[*Continued from first page.*]

sonry at the east end to face of masonry at the west end, is 4,280 feet, there being 35 feet of arching constructed outside of the rock faces, in order to prevent loose earth, stone, etc., from falling on the track. The back arching within varies from 22 to 34 inches in thickness, and extends over some 3,100 feet, or about three quarters of the entire length. The roof was thus reinforced wherever it was considered not absolutely safe.

The east end of the tunnel enters the rock about 2,700 feet north of the entrance of the Bergen tunnel, with which its line forms an angle of 40°, the west end appearing on a higher plane and within some 50 feet of the older bore. It is 27 feet wide in the clear, and the total height is 20 feet 7 inches. Ventilation is secured by seven shafts, all (with one exception) brick lined. Three are elliptical in section, opening the full width of the tunnel in the long, and measuring 8 feet in the short diameter; one is 16½ feet by 7 feet, two are 6 feet in diameter, and another, opening the full width of the tunnel, is 12 feet wide.

MAP OF THE DELAWARE AND LACKAWANNA RAILROAD'S NEW WORKS.

Besides the actual excavation, considerable labor has been necessitated in the construction of approaches. The natural bog on the east side of the ridge has been filled in to support about three quarters of a mile of track. On the west side, a mile and a half of new road has been built to connect with the old line, passing through the Bergen tunnel. In both of these short sections, several fine bridges, which are illustrated in the accompanying engraving, have been erected. On the east side there are three bridges at Henderson street, carrying over seven tracks; at Grove street there is one four-track bridge. This last, together with the iron skew bridge of 193 feet span over Hoboken avenue, and the bridge over the Erie oil track, are represented in the illustration. On the west side, there is a fine iron skew bridge near the mouth of the tunnel, so that the line of the road passes directly over the Erie track. This will be found represented in the engraving, together with the bridges over Tonnelle and James avenues, and the celebrated skew structure across the Hackensack river. The last mentioned bridge is a triumph of engineering skill, owing to the difficulties offered by the marshy soil and destructive power of the river. It has two spans of 200 feet and one draw of the same length. The material is iron built upon masonry, which found a stable foundation only after 1,700 piles had been driven. The eastern abutment was washed away soon after completion, and wholly wrecked, despite the fact that it was built on over 300 piles, each a foot in diameter and each driven down forty feet.

The cost of the tunnel and approaches, as nearly as can be ascertained at present, was as follows: Excavation and shafts, $800,000; brick arching, $105,000; filling bog, grading, track laying, etc., on east side of ridge, $450,000; land, right of way, road, etc., on west side, $875,000; bridges, $557,000. The total cost was therefore about $2,787,000. If to this be added the outlay for the ship canal (now in progress), 3,000 feet long and 100 feet wide and 20 feet deep, designed to increase the dock facilities of the Delaware and Lackawanna Company, the entire expense of all the engineering work undertaken by that corporation reaches an aggregate of $2,850,000.

The engineers of the tunnel were Mr. James Archbald, Chief Engineer of the railroad, and Mr. Samuel Rockwell, Resident Engineer. The contractor was Mr. John McAndrew, and the bridges were mostly constructed by the Delaware Bridge Company. It is expected that the trains will pass through the bore for the first time during the present month.

Communications.

The French Exhibition.

To the Editor of the Scientific American:

If Congress should fail to make any appropriation for the proper representation of this country at the French Exhibition next year, there are men patriotic enough to give their services for such an end; and the sooner a commission is formed, and intending exhibitors invited to apply for space, the better. One chief commissioner, with two or three assistants willing to work, would be ample; and exhibitors would gladly pay their own expenses rather than depend on the favors they may get from such strugglers for place and power as have characterized our two last exhibition commissions abroad. A small appropriation of course would be desirable (to fairly pay the expenses of the commission), when judiciously applied, and for fitting the space allotted and keeping it clean; and the resolution making the same should specify that not more than $5,000 should be paid the chief commissioner, and not more than $3,000 each to three assistants, to include all their private expenses; about $20,000 for fittings and decorations, and $5,000 for labor and the like. Then about $10,000 should be strictly applied to assisting exhibitors, making $50,000 in all. This, in honest and judicious hands, would be ample.

The government has plenty of transports and seamen, and should send to Havre or Ostend all the United States' contributions. With this, exhibitors would be satisfied; and I think, if taken hold of in time, a very good show on the part of the United States would be made.

The SCIENTIFIC AMERICAN can bring this about, and so assist in the matter that the thing can be accomplished without a "fuss," as has been generally the case. When Congress failed (in 1861) to make an appropriation and the Cabinet continued to me the position of Commissioner, in place of the 24 who resigned, I took hold and carried it through; and because there was no money to quarrel about, we had a good and peaceful time; out of 109 exhibitors, we had 97 prizes awarded, and 59 of them first-class. Contributions from several wealthy Americans enabled me to fairly fit up and decorate the space allotted; and with a private expenditure of $1,700 we kept our credit good with foreign commissions, and came out of it, I believe, with the perfect goodwill of every exhibitor. My whole expenditure did not exceed $7,000, of which over $5,000 was voluntarily contributed, McCormick, Osborn, and Walter A. Wood each giving $150; Steinway and the Glen Cove Starch Company also did the fair thing. I would try it again rather than that we be behind time or shut out altogether.

I presume Mr. Corliss would accept the chief commissionership, if tendered him; and no doubt Charles Francis Adams, or perhaps Mr. Washburn, late Minister to France, if wanted. Let us have a good American exhibit. We surely shall not have if we wait till the end of October.

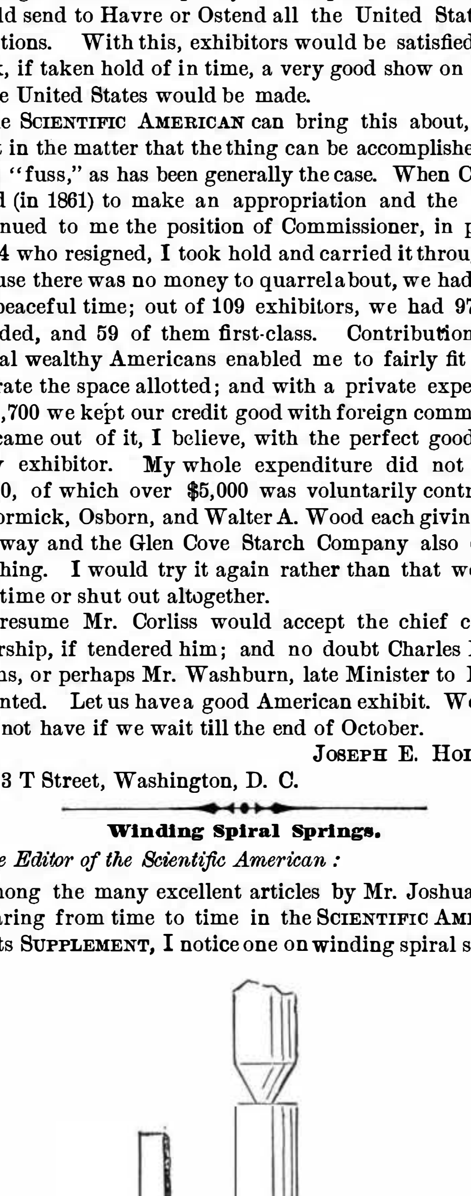
JOSEPH E. HOLMES.

1013 T Street, Washington, D. C.

Winding Spiral Springs.

To the Editor of the Scientific American:

Among the many excellent articles by Mr. Joshua Rose, appearing from time to time in the SCIENTIFIC AMERICAN and its SUPPLEMENT, I notice one on winding spiral springs.



Now as many of your readers who have lathes may not have the means of cutting a spiral, and others may want a spring for an odd job where it would cost too much to make a mandrel, I send you a sketch of the method we practice here. We simply take a common straight mandrel, or a centered rod of round iron or steel, a little smaller than the inside diameter of the spring is to be, place an ordinary dog on one end, and put it into the lathe; then we take the wire to be wound, and bend about ¾ of an inch at one end at right angles. This can generally be done by placing the end in the vise and bending cold. Insert this bent end into the dog, letting it rest against the screw, give the lathe about half a turn by hand, then put on the guide, which is an iron rod, preferably square and as thick as you want the spirals to be apart. Bend one end to form a hook that will pass over the mandrel freely, the other end being left long enough to pass down between the lathe shears to keep from revolving. Start the lathe, holding the wire against the guide with a slight pressure, and the spring will wind, feeding the guide along ahead of it. After the spring has been wound, turn the lathe backwards one or two turns, or enough to take the pressure off the spring, before it is relieved from the lathe. I have found no difficulty in holding No. 6 steel wire in my hand while being wound over a ⅝ mandrel; but for larger sizes, especially if hard, a rest may be inserted in the tool post, and the wire allowed to pass over that. This rest, to prevent abrading the wire, may be a piece of hard wood of a size that will go into the post, and extending 10 or 12 inches, being supported on the outer end by a block. If a number of short springs are wanted, one can be wound as long as the strength of the mandrel or length of the lathe will admit, and afterwards cut into lengths. The short end of the guide hook is bent to conform to the spiral.

Hamilton, Ohio. J. T. G.

Steam Economy Computations.

To the Editor of the Scientific American:

A correspondent, W. A. Mussen, in your issue of May 5, alludes to a method of computing theoretical steam economy, which he finds in the circular of a manufacturing company. Having had something to do with the preparation of the rules he quotes, I deem it but just to the rules, and to the critics whose opinions he invites, to offer a trifle of explanation. The "constant number 859,375" is found by the following process, for which credit is due, so far as I am aware, to Mr. Jesse Warrington, now of Jackson, Mich.

The standard horse power is 33,000 foot-lbs. per minute. Hence $33,000 \times 60 \times 12 = 23,760,000$ is its equivalent in inch-lbs. per hour. This, it is evident, will be the displacement in cubic inches per hour of an engine which will give one horse power with 1 lb. mean pressure. Then taking the number 27·648 as the number of cubic inches per lb. of water, we have $23,760,000 \div 27{\cdot}648 = 859,375$ (and singularly enough, without a remainder), as such displacement in lbs. of water. From this point your correspondent gives the *rationale* of the process clearly enough; but when he makes an application of it, he takes for the volume of 16 lbs. (the terminal pressure of his diagram), the number 954, which is not the volume of that pressure by any table I know of. According to the authorities referred to, it is 1,515, and by the older tables, 1,576. Taking the former, his diagram would figure 22·304 instead of 35·46. So far as he has quoted the circular, no tables of volumes need have been referred to. It contained a table, in the preparation of which they were used, hence the reference; but this he has not quoted. This constant number may be used with any table of volumes which may be considered most accurate.

The method of determining the proper allowance for clearance and compression also needs a word of additional explanation. When the exhaust takes place above the return or counter pressure, a certain amount of loss takes place from the expansion of the steam in the clearance space. But when the compression pressure reaches that of the release, this loss is restored; and whatever percentage of the stroke remains to be made after that may be deducted from the theoretical rate. When the compression pressure does not reach that of the release, we may find, by extending the compression curve theoretically till it does so, how much further the piston must have traveled to have restored the release pressure, and add an equivalent amount to the result of the calculation.

Finally, it is not expected nor claimed that calculations of this kind can give very closely the actual consumption of any engine. Their chief value is for the comparison of different engines, and different conditions existing with the same engine. They also give the theoretical maximum economy, with which to compare the actual, in order to judge of the degree of perfection existing in the engine and its surroundings. No engine can ever reach it; but a large one, furnished with dry steam somewhat superheated, with well protected pipes and cylinder, may possibly come within 10 or 12 per cent of it, but the average loss is probably much nearer 30 per cent.

Like Mr. M., I cordially invite criticism and exchange of ideas on this and kindred subjects.

Salem, Ohio. J. W. THOMPSON.

The Water Consumption of Steam Engines.

To the Editor of the Scientific American:

In a recent issue, I notice an article entitled "Water Evaporated through Engines," in which was published a method of computing the water consumption per horse power per hour. As the method was furnished by myself, I will say that all that is claimed for the process is that it will give identical results with other more complex processes, in which the size of cylinder, number of revolutions per minute, total piston displacement per hour, and clearance are used as factors in the calculation. It does not depend for its accuracy on the fact that steam follows the Mariotte law of expansion. While it does not account for leakage of piston, or condensed steam that passes out of the cylinder as water, it does account for leakage of steam into the cylinder between the point of cut-off and release; and the supplementary rule by the one process gives the correction for cushion and clearance. That the result as obtained by the rule was not expected to agree with that of actual measurement of the water passed through engine is evident from the following, which I copy from the circular in which it was printed: "It is not claimed that the theoretical rate of water consumption, as deduced from the diagrams, can ever be realized in practice. A certain amount will always be lost from condensation, leakage, and unevaporated spray in the steam, which no process of calculation makes allowance for." Your correspondent is in error in his calculation. The volume of steam at 16 lbs. pressure is 1515 according to Roper's "Handbook," and 1573 in the American *Engineering*, in lieu of 954. He has taken the terminal pressure about 2 lbs. too low, as I judge from appearances, not having means at hand to measure it.

Jackson, Mich. JESSE WARRINGTON.

Marbleized and Granite Ware.

To the Editor of the Scientific American:

My attention having been called to certain statements in the newspapers concerning poisonous enameled ware, known as "marbleized" and "granite" iron ware, I desire to state in your columns that, in order to arrive at the facts in the matter, I have made several analyses of these wares, obtained directly from the manufacturers and from dealers and agents in the city, with the following results:

Marbleized ware.—In No. 1 the enamel was found to be a silicate containing crude iron and a small quantity of lead. No. 2 was a similar vessel, obtained from another dealer; but it contained, besides the silicates mentioned in No. 1, a little arsenic (about 0·2 per cent). No. 3 contained considerable lead, but only a trace of arsenic. No. 4 was a small dipper or ladle, obtained directly from the manufacturers, contained neither arsenic, lead, or other objectionable ingredient. In five different analyses of the granite ware I found no trace of arsenic or other soluble metals. Some pieces of it, however, contain a little antimony, which, although generally considered an objectionable ingredient in such enamels, is not liable to produce any bad effect, under ordinary circumstances, in this instance. I have also made several analyses of white enameled ware; and in two cases out of three I have discovered traces of lead in them.

It has frequently been said that lead, in some form or other, is becoming an apparently essential ingredient in our daily nourishment. If we take lead in our drinking water, lead in our earthenware and crockery, lead in our tinned goods and solder, lead in our non-poisonous (?) enameled ware, lead in our paints and the wrappings of our cured meats, and if we are to place any confidence in the adaptation-to-circumstance theory, may we not expect to see, in the not far distant future, the average citizen take his food with an exquisite relish due to *sauce de plomb?* But at the present time many of us are not of the "fittest" in this respect, and we offer to our health officers a modest suggestion, that the plumbiferous and arsenical additions to our food be somewhat restricted.

It is, perhaps, in justice, due to the manufacturers of these marbleized and granite wares to say that the greater part of their goods—all, in fact, of the "granite" ware—now offered for sale in our markets are perfectly free from all deleterious substances, as is certified to by many of our best chemists—Professors Henry Morton, Drs. Wood, Hayes, Nichols, Silliman, Doremus, and others—and that the wares, as now manufactured, are as they should be.

New York city. W. H. FULLER.

PRACTICAL MECHANISM.

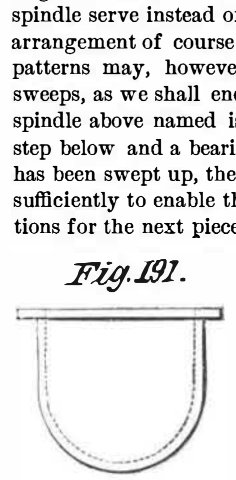
BY JOSHUA ROSE.

NEW SERIES—NO. XXVI.

PATTERN MAKING.—SWEEP WORK.

The above title applies to a class of work, generally of large size, in which boards or sweeps fixed to a revolving spindle serve instead of patterns to form the moulds. This arrangement of course will only produce circular moulds; patterns may, however, be used in conjunction with the sweeps, as we shall endeavor to illustrate further on. The spindle above named is a light vertical shaft revolving in a step below and a bearing overhead: when a part of a mould has been swept up, the spindle can be raised out of the step sufficiently to enable the work to be removed and preparations for the next piece substituted.

Fig. 191.



Let it be required to produce a casting such as is shown in Fig. 191, a sort of pan or boiler, often used. Fig. 194 is a sectional view of the mould complete; it is formed of two parts, the lower being called the "seat," and the upper the "cope." Figs. 192 and 193 illustrate the method of forming each of those parts. The material used by the founder is called loam, a clayey, plastic composition, very soft. After a certain quantity of this material has been piled up, the sweep is revolved: it shears down the high places and indicates the holes or hollows. Into the latter more material is placed, and the sweep is passed round again, and so on until the job is perfected. It will be noticed in Fig. 194 that the two parts of the mould are retained in their proper position by a projection on one fitting into a recess in the other; this is the seat proper and is indicated throughout by S S. The pattern maker's part is to form the sweeps, which he does in the following manner: On a piece of board of the proper thickness for a sweep, the size of which depends on the size of the work, he draws an outline of the job, interior and exterior, from the center outwards; and beyond this he lays off his seat, as shown at Fig. 193, the dotted lines representing the interior of the piece.

Fig. 192.

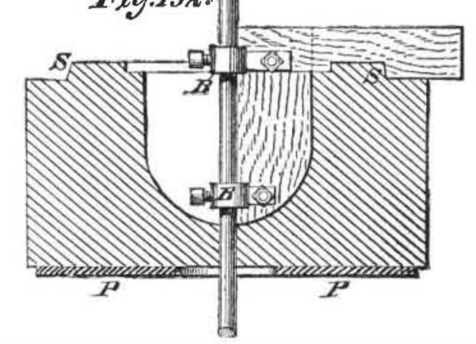
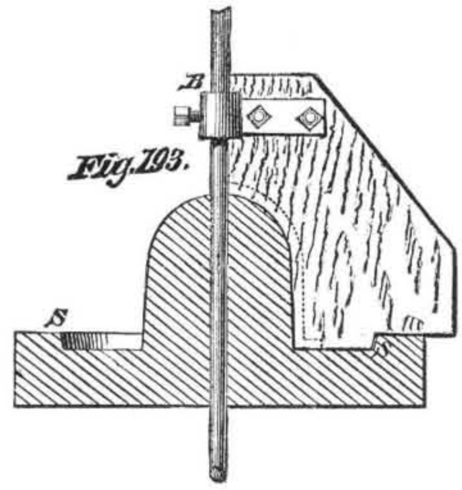


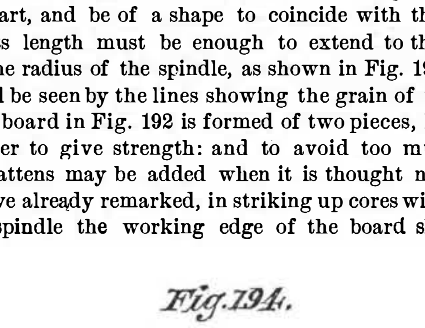
Fig. 193.



He has then simply to cut away to the interior line, and also the step at S, and one board is finished, unless he knows the diameter of the spindle and the position of the holes in the carrying bracket attached thereto, in which case he is supposed to cut off, parallel with the center line, a portion equal to the radius of the spindle, as a recess for the hub of the bracket, B, and to bore the holes for the bolts. The board, Fig. 192, when reversed, should fit that in Fig. 193 at the lower part, and be of a shape to coincide with the dotted line. Its length must be enough to extend to the center, *minus* the radius of the spindle, as shown in Fig. 192.

It will be seen by the lines showing the grain of the wood that the board in Fig. 192 is formed of two pieces, lapped at the corner to give strength: and to avoid too much cross grain, battens may be added when it is thought necessary. As I have already remarked, in striking up cores with a horizontal spindle the working edge of the board should be beveled; and it is hardly necessary to say that the same is applicable in this case. P P, Fig. 192, is a circular plate of cast iron, used to support the mould while soft; it is not shown in Fig. 193. By the same method, only varying the outline of the sweeps, a large class of circular work may be produced, including vases, speed cones, etc. Sometimes it is necessary to cast brackets, pipes, or other projections upon the main piece; to do this patterns must be made of those projections, and as many patterns as there are projections. The height at which it is required to bed in these brackets, etc., must be indicated to the moulder by a small V cut into the sweep; this will produce, as the sweep revolves, a line upon the mould. For the rest, unless simple directions can be given, the pattern maker usually visits the foundry, and assists in placing, or at least in verifying, the position of the pieces. When the mould is sufficiently hard, and before it is baked, these patterns are withdrawn.

Fig. 194.



A good illustration of the manner in which pattern work may be used in conjunction with sweeps is furnished in the ordinary engine cylinder. Fig. 195 is a sectional elevation of a complete mould; Fig. 196 is a horizontal section of the same, on the line A B, showing the outlet for the exhaust steam. This mould is composed of four parts that are swept or struck up, namely, S S the seat, A B the body, C C the cope, and M the main core. The latter may be struck upon a horizontal arbor or formed in a box. In addition to the parts above enumerated are the two steam port cores and the exhaust port core, all formed in core boxes. The procedure is as follows: With a board shown in Fig. 197, the seat, S S, is struck up: upon this when dried is placed a flange of wood. It is set centrally; the seat is also carefully beveled and set by the spindle. A pattern of the slide face, with the parts in which the steam and exhaust passages occur, is set in position on this flange; the top flange of wood is now added, and temporarily fixed to the slide face pattern, and shored up on the opposite side, so as to maintain it true and level.

Fig. 195.

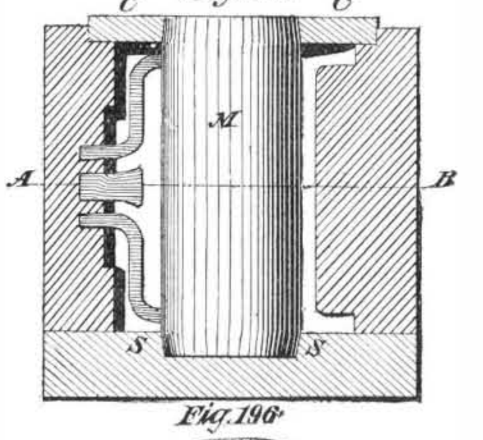


Fig. 196.

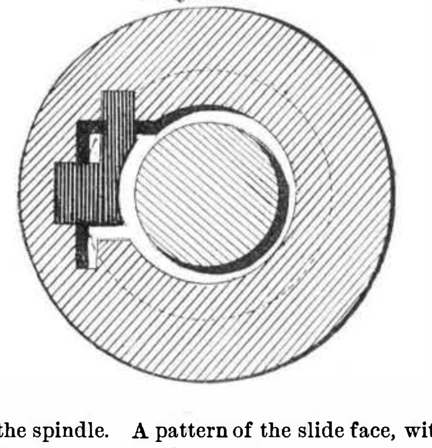
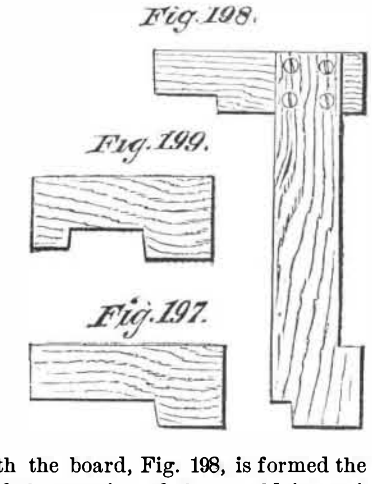


Fig. 198.

Fig. 199.

Fig. 197.



With the board, Fig. 198, is formed the body, A B; the shape of the exterior of the mould is not important; it is left rough, but some mark must be made so as to be able after removing it from the seat, to restore it to the position as before. When the body has dried sufficiently, the pattern flanges and slide face are withdrawn, the body being lifted from the seat for this purpose by means of bolts passing through it, and terminating in a cast annular plate at the bottom. The projecting flanges on the slide face are attached by wires or dovetails; otherwise the piece would be locked in the mould. The side print for the exhaust port is attached also by a loose wire. Fig. 199 is a board for sweeping up the cope, C C. The whole of these boards are represented as carried to the center of the spindle; allowance must therefore be made for the spindle and bracket. For very large cylinders, wood flanges are not used, the sweeps being made to a shape to perform the whole of the work.

Rye for Pasture.

A correspondent of the Elmira (N. Y.) Farmers' Club writes as follows: "Farmers who are in want of first-class pasture at least expense, for this season, should prepare a lot for the purpose and sow the same to winter rye; and they will soon have a pasture for sheep, calves, poultry, in fact any kind of stock; and for young lambs it cannot be excelled. Heavy stock will trample it into the ground, to some extent, if put on early in the season, but later they can be kept on it at a profit. Winter rye sown in the spring will not head out till the second year, but will stool out so as to cover the ground, producing a luxuriant mass of feed that will pay every experimental trial. It can be cut for soiling purposes the second year for grown-up stock, or it can be raised for pasture, as stated before, or it can be allowed to attain its growth and mature a crop to harvest. It will also stand drouth very well, and enrich the land. From one and a half to two bushels per acre should be sown, according to the wealth of the land."

THE EDSON RECORDING GAUGE—A fully illustrated description of this important invention was published in No. 70 of the SCIENTIFIC AMERICAN SUPPLEMENT.