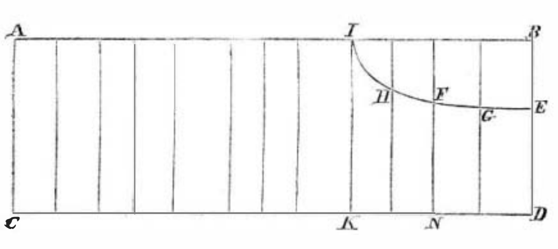
EXPANSION OF STEAM.

An engine is working on the "expansive" principle when the steam does not follow the piston its full distance through the cylinder or when the steam is "cut off" before the end of the stroke; that is, when the communication between the steam already in the cylinder and that in the boiler is closed.

It is clear that the steam in the cylinder will do some work by expansion during that part of the stroke which is uncompleted after it is cut off, and this work (which is done without any further supply from the boiler) is the saving of steam, and consequently of fuel, due to the expansion of steam.

This saving of steam and fuel is diminished to a small extent by a loss of power. For if we have a boiler carrying a certain pressure of steam, and the engine just does the work when using steam full stroke, it will be necessary to have a larger cylinder or increase the pressure in the boiler in order to do the same amount of work "expansively," and this will be attended with a saving of fuel in both cases on account of the expansion, and in the latter case there will be an additional saving from the fact that the greater the pressure under which the steam is produced, from a given amount of fuel, the greater the amount of work which can be developed from it. In order to illustrate this, it will be necessary to explain what work is, and the manner in which it is represented graphically. Work is the product of the resistance multiplied by the distance which it moves through. For instance, if there are ten one-pound balls to be moved the distance of one hundred feet, the total work to be done is said to be one thousand foot pounds: if they were moved one at a time, the work each time would be one hundred foot pounds, and in ten times, one thousand, as before. As the area of a rectangle is the product of two factors, viz., two of its sides, it may be taken as a graphical representation of "work" by considering one of its sides to represent the distance through which the resistance moves and the other side to represent the amount of this resistance. In the figure, let the line, A B, be the distance, and A C, the resistance: then the area, A B C D, will be the work done. Hence if we suppose A B to represent the stroke of an engine, and A C the pressure throughout the stroke, the area, A B C D, will show the work done during each stroke. If the stroke be three feet=A B, and the pressure twenty pounds, the work of each stroke will be sixty foot pounds=area, A B C D. When the steam is cut off at any point as at I, the steam will commence to fall in pressure as represented by the lines between the curve, I E, and the line, K D. The work done by the expanded steam will be shown by the area, A C D E I, the work lost, by the area, I F E B, and the work saved by the area, I F E D K. In order to determine these areas it will be necessary to find the average length of the lines between the lines, A I E and C D.

We are enabled to do this by considering steam a perfect gas (from which there will be no appreciable error in practice if the expansion is not carried beyond limits to be mentioned hereafter), and consequently being less in pressure as the space it occupies is larger. If the stroke be three feet, as before, and the steam be cut off at I, two feet from A, the steam will occupy one and a half times greater space at the end of the stroke than it did when it was cut off, and the pressure will be one and a half times less, that is $20 \div 1\frac{1}{2} = 13\frac{1}{3}$ pounds=D E.



At a point, F, half way between point of cutting off and end of stroke it will occupy one and one quarter times as much space as it did before, and the pressure will be one and one quarter times less, that is $20 \div 1\frac{1}{4} = 16$ pounds=N F. By proceeding in a similar way we find the pressure at H to be $17\frac{2}{9}$ pounds, and at G, $14\frac{6}{11}$ pounds, and at each of the points before cutting off, twenty pounds, and hence the average pressure will be $[8 \times 20 + 17\frac{2}{9} + 16 + 14\frac{6}{11} + 13\frac{1}{3}] \div 12 = 18\frac{1}{2}$ pounds, and the area A C D E I, or work done $= 18\frac{1}{2} \times 3 = 55\frac{1}{2}$ foot pounds. The area, I F E D K=work saved $= 55\frac{1}{2} - 40 = 15\frac{1}{2}$ foot pounds. The area, I F E B=work lost $= 60 - 55\frac{1}{2} = 4\frac{1}{2}$ foot pounds. From which we find that the steam, in expanding to $1\frac{1}{2}$ times its original bulk, does 37 per cent more work than when following full stroke. The work, however, when working full stroke, was 10 per cent more then when cutting off at two-thirds stroke, hence we must use more steam in order to do as much work as before. The additional amount of steam required will be 7·3 per cent (and not 10 per cent, which is the amount of work required) because the steam which we add to bring up this loss of work acts expansively with that we have been considering, and therefore does 37 per cent more work than if it followed full stroke; and 37 per cent of 10 per cent is 3·7 per cent. The total saving of steam working expansively one-third of the stroke, is therefore equal to the first saving of 37 per cent less the 7·3 per cent which must be added in order to lose no work, or nearly 30 per cent. From the above it appears that the use of high steam and a large use of the expansion principle, would be attended with great economy, and, in fact, wherever the power required is nearly uniform, as in manufactories and on smooth rivers and lakes, this principle is almost universally adopted. There are, however, cases in which it is impossible to get the full benefit of expansion.

In locomotive and propeller engines, owing to the simplicity of the machinery required to run smoothly at high speeds, it is limited to the link motion, with which it is impossible to cut off advantageously before five-eighths of the stroke has been completed. All slide valves are limited in the extent to which they can cut off advantageously by the same cause which limits the link motion, viz., a choking of the exhaust, causing excessive "back pressure" or else an early release of the steam behind the piston before the stroke is completed.

The extent to which expansion can be carried economically is limited. When steam expands from a high to a low pressure and does no work but simply enlarges its volume, it is superheated, that is, it is of a greater temperature than steam which has been produced at the lower pressure. If, however, the steam performs work in expanding, such as driving the piston of an engine, part of the steam will become liquefied, thus showing that its temperature has been lowered. This fall in temperature is not of practical importance unless the steam is expanded to more than three and a half times its original bulk, which doubles its efficiency, when it cools the surrounding cylinder to a considerable extent, and thereby condenses the steam of the next stroke until the metal is brought to its temperature, soon after which it is again cooled by the expansion of this last steam. The greater part of the water formed in the cylinder while the engine is in operation is now attributed to this condensation, and not priming or foaming, as heretofore.

From what has been said, it is clear to see that steam used expansively is an economical practice, and should be so used to some extent in every case, and especially where the first cost, weight, and bulk of the machinery are of little importance compared with the fuel to be consumed.

HAINES'S SAFETY BRIDLE.

We have published several engravings with explanations of improved reins for driving, designed to obviate the annoyance to the horse of the common unyielding check rein, and to secure the occupants of a vehicle from the dangers of hard-bitted and fractious animals. The two engravings show the construction and action of an improved rein patented by Joseph C. Haines.

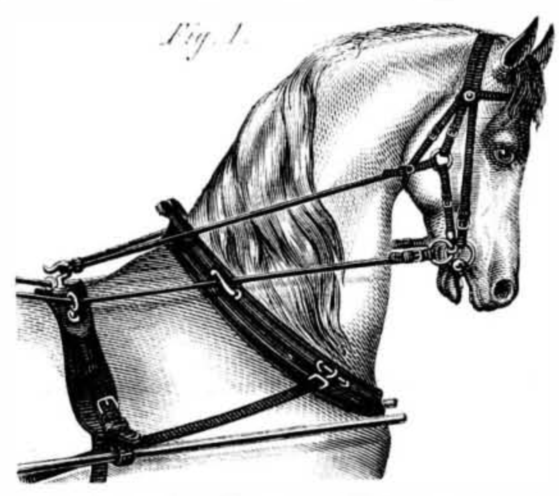


Fig. 1.

Fig. 1 shows the harness as it is in ordinary driving, and Fig. 2, the reins when used to check a refractory horse. By a glance at either of the figures it will be seen that the reins proper and the check strap are united by means of a strap parallel with the headstall. In ordinary driving, however, the rein ring is held close to the bit ring, as in Fig. 1, by means of a bent metallic connection between the rein and check which makes a bearing on the bit ring. But when it is desirable to bring the horse up "standing," a powerful pull on the reins draws the rest through the ring, and straightens the head-stall strap, bringing the head up and effectually controlling the animal, as is seen in Fig. 2. The fixed point of attachment at the top of the horse's head forms a fulcrum against which a powerful leverage can be exerted, sufficient, it is claimed, to control the hardest-bitted horse.

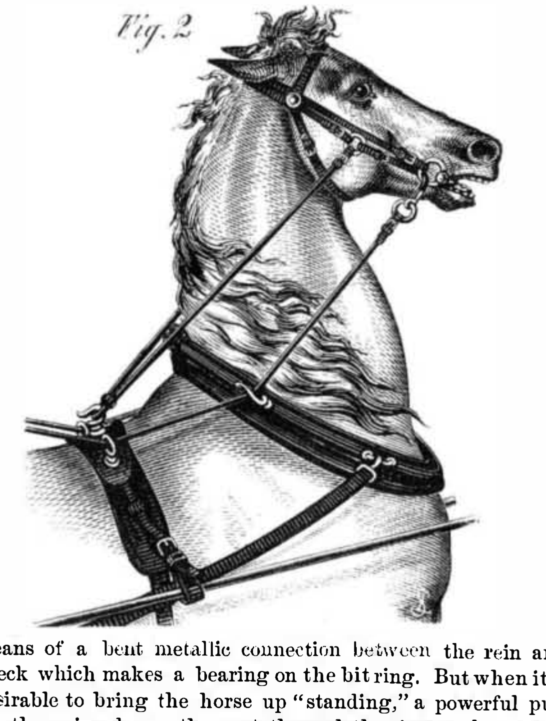


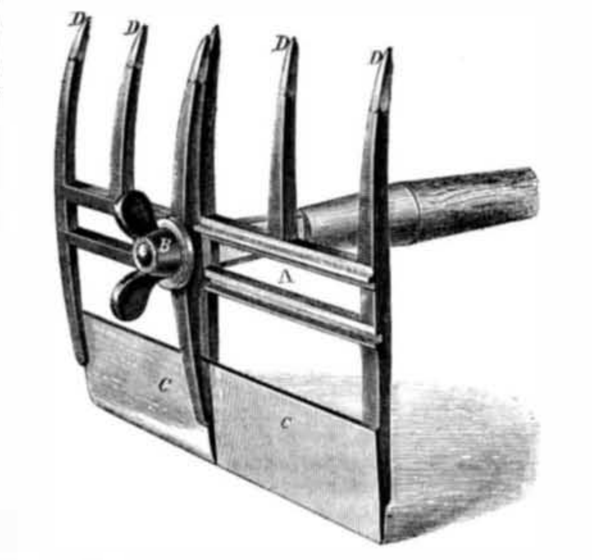
Fig. 2.

The bearing used at the bit ring in ordinary driving may be of metal, or of the leather itself, recessed to fit the ring. The arrangement has been fully tested and is said to be satisfactory in its operation.

Patented July 10, 1866. For the right to use, manufacture, and sell, address J. C. Haines, Lewiston, Pa.

RENZ'S EXTENSION WEEDING HOE AND RAKE.

The object of this device is to provide a simple garden implement, which can at will be changed in size and form to subserve several purposes. The frame is of cast or malleable iron, connected to a handle by means of a screw shank, which slides in the slot, A, and secured in any position by the thumb nut, B. Over this frame is a corresponding one, the central bars of which are rabbeted to receive the slides of A. Each frame has a steel blade, C, and rake teeth, D. When fully extended, the two blades form one of considerable length, and the rake is open, as shown in the engraving. If the outer frame is slipped half the distance between the teeth, it makes a narrower blade and a rake only one-half as coarse as when fully extended. The whole frame can be secured by the center or near either end. Any adjustment desired can be made instantly.

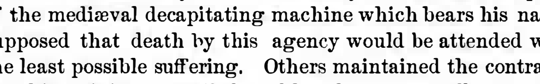


Patented through the Scientific American Patent Agency, Dec. 4, 1866. For further information address Mitchell Renz, Naugatuck, Conn.

NEW PATENT PIN.

The phrase "pin money" is to us of modern days a meaningless term, but if we go back to the time when the expression originated, we find it had a painful significance, for prior to the introduction of the machinery for their manufacture, a pin made by hand was in value a synonym for a penny. The extravagance in the use of pins at the present day is incredible. The statement is given in another column of the number daily manufactured in England, and as the demand shows no decrease, we can estimate the number lost annually.

The annexed engraving shows a new article in this line, which will remain in position when once placed, and not injure the fabric. The improvement is in forming the shank with one or more swells or enlargements, beginning at or near the point, and terminating in square or beveled shoulders, or, if designed to be permanently placed, as in fastening papers together, the expanded portion is provided with barbed points, so that if once inserted it cannot be withdrawn. By using this pin, no anxiety need be felt by the ladies lest some article of apparel should become unpinned.



Patented Dec. 11, 1866, through the Scientific American Patent Agency. [See advertisement on last page.]

Pain of Decapitation.

Dr. Guillotin, who from humane motives proposed in the constituent Assembly of revolutionary France the adoption of the mediæval decapitating machine which bears his name, supposed that death by this agency would be attended with the least possible suffering. Others maintained the contrary; but his opinion prevailed, and has been generally accepted. Latterly, however, the French Academy of Sciences has reviewed the question. Experiments made some years ago in the shambles of Paris proved that, although sensation must be instantly paralyzed below the division of the spine, yet the sensorium continued active for more than one minute. The facial muscles were agitated with violent convulsions, the respiratory organs of the face worked, the mouth alternately opened and closed, and the animal appeared to experience intense agony, and an imperative desire to breathe. The eyes also retained their sensibility, shutting at the approach of a finger, and then opening, as in life. The anecdote is therefore not wholly incredible, that on the beheading of a state prisoner in England, when the executioner, according to custom, held up the head, with the words: "This is the head of a traitor," the mouth of the still living head ejaculated the answer: "That's a lie !" Whether the vocal organs could, by any possible effort, draw through the severed windpipe a sufficient current of air to form a sound, the learned might perhaps be able to judge. That after decapitation the head is still the living man, for some moments, seems to admit of no doubt.

A GREAT FOSSIL.—Montana contributes to palæontology a molar of three pounds weight, in a fragment of jaw bone five feet long and weighing fifty-seven pounds. It has a marvelous snarl of roots, likened to "a cluster of four beavers' claws, overlapping each other." It is in the possession of Mr. Elliott, of the Montana *Post*.