number. They estimate the water power requisite to carry on their works at an equivalent of 1,500 horse power, and submit with their application the necessary maps, plans, and drawings. They further announce that a company with a capital of 12,000,000f. (about 480,000*l.*) is prepared to conduct the enterprise, and they offer all reasonable guarantees against any marring or defacement of the natural beauties of the falls. The proposition is being met with a strong opposition, led by the hotel keepers and many others who are dependent on the tourist business.

The Rabbit Plague in Australia—Reward Offered for a New Invention.

A very large area of the arable lands of Australia is now overrun with rabbits. So numerous and active are these animals that they destroy trees, grass, crops, and everything that grows. They move in great armies, and carry destruction in their path. All efforts to exterminate them have so far proved fruitless. The authorities now offer the handsome reward of $125,000 for an effective method of overcoming the evil. The following is the text of the offer:

Department of Mines,
Sydney, August 31, 1887.

It is hereby notified that the government of New South Wales will pay the sum of £25,000 to any person or persons who will make known and demonstrate at his or their own expense any method or process not previously known in the Colony for the effectual extermination of rabbits, subject to the following conditions, viz.

1. That such method or process shall, after experiment for a period of twelve months, receive the approval of a board appointed for that purpose by the Governor, with the advice of the Executive Council.

2. That such method or process shall, in the opinion of the said Board, not be injurious, and shall not involve the use of any matter, animal or thing which may be noxious to horses, cattle, sheep, camels, goats, swine, or dogs.

3. The Board shall be bound not to disclose the particulars of any method or process unless such Board shall decide to give such method or process a trial.

Francis Abigail.

All communications relating to the above must be addressed to the Honorable F. Abigail, Secretary for Mines, Sydney, New South Wales.

Some time ago the inspector of stock of Victoria, in an official report, gave the following account of the rabbit pest in that colony:

Rabbits are to be found, less or more, all over the western and northwestern portions of Victoria, and as far up the Murray as the Owens River, but in no great numbers as yet, and from Echuca upward they are principally confined to the banks of the river. In the western districts they are very numerous and destructive, and in the Wimmera, where the country is comparatively scrubby and poor, it may be said they have all but taken possession of the crown lands, and to a large extent also of the alienated land. On one property alone in the Colac district it is said that between $150,000 and $200,000 have been spent in destroying rabbits, while some owners are paying as much as $10,000 a year to keep them down, many $5,000 a year, and almost every holder of land is year by year put to a considerable expense in protecting his pasture and crops from these pests.

A great many modes of dealing with this evil have been tried in Victoria, viz., fencing the rabbits out, shooting, hunting with dogs, ferreting and netting, snaring and trapping, digging out and blocking up the burrows, and destroying the rabbits with noxious gas and poison. In all these modes, again, the work is at times done by the owner's own men, sometimes by contract, and at other times under the bonus system. When the rabbits are to be fenced out, a wire netting, 4 feet broad, with 2½ inch mesh, is put on an ordinary wire fence, the netting to the extent of one foot being bent and put in the ground at an angle to prevent the rabbits from burrowing. They try to do so close at the foot of the fence, but stop when they come upon the netting. The cost of the netting for a fence rabbit proof of this sort is about $250 a mile; and if it is found that rabbits cross the Murray after our land is cleared, and Victoria continues to be infested, it may be necessary to run a rabbit proof fence along the river to keep them from again obtaining a footing in this colony. Dogs (terriers, cockers, and other dogs which hunt by scent) and guns are generally used together, though sometimes kangaroo dogs and greyhounds are taken out with the terriers to kill the rabbits they put up. Where the rabbits have made a settlement, the most effective, but the most expensive, way is to dig them out, or, where it can be done (in rocky and stony ground), to block up the burrows and starve the rabbits in their holes. Ferreting and netting is also a very successful mode of destroying them; but ferrets are comparatively scarce, they are liable to be lost, and every one cannot manage them. A good many have also been taken in traps and snares, but these appliances are also expensive and comparatively slow.

The exterminator (the machine employed to charge the burrows with noxious gas) is also in some cases an effective mode, but it is expensive, and the machine is cumbersome and unwieldy to take about, while the holes at times in the warrens are of such a sort (as in the case of bilbee and wombat holes, of which the rabbits take possession) as to render the gas inoperative; and in other cases there are fissures in the ground which allow it to escape. A good many different sorts of poison have been laid, and in a great many different vehicles.

1. *The Poison.*—The poisons most frequently used have been arsenic and phosphorus, and in a few cases strychnine. Arsenic has been longest used, generally in conjunction with sugar and bran. Phosphorus, again, has been more recently tried, and is now far more generally laid than any other poison.

2. *The Vehicle.*—A mixture of crushed wheat and sugar, or bran and sugar, has been found an excellent vehicle, so far as destroying the rabbits is concerned, but the mixture is dangerous for stock, more especially sheep. Whole wheat has been used successfully, with arsenic, and latterly with phosphorus, but does not seem to retain the poison so long as the oats, and is more liable to be eaten by sheep. Oats have within the last few years been employed very successfully and extensively as a vehicle for phosphorus. Carrots have also been tried with good results as a vehicle for arsenic. This is what was to be expected, as all animals are fond of carrots, but the supply is comparatively limited, and in many cases they cannot be laid without endangering the stock; they are poisoned by bruising the outside and strewing it with arsenic. Potatoes have been used successfully as a vehicle for strychnine, and could of course also be used for other poisons, especially arsenic. Turnips, pumpkins, and melons could be used in the same way as carrots, and cabbage leaves, turnip tops, green corn, and sorghum could also be made vehicles by slitting or opening them, where there is room, and laying the poison in slits or openings. But all these, like carrots and potatoes, can only be used where the stock can be removed from the paddock, or where these vehicles can be laid where the stock cannot get them. In cases, however, where the rabbits have been reduced in number, and it is of course of great importance to complete their destruction, sufficient precautions could be taken by laying down hollow logs, digging holes in the ground, fencing off small patches, and in other ways to keep the stock from reaching the poisoned vehicle.

Oil of rhodium has been employed successfully in conjunction with some of these vehicles as an attraction for the rabbits, and, although expensive, might be added where they cannot otherwise be induced to take the poison, or it might be so to make them take it more readily. The reports under this head are very conflicting with regard to effect of poisoned grain. It is allowed that the poisoned grain is not nearly so successful when the grass is green and plentiful as it is when dry and scarce. It is also generally allowed that while oats and wheat poisoned with phosphorus have at first been successful in destroying the rabbits, it is at the same time the opinion that the rabbits after a time cease to take either the one or the other. I think, however, that these results are only what were to be expected. When the grass is plentiful and green, not only will the rabbits be comparatively careless about food such as oats or wheat, but they will not be so likely to see the grain on the ground as they would when the grass is brown and bare. Then, again, all animals are endowed in a greater or less degree with the instinct which leads them to refuse to take what they see is destroying them. The rabbits would at first—and perhaps for a little time in the case of arsenic, and longer in that of phosphorus, which is a slow poison—take the grain; but as soon as those which took it began to die in any number, the others would stop eating the grain. It is well known that the same thing happens where poison is laid for native dogs, rats, and other animals.

Although I think the failure of the attempts made in Victoria to destroy the rabbits with poison is largely due to not changing the vehicle in which the poison was laid, the main cause of the failure there has, in my opinion, been the want of simultaneous action on the part of the owners whose land was infested with rabbits. The law in Victoria is only applicable to a portion of the lands of the colony—that alienated by the crown; and even in the case of land to which the law does apply it has very seldom been enforced, for it has provided no penalty for neglecting to destroy. There the defaulting owner can only be compelled to do so by the shire councils—who have the carrying out of the act—putting men on the defaulter's holding to destroy the rabbits; and, like our own boards of directors, these councils dislike to exercise this power, and have seldom or never done so. The result has been that while some owners did all they could to clear their land, others did nothing. The rabbits are, therefore, increasing in some districts; as numerous as ever in others; and, although a great many have been destroyed, their spread has not been really checked, for they are every other month making their appearance in fresh districts. Under these circumstances, it is not surprising that in Victoria owners speak hopelessly of being able, except at an expense which would be most oppressive, to do more than keep the rabbits down; but there is little doubt that the result there would have been altogether different had owners been compelled, as they can be in this colony—and as I trust they will be—to carry out the work of extermination promptly and simultaneously on all the holdings.

The Flea.

Fleas love dirt, and in it they flourish and multiply most abundantly. But in spite of St. Dominic's curse and their unclean haunts, they are interesting little fellows. Let us put one under the microscope. It seems to be clothed in a sort of armor formed of brown overlapping plates, that are so exceedingly tough as to be almost indestructible. Its head is small and very thin, and it has a single eye upon each side. This eye is black, and the rays of light scintillate within it like sparks of fire. Puget managed to look through one of these eyes, and he found that it diminished objects in size, while it multiplied them in number—a man appearing like an army of fairies, and the flame of a candle becoming a thousand tiny stars. From the shape of its head, and for other reasons, the flea is supposed to use only one eye at a time. The offensive weapon of the flea is composed of two palpi, or feelers, two piercers, and a tongue. When it feeds it stands erect, thrusting this sucker into the flesh, and it will eat without intermission until disturbed, for it voids as fast as it swallows its food. It is interesting to put several in a glass, and, giving them a piece of raw meat, see them all standing on their hind legs to suck up its juices.

Their manner of breathing is still undetermined, but it is thought most probable that they receive air into their bodies through small holes at the ends of the palpi.

The legs of a flea are marvels of strength and elasticity. They are joined to the body by long tendons that act like wire springs. In making its leap, which, it is said, can cover two hundred times its own length, the flea draws the leg close up to the body, and then throws it out with great force; but the impulse proceeds from the first joint alone, the others only increasing it by their stretch while the leap is being made.

Fleas are possessed of great strength. Mouffet tells of a mechanic who made a gold chain, as long as his finger, that a flea dragged after him; and a golden chariot, which he drew also. Bingley writes of a watchmaker in the Strand who had an ivory four-wheeled chaise, with a coachman on its box, drawn by a flea. The same man afterward made a carriage with six horses, a coachman, four persons inside, two footmen behind, and a postilion on one of the horses, all of which were drawn by a single flea. Latrielle mentions a flea which dragged a silver cannon, of twenty-four times its own weight, mounted on wheels, and showed no fear when it was charged with gunpowder and fired off. Rene says that he saw three fleas drawing a tiny omnibus; that a pair drew a chariot, and that a brass cannon was dragged by a single one.

There are several varieties of fleas, but they are so much alike that their differences are interesting only to scientific people. The cat flea will do as well as any to show us the process of breeding. During the spring and summer months she simply drops her eggs into the fur of the cat, but in the autumn and winter she glues each firmly upon a hair. These eggs are so small as to be barely visible to the naked eye, but under the microscope they are very beautiful, looking like the loveliest pearls, and are perfectly translucent. The flea deposits nearly two hundred at a time, running about and dropping them here and there. They soon hatch into small, white, footless worms. In from one to two weeks they go into cocoon. Nothing can be prettier than this cocoon. I wish I could show it to you, but will try to describe it. It is like a flask of clear glass, tinged at the edges with pearly tints, and dotted over with gold. The little sleeper within lies in a circle, is rose colored, and looks like the delicate petal of a flower. In about six weeks he reaches maturity. At first he is not larger than a mite, but when well fed grows quickly in size and strength.

Fleas are quarrelsome, and great fighters. When several are confined in a glass, they will stand on their hind legs, striking at their opponents with the others, and roll over and over each other, losing legs and antennæ, and at last giving up their lives in the fight. There is a record of a flea which lived ten days after such an encounter, with no antennæ; three plates of his side broken in; one eye gone; and with only four legs, and these cut off to the first joints.

Fleas are supposed to feel a great antipathy to worm wood and other bitter herbs; and, in England, the country people have a habit of placing these about their cottages for the purpose of banishing the lively little pests.—*S. L. Clayes, Swiss Cross.*