formed, in successful operation for the past six months no H. L. Weston's engine, corner 29th street and Seventh avenue, New York city, where it may be seen in operation.

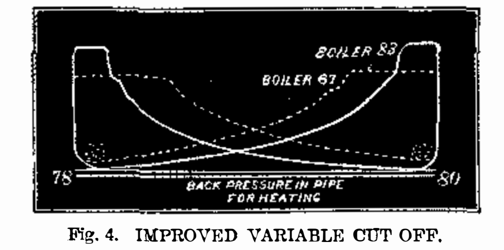

Fig. 4. IMPROVED VARIABLE CUT OFF.

For further particulars relative to sale of patent, etc. (dated April 30, 1878), address the inventor, Mr. E. L. Dingley, 112 Wooster street, New York city.

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(Illustrated articles are marked with an asterisk.)

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THE SCIENTIFIC AMERICAN SUPPLEMENT

No. 133,

For the Week ending July 20, 1878.

THE USES OF MECHANISM.

The press reports inform us that at the beginning of the harvest season the farmers of Ohio were warned, through a circular letter signed "Working Men's Bread or Blood Committee," that if they used mowing or reaping machines in getting in their crops, the machines would be destroyed and the barns containing the gathered crops would be burnt.

The machines were used as a matter of course; and happily the threatened destruction of machines and crops has not been attempted. Whether we are to attribute the escape of the farmers to their extra vigilance or to the absence of any considerable following to the ill-named committee, it is impossible now to say. It would be pleasant to know that the latter reason was the true one, and that even among the lowest of the farm hands of the West there is no large number of men who keep up the ancient and witless feud against machinery. But what can we expect of the untaught, when men in the higher ranks of society, to whom the truth is easily accessible, persist in teaching the industrial foolishness that machinery lessens the demand for men?

Witness the venerable Thurlow Weed, whose advanced age and long association with political affairs ought to have given him, one would think, the means for forming a just judgment on this point. Yet this is the way he moralizes when he gets to talking of the changes he has witnessed:

"I am amazed when I look back and think of the changes that invention has wrought in the life of society," he said the other day to a *Tribune* reporter. "The gas jet has taken the place of the tallow candle, the telegraph of the post; but the changes are mainly due to steam and the multiplication of machinery. This affects—indeed, has revolutionized—all the industries of the country. Even the agriculturist has superseded hand labor almost wholly with machinery. This has thrown hundreds of thousands of people out of their ordinary employment." Further on, while deploring the influence of machinery, Mr. Weed remarked: "Take the example of the sewing machine. This has thrown tens of thousands of women out of employment, and affected the morals of the country alarmingly."

That position is not less powerless than age to ward off the foolishness of willing ignorance is evident from the following utterance of Senator Beck, which we find in the *Congressional Record* of May 2. He said:

"Machinery is driving out of the manufacture of products hundreds and thousands of human beings every year. We have machinery to-day in this country that can do the work of one hundred and seventy-five million men. I think it can do the work of two hundred millions; but the report says one hundred and seventy-five millions. Each machine that is invented and put in operation drives from the manufacture of the articles that it manufactures all the human labor that formerly did its work. I repeat that hundreds and thousands of human beings were at one time earning an honest living by doing the work that machinery now performs."

At a time like this, when so many designing demagogues are trying to make political capital by playing upon the ignorance and prejudice of the least informed of the working classes, talk like this from men in the position of Senator Beck and Thurlow Weed is unpardonable; it is worse than foolish; it is positively criminal. Not only is there no evidence to give it a shadow of justification, but the proofs of the contrary are abundant and accessible to all. The readers of the SCIENTIFIC AMERICAN have had almost a surfeit of such evidence in recent issues of this paper.

Mr. Weed tells us that tens of thousands of sewing women have been turned out of employment by the sewing machine, and multitudes have been driven in consequence to a life of crime. Where is the proof? The census reports show two things in this connection: first, that the earnings of sewing women have largely increased since the introduction of sewing machines; and second, that the number of persons earning a living by sewing has increased since that invention was made, in a ratio considerably larger than the ratio of increase for the entire population. The truth is, that so far from lessening the employment and wages of women, the sewing machine has largely increased both. If Mr. Weed has any private evidence to the contrary, we should be glad to see it. And so with the "hundreds of thousands of farm hands" that have been thrown out of farm work by farm machinery. Where are they? The best evidence we can find—the census reports—show that since the introduction of agricultural machinery there has been not only a large and rapid increase in the number of farm hands employed in this country, but the rate of such increase has been much greater than the rate for the population as a whole. More than that, as shown in a late issue of this paper, the increase of farm hands has been vastly greater and more rapid than would have been possible without the aid of machinery. As Elihu felt constrained to remark in that most ancient of symposiums, recorded in the Book of Job, "Great men are not always wise, nor does wisdom always come with age."

Witness again the honorable Senator from Kentucky. "We have machinery," he says, "that can do the work of two hundred million men, and every machine has turned out of employment as many men as it can do the work of." Such being the case, we cannot escape the conclusion that our machinery has usurped the employment of more men than were ever engaged in manual production in all the world!" Had Mr. Beck been possessed of the slightest desire to know the real relation of machinery to labor, he could easily have learned that in every instance the introduction of machinery has been attended by an increase in the number of men employed in the trade or trades affected. Abundant evidence of this great law of industrial economy has been given in recent issues of this paper. Here are some figures even more significant than any before given, since they cover a period of great industrial depression.

The little State of Rhode Island is nothing if not mechanical. There never was a time when machinery was more rapidly introduced and improved than during the years between 1870 and 1875. Comparing the manufacturing statistics of the State given in the National census report of the former year, and those of the State census of the latter year, it appears that notwithstanding the panic and its results there was, during these years, a considerable increase in the number of hands employed and in the wages paid:

All Manufactures.	1870.	1875.
Number of establishments	1,850	2,019
Capital invested	$66,557,322	$49,942,871
Hands employed	49,417	56,540
Wages paid (per annum)	$19,354,256	$23,707,513
Value of raw materials used	$73,154,109	$76,715,970
Value of products	$111,418,354	$126,659,875
Number of steam engines	402	523
Horse power of engines	23,546	34,241

A like comparison of State and National statistics with regard to the cotton factories of Massachusetts shows similar results, except in the latter case there was an increase in the amount of capital employed, and a larger increase in the number of hands at work:

Cotton Manufactures.	1870.	1875.
Number of establishments	191	220
Number of spindles	2,619,541	3,859,237
Persons employed	43,512	60,176
Capital invested	$44,714,375	$63,844,708
Value of stock used	$37,371,599	$41,059,893
Value of goods made	$59,403,153	$77,934,753

Thus we see that notwithstanding the increase in the number of steam engines and other productive machinery in Rhode Island—more properly, in consequence of such increase—there was a gain of 14 per cent in the number of operatives employed, while the gain in the cotton industries of Massachusetts was 26 per cent during the same five years. In Ohio, as in several other Western States, the progress of manufacturers and the increase in the number of hands employed were very much greater. The census of 1870 gives the value of the manufactured products of Ohio as $269,713,000. The report of the State Auditor for 1875 makes the value of the same line of products $400,000,000.

It is true that during late years financial disasters, not in any way due to machinery, have stopped many factories and thrown many operatives out of employment; but the number of such men out of work is as nothing compared with the swarms of laborers thrown out by the stopping of city "improvements," and other jobs of like nature. And those industries into which machinery has been most largely and successfully introduced are just the ones which suffer least to-day, and have suffered least since the hard times began.

It is time the cant about machinery hurting men was banished from respectable society; time that men who have learned that the world is not flat shall learn also the equally well demonstrated truth that it is not possible for machinery to give employment to steadily increasing numbers, and at the same time turn out of employment every year twice as many men as were ever at work. It is bad enough for Kearneyites and Socialists to indulge in such nonsense. From Senators and "venerable statesmen" it is intolerable.

WORKING GOLD ORES.

Communications are sometimes addressed to us asking our advice or opinions concerning various methods of working gold ores, and recently several correspondents have sought to know if there be any approved way of saving the fine gold which is coated or incased with iron or other substance that prevents or seriously interferes with amalgamation.

The chlorination process, which dispenses with amalgamation, has long been in practice in this country and gives very satisfactory results, being especially adapted to the treatment of ores containing fine gold. The ore is stamped, then roasted and stirred in a furnace at low temperature until all the sulphurets, etc., are decomposed, then removed, spread and cooled, after which it is moistened with water and introduced into wooden tubs or vats, with bottoms arranged for the admission of chlorine gas, which is generated by heating a mixture of sulphuric acid, manganese, and salt. This gas is conducted into the tubs until it has covered and penetrated the mass of ore, and is allowed to remain in this intimate contact for several hours (the time depending upon the size of the particles of gold), until all the gold is converted into a chloride which is soluble in and is then dissolved out by water, to be treated with sulphate of iron, which precipitates the precious metal in a metallic condition as a fine dark brown powder.

This is unquestionably a sure process, but its economical value depends very much upon the proportions or amounts of the base metals in the ore. To overcome what may almost be termed the repellent action of this coated fine gold upon mercury—to prepare it for amalgamation—nitric and sulphuric acids have been used and rejected because of the expense; for they will not select and remove this coating to the exclusion of the inferior metals, for all the copper, iron, etc., present equally demand their share of the reagents; so that it is only ores of exceptional character and richness that will justify such treatment.

As it is especially those particles of gold, so minute and thin that they escape the action of the stamps, which, in many instances, form the larger percentage of the assay, and which nevertheless elude amalgamation, it is evident that stamps are not suited to this class of ores unless another manipulation is introduced between them and the amalgamator, and to our mind a most efficient one would be to heat the fine ore to a bright red or white heat and suddenly cool it with water, the theory being that the expansion by heat and instant contraction by cold will scale off or crack the coating so that the mercury can get at the gold by the usual processes of amalgamation.

We remember somewhere to have read of a furnace especially designed for this purpose, but do not at present recall its history, but the feasibility of the plan seems to us undoubted. Another method which has been suggested and which has a practical look about it is to reduce the ore to a fine powder in some machine which will cause so violent an attrition of the particles one against another as to rub off the interfering casing or coating and leave them clean and bright for the action of the quicksilver.

It is claimed that this is effectually done by one or more of the pulverizers or attrition mills now in the market, and that they also separate the metal from the gangue or matrix much more thoroughly than can be or at any rate is done by stamps, and that they deliver it in a condition more favorable for the action of the amalgamator, in pellets instead of in thin, flattened particles which so largely escape with the overflow of the water; but of these points mining superintendents can best judge of actual trial; and the importance of finding a solution of them should warrant the expense of thorough investigation.

Neither tradition nor modern practice has helped us to such understanding of the working of the refractory gold ores as they have of the ores of silver, and, in consequence, to this day we are neglecting many of our richest gold mines for the comparatively poor but more easily worked ones of the other metal.

A successful process is not necessarily—indeed must not be—a complicated or expensive one, and these which we have suggested seem, in these respects at least, to answer the requirements for a certain class of ores; but there are other ores of gold—notably the tellurides, which are among the richest—demanding improved methods of working, and sure to amply reward the successful inventor.

The action of these ores under the blow pipe frame would seem to indicate that two of the conditions necessary to successful reduction must be an exceptionally high temperature in combination with an abundant supply of air.

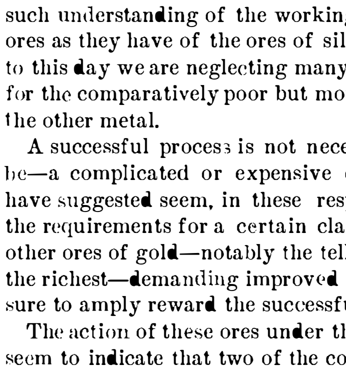
THE SUN.

BY S. P. LANGLEY. ALLEGHENY OBSERVATORY, PA.

In giving a brief account of our knowledge of the sun, which I have been asked to prepare for the readers of the SCIENTIFIC AMERICAN, it may be presupposed that all know how within a few years we have come to a new sense of the sun's immediate importance in every action of life. Men have always known that it lighted them, and ripened their grain for the harvest, but lately we have discovered that our own bodies are grown by it as much as the corn in the fields, and that in fact everything that has life on earth is made by it.

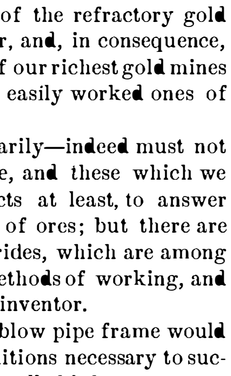
George Stephenson, according to a well known anecdote, used to believe that the sun, in some way, drove his engines, though he could not exactly explain how; but now we know, exactly speaking, that not only every movement

Fig. 1.



SPHERE OF SUN & LUNAR ORBIT

Fig. 2.



of every living thing comes from a motion that once started from the sun, but that, whether it is an ant lifting a grain of sand, or an engine raising a forty ton hammer, it is there the power comes from, as clearly as that which moves the piston comes from the boiler. These being not figures of speech, but statements meant to be taken literally and in their plain meaning, it is easy to see why the study of solar physics is growing in importance, as it is being found to have a bearing on almost every branch of human knowledge, and in unlooked for places. Thus the geologist shows not only that the sun put the coal in the ground for us, but that it piled the ice in the glaciers, which were once dragged along the northern continent; the chemist finds its rays affecting the most intimate properties of matter, and so on through the range of natural science, while the writers of the new history are bringing to notice the way in which it has affected the mental differences between the races of the North and South, and has in the course of ages imprinted its effect on the human mind itself.

We shall now try to give, in the plainest way, the principal facts known about this great source of power; some intelligible idea of the means by which they have been discovered; of the apparatus of research, and of the direction original research is now taking. To do this we must begin with the knowledge of a few things about its distance and size, which given in round numbers can be easily remembered.

The sun's distance, then, is 92,000,000 miles; its diameter 860,000 miles; its surface between 11,000 and 12,000 times and its volume about 1,300,000 times that of our globe. It is easier to read such figures than to grasp the reality they convey, but this latter is all the more necessary because we have a disposition to look on the heavenly bodies as less real and material than things at hand. The sun, though, is just as material a thing as a hot coal in the grate, and we can tell, for instance, exactly how many million tons of coal would keep up its heat supply during one

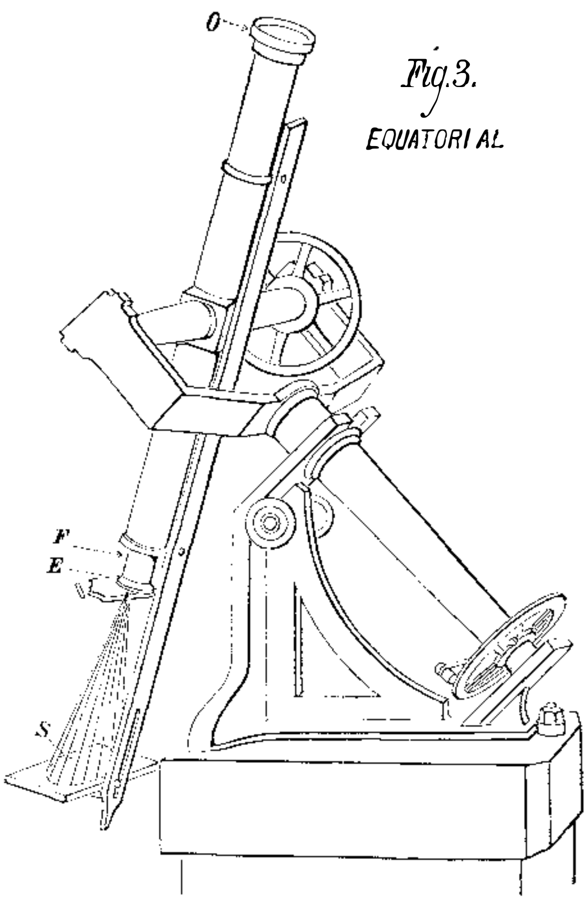


Fig. 3.

EQUATORIAL

minute. Let us try to make these great numbers more comprehensible by comparison. In rapid railway travel, continued day and night at the rate of 600 miles in twenty-four hours, we should be forty days in making the circuit of the earth. The same uninterrupted speed would take us to the sun in rather over 400 years. An ordinary telegraphic signal, if a continuous wire were laid round the earth, would circuit the globe in very nearly one second. If the wire stretched from the sun to the earth, the armature would not move in the terrestrial station till over an hour after the solar operator had pressed the key, or, as it has been ingeniously said, in reference to the fact that sensation requires a certain known though very brief time to travel up the nerves from the hand to the brain, "if a man's arm were long enough to let him touch the sun, it would be over three years before he felt that his fingers were burnt."

The actual size of the sun must evidently be immense to appear as large as it does at such a distance, but this known diameter of 860,000 miles, applied to a sphere of continuous matter, is again nearly inconceivable. To get some notion of it, suppose the sun were hollowed out, and that the earth were placed in the center of the empty shell. Now if the large circle in the figure, Fig. 1, represent the globe of the sun, the dot at its center represents with approximate correctness the size of our earth, and the small circle the actual orbit of the moon, which might revolve at the same distance from the earth as now within the globe of the sun, and still have nearly 200,000 miles clearance between it and the surface! As for figures representing its bulk we must simply forego any attempt to "realize them," and we shall find a similar difficulty when we come to measure its heat.

We must leave the description of the methods by which astronomers have determined these dimensions, untouched, and pass to an account of the solar surface and the means by which we study it, some of which are simple enough to be within the reach of any reader who wishes to see for himself.

The most primitive apparatus by which we can ordinarily see the sun's spots consists of a darkened room with a pinhole in the shutter, letting a single beam of light in. The little circle of light seen on a paper held in the course of the rays, and which enlarges as we go away from the pinhole, is an image of the sun itself, and if the room be long enough to admit of a circle of two inches or more being formed, any considerable spots may be seen without the use of any lenses whatever. I have seen even a small spot in this way, but would hardly advise any one to take much pains with the experiment, for the results are not worth it; though by this rude means the first transit of Mercury ever seen was observed by an early astronomer, Gassendi. A very much better view can be obtained by any one who has a good spyglass, and will take the trouble to secure the necessary steadiness by mounting it on a post, with the help of two small blocks of wood and two thumb-screws, so as to turn in any direction and be clamped there. If the two screws about which the blocks pivot, Fig. 2, are one horizontal, the other vertical, the telescope moves "in altitude," or up and down, with the block turning about the horizontal screw, and "in azimuth," or parallel to the horizon, when the second block turns about the vertical screw, carrying the first with it. A combination of the two motions enables it to be pointed anywhere, and such an instrument, whether made at the cost of a few cents by the roughest carpentry, or in brass and steel by the optician at the cost of thousands of dollars, is the same in principle, and is what astronomers call an "alt-azimuth."

When we first look at the sun through a telescope so mounted and clamped, we are surprised to see how fast it moves out of view, and how busy we are kept in following it. In the morning we not only have to be moving the telescope around the vertical axle to follow the sun's westward motion, but upward about the other, to keep pace with its rising one; and in the afternoon, while still changing to the westward, we have at each such change to point lower also. To avoid this double motion let the top of the post be sawed with a slope to the north, so that if one side of a carpenter's square be laid on the incline, the other will point to the north pole. If the screw which before was vertical be set into the sloping face, and the arrangement be otherwise unaltered, the telescope will now follow the sun with a single motion, which is parallel to the equator, since the pivot on which it turns now points to the pole, the instrument thus turning about part of the same axis the heavens themselves appear to revolve on.

An instrument so mounted, whether roughly or elaborately, is called an "equatorial," and this is the form almost universally employed by astronomers in physical research. The annexed engraving, Fig. 3, shows the principal parts of a small equatorial which is being used to view the image of the sun by projection.

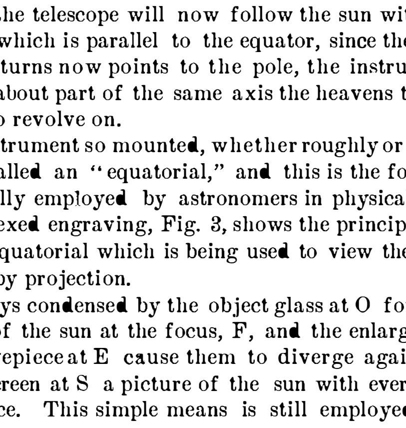
The rays condensed by the object glass at O form a small picture of the sun at the focus, F, and the enlarging lenses of the eyepiece at E cause them to diverge again, making on the screen at S a picture of the sun with everything on its surface. This simple means is still employed with advantage even on the large instruments of observatories, and it gives a much better view than the direct one with common darkening glasses. The screen can be attached to any telescope or spyglass in the way shown in the sketch. If a very low magnifying power be used the whole sun can be seen at once, and the appearance of the spots, the progress of a solar eclipse, or the transit of a planet watched with ease by a number of persons.

If the screen be replaced by a collodion surface at the focus, the little picture may be permanently fixed by photography, and in this way very admirable records have been obtained by Mr. Rutherfurd of New York, Mr. De la Rue in England, and quite recently by M. Jannsen in France. Of these we shall speak later.

STUDY OF THE SUN'S SURFACE.

Let us place our screen at a proper distance, say from one to two feet from the eyepiece, and turn the telescope on the

Fig. 4.



SUN SEPT. 19. 1870.

sun, observing that it will usually be best to diminish the aperture of the object glass (by a paper diaphragm) to at least one twentieth of its focal length, and thus lessen the danger of breaking the other lenses by the heat.

When we point near the sun but not on it, a circle of light will appear on the paper which must not be mistaken for the solar image. This latter, unless a very low power be used, will appear as a larger circle invading the first one, and it will be blurred and indistinct until the eyepiece and then the screen have been adjusted to a correct focus. This is done by moving the eyepiece in or out until the "limb" (that is, the edge) of the sun appears sharply defined. Here is a miniature copy of a tracing of the sun's face, thus made directly on the paper at the Allegheny Observatory on September 19, 1870. (Fig. 4.)

In the intense whiteness of the solar image we see a number of small spots, and these are not on the paper, for they will not move with it, nor in the glasses, for they do not change when those are turned round. They must be, then, in the sun itself. Some of them are hardly more than specks, but we will select one of the largest (that at A) for further examination, and see afterward what it looks like when more magnified. First, however, trace the outline of the image with a pencil and in the same way pencil over the spots, and we have just such a little permanent picture as this. The astronomical telescope reverses everything, but