AMATEUR MECHANICS.

For amusement, exercise, and profit we commend, to those who are mechanically inclined, the practice of working with tools of the smaller sort, either in wood or other of the softer materials, or in metals, glass, or stone. This practice renders the hands dexterous, the muscles strong, and the head clear, with the further advantage of producing something for either ornament or use. Of course a bench with a vise and a few wood working and iron working tools will be required; but the most expensive as well as the most essential tool is a lathe. With this tool, not only turning in wood, metal, ivory, rubber, etc., can be accomplished, but it may also be used for screw-thread cutting, gear cutting, drilling metals, boring wood, spinning metals, milling, sawing metal and wood, grinding, polishing, moulding, shaping, and other purposes. A first class plain lathe of small size cannot be purchased for less than $50 or $60, and one of inferior quality will cost $20 to $30.

While the purchase of a lathe is recommended there may be many who would prefer to make one. A lathe that will do admirably and which may be easily made is shown in the accompanying engravings, Fig. 1 representing in perspective the lathe complete; Fig. 2 is a perspective view of the lathe without the table; Fig. 3 is a vertical longitudinal section of the lathe, showing the manner of securing the head and tail stocks to the bars which form the bed or shears.

In making this lathe one pattern only will be required for the two standards of the head stock, and the support of the ends of the bars. The lower part of the tail stock is made in two parts, so that they may be clamped tightly together on the shears by means of the bolt that passes through both parts, and is provided with a nut having a lever handle. The rest support is also made in two parts, clamped together on the ways in a similar way.

The patterns may be easily sawed from 1¼ inch pine. The holes that receive the round bars should be chambered to receive Babbitt metal, used in making the fit around the bars forming the shears, around the head and tail spindles, and around the shank of the tool rest. The smallest diameter of the holes that receive the round bars should be a little less than that of the bars, so that the several pieces that are placed on the bars may be fitted to hold them in place while the Babbitt metal is poured in.

The dimensions of the lathe are as follows:

Length of round bars forming shears, 24 inches; diameter of bars, 1 inch; distance from the upper side of upper bar to center of spindle, 3 inches; between bars, ¾ inch; between standards that support the live spindle, 3½ inches; size of standard above shears, ¾x1¼ inch; diameter of head and tail spindles, ¾ inch; diameter of pulleys, 5 inches, 3½ inches, and 2 inches; width of base of standards, 5 inches; height of standards, 7 inches.

The live spindle should be enlarged at the face plate end, and tapered at both ends, as indicated in the engraving.

The pulleys, which are of hard wood, are made of three pieces glued together, bored, and driven on the spindle, secured by a pin passing through both it and the spindle, and turned off.

The bars forming the shears may be either cold rolled iron or round machinery steel; they will require no labor except perhaps squaring up at the ends. The castings having been fitted to the bars, and provided with set screws for clamping them, the two standards that support the live spindle and the support for the opposite end of the bars are put in position, when the bars are made truly parallel, and a little clay or putty is placed around each bar and over the annular cavity that surrounds it, and is formed into a spout or lip at the upper side to facilitate the pouring of Babbitt metal. The metal must be quite hot when poured, so that it will run sharp and fill the cavity. To guard against a possible difficulty in removing the castings from the bars it might be well to cover the side of the bar next the screw with a thin piece of paper. The pieces of the tail stock and tool rest support are fitted to the bars by means of Babbitt metal, the metal being poured first in one half and then in the other. The bolts which clamp the two parts of the rest support and tail stock together are provided with lever handles. After fitting the parts to the two bars by means of Babbitt metal, the tail spindle, which is threaded for half its length, is placed in the tail stock parallel with the bars and Babbitted. A binding screw is provided for clamping the tail spindle, and the spindle is drilled at one end to receive the center, and has at the other end a crank for operating it.

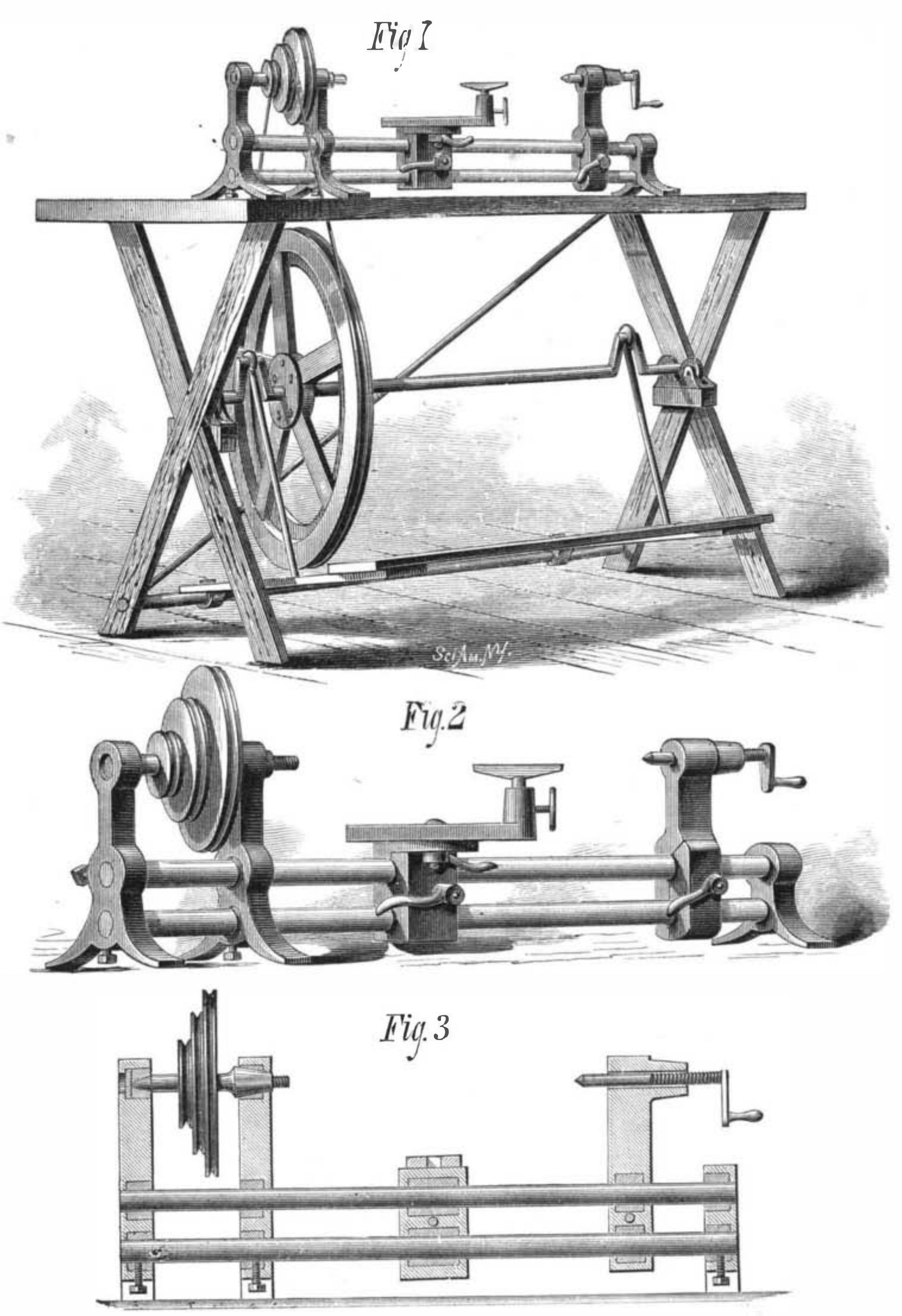
A steel or bronze button is placed in the hole in the standard that supports the smaller end of the live spindle, and the spindle is supported in its working position and Babbitted.

The thread on the spindle should be rather coarse, so that wooden or type metal face plates and chucks may be used.

The table shown in Fig. 1 is simple and inexpensive. It consists of two pairs of crossed legs halved together and secured to a plank top. A small rod passes through the rear legs near their lower ends, and also through a piece of gas pipe placed between the legs. A diagonal brace is secured to the top near one end, and is fastened to the lower end of the rear leg at the other end of the table.

A block is secured to each pair of legs for supporting a pair of ordinary grindstone rollers, which form a bearing for the balance wheel shaft. This shaft has formed in it two cranks, and it carries an ordinary balance wheel, to the side of which is secured by means of hook bolts a grooved wooden rim for receiving the driving belt. The cranks are connected, by means of hooks of ordinary round iron, with a treadle that is pivoted on the gas pipe at the rear of the table. The shaft will work tolerably well, even if it is not turned. The cranks must have half round grooves filed in them to receive the treadle hooks. The size of the different diameters of the drive wheel may be found by turning the larger one first and the smaller ones afterward, using the belt to determine when the proper size is reached. The wooden rim may be turned off in position by using a pointed tool.

The lathe above described, although very easily made and inexpensive, will be found to serve an excellent purpose for hand work, and if the holes, instead of being Babbitted, are bored, and if the bars forming the shears are turned, the lathe may be converted into a kind of engine lathe by placing a feeding screw between the bars, and putting a small tool post in the rest support. M.



LATHES FOR AMATEUR MECHANICS.

Machine Shop Economy.

In times like the present, when even with good management our best machine shops are enabled to exhibit but small margins of profit, and shops with indifferent management exhibit margins on the wrong side, it is a question of paramount importance what kind of economy should be pursued in order to maintain a successful business. The directors of long established machinery enterprises differ widely upon some methods of conducting business, and while one gains success by pursuing a certain plan, another, with perhaps as much ability, cannot pursue the same with satisfactory results.

While in the main there are many different plans upon which successful machinery establishments are conducted, there are some underlying principles that must be observed to avoid meeting with difficulties. The rate of wages paid is certainly a large element of shop economy, but there are so many other elements that should be considered before wages are reached, that we often find proprietors, who pay their workmen at a comparatively high rate, doing a more prosperous business than their competitors who have reduced wages to the lowest possible scale. Many machine shop owners, not having mastered the various economies of management, as soon as profits begin to shorten, pounce directly upon the wages paid to their workmen, and pare them down so as to make up for the deficiency elsewhere. They don't seem to realize that there are important elements of economical management other than closely watching the wages of labor and the cost of material. It is sometimes necessary to reduce the rate of wages, but what a different effect it has upon the men in different shops! In one shop you scarcely hear a murmur—no angry meetings—no threats of a strike—no growling at the head of the establishment. The intelligent workmen understand the reasons for the reduction without a wordy explanation, and accept it, feeling confident that it has not been unjustly made. In another shop it causes ill feeling, angry protests, and perhaps a disastrous strike. The owner often charges his trouble to the character of his workmen. Let him review his course, and see if the great cause is not in his own management. Mechanics are keen and observing. If the business is poorly managed they are not slow to mark it, and when a cut is made in wages can generally cipher out the cause. It is good economy to keep a systematic record of the cost of everything. This record will be found very valuable in making estimates, much more so than guess work. It is not good economy to keep using worn-out tools when any work of consequence is to be performed. The extra cost of labor and spoiled pieces would soon pay for new tools. It is not good economy to keep discharging capable workmen for petty causes, and employing new hands to take their places. It is poor economy to use slow-cutting grindstones to accomplish work that fast cutting emery wheels are suited for. It is questionable economy to employ lathes, planers, and drills to perform work of any extent that a milling machine will do better in less time and at much less expense.

It is decidedly bad economy to employ engines and boilers that waste fuel and are troublesome to keep in good running condition. It is mistaken economy to buy inferior tools, machines, and shop supplies, because they are low priced.

It is very defective economy to fit the parts of machines together by trial instead of making them by aid of correct drawings and standard tools for accurate measurement. It is faulty economy to practice borrowing and lending working tools.

The idea that economy consists in withholding every expense not absolutely demanded is erroneous. An extra outlay in one or another direction often assures the saving as well as the making of money. Wise economy looks to the future as well as the present, and requires that all work sent out from a shop should be of the best and most reliable character.—*American Machinist.*

The Reward of Invention.

Capital and Labor publishes the substance of a letter from Mr. Henry Bessemer with reference to the refusal of the English Government, or of its ambassador in Paris, to allow the Grand Cross of the Legion of Honor to be accepted by its countrymen, and in his letter Mr. Bessemer furnishes some autobiographic particulars which cannot fail to be of interest. He tells us that at the age of eighteen he came to London from a small country village, knowing no one, and himself unknown; but his studious habits and his love of invention soon gained for him a footing, and in two years he was pursuing a method of his own invention for taking copies from antique and modern bassi-rilievi in a manner that enabled him to stamp them on a cardboard, thus producing thousands of embossed copies of the highest works of art, at a small cost. The facility for making a permanent die, even from a thin paper original, capable of producing a thousand copies, would have opened a wide door to successful fraud if the process had been known to unscrupulous persons; for by its means, Mr. Bessemer states, there is not a government stamp, or the paper seal of a corporate body, that every common office clerk could not forge in a few minutes at the office of his employer or at his own home. The production of a die from a common paper stamp is the work of only ten minutes; the materials cost less than one penny. No sort of technical skill is necessary, and a common copying press or letter stamp yields most successful copies. There is no need for the would-be forger to associate himself with a skillful die sinker, capable of making a good imitation in steel of the original, for the merest tyro could make an absolute copy on the first attempt. The public knowledge of such a means of forging would, at that time, have shattered the whole system of the British Stamp Office, had a knowledge of the method been allowed to escape. The secret has, however, been carefully guarded to this day.

During the time that Mr. Bessemer was engaged in studying this question he was informed that the government were themselves cognizant of the fact that they were losers to a great amount annually by the transfer of stamps from old and useless deeds to new skins of parchment, thus making the stamps do duty a second or third time, to the serious loss of the revenue. One official in high position said that he believed they were defrauded in this way to the extent of probably £100,000 per annum. To fully appreciate the importance of this fact, and realize the facility afforded for this species of fraud by the system then in use, it must be understood that the ordinary impressed or embossed stamp, such as is employed on all bills of exchange, if impressed directly on a skin of parchment, would be entirely obliterated by exposing the deed for a few months to a damp atmosphere. The deed would thus appear as if unstamped, and therefore invalid. To prevent this it has been the practice as far back as the reign of Queen Anne to gum a small piece of blue paper on to the parchment; and for still greater security a strip of metal foil is passed through it, and another small piece of paper with the printed initials of the Sovereign is gummed over the loose ends of the foil at the back. The stamp is then impressed on the blue paper, which, unlike parchment, is incapable of losing the impression by exposure to a damp atmosphere. But, practically, it has been found that a little piece of moistened blotting paper applied for a whole night so softens the gum that the two pieces of paper and the slip of foil can be removed from the old deed most easily, and be applied to a new skin of parchment, and thus be made to do duty a second or third time. Thus the expensive stamps on thousands of old deeds of partnership, leases, and other old documents, when no longer of value, offer a rich harvest to those who are dishonest enough to use them. A knowledge of these facts led Mr. Bessemer to fully appreciate the importance of any system of stamps that would effectually prevent so great a loss; nor did he for one moment doubt but that government would amply reward success. After some months of study and experiment, which he cheerfully undertook (although it interfered considerably with the pursuit of regular business, inasmuch as it was necessary to carry on the experiments with the strictest secrecy, and to do all the work himself during the night after his people had left work), he succeeded in making a stamp that satisfied all the necessary conditions. It was impossible to remove it from one deed and transfer it to another. No amount of damp, or even saturation with water, could obliterate it, and it was impossible to take any impression from it capable of producing a duplicate.

Mr. Bessemer says that he knew nothing of patents or patent law in those days; and adds that if he had for a moment thought it necessary to make any preliminary conditions with government he would have at once scouted the idea as utterly unworthy, thinking his interests absolutely secure. In this full confidence he sought an interview with the then chief of the Stamp Office, Sir Charles Presley, and showed him by numerous proofs how easily all his stamps could be forged, and also the mode of prevention. He was greatly astonished, and at a later interview he suggested that the principle of the invention should be worked out fully. This Mr. Bessemer was only too anxious to do; and some five or six weeks later called again with a newly designed stamp, which greatly pleased him. The design was circular, about 2½ inches in diameter, and consisted of the Garter with the motto in capital letters surmounted by a crown. Within the Garter was a shield with the words "five pounds." The space between the shield and the Garter was filled with network in imitation of lace. The die had been executed in steel, which pierced the parchment with more than 400 holes, each one of the necessary form to produce its special portion of the design. Since that period perforated paper of this kind has been largely employed for valentines and other ornamental purposes, but was previously unknown. It was at once obvious that the transfer of such a stamp was impossible. It was equally clear that dampness could not obliterate it; nor was it possible to take any impression from it capable of perforating another skin of parchment.

This design gave great satisfaction, and everything went on smoothly; Sir Charles consulted Lord Althorp, and the Stamp Office authorities determined to adopt it. Mr. Bessemer was then asked if, instead of receiving a sum of money from the Treasury, he would be satisfied with the position of Superintendent of Stamps, at some £600 or £800 per annum. This was all that he then desired, rejoicing over the prospect, for he was at that time engaged to be married, and his future position in life seemed assured. An incident now occurred that reads almost like romance. A few days after affairs had assumed this satisfactory position, he called on the young lady to whom he was then engaged (now Mrs. Bessemer), and showed her the pretty piece of network which constituted the new parchment stamp, explaining how it could never be removed from the parchment and used again, and mentioning the fact that old deeds with stamps on them dated as far back as the reign of Queen Anne could be fraudulently used. She at once said, "Yes, I understand this; but surely, if all stamps had a date put upon them, they could not at a future time be used again without detection?" This was indeed a new light, and greatly startled the inventor, who at once said that steel dies used for this purpose could have but one date engraved upon them. But after a little consideration he saw that movable dates were by no means impossible, and that this could easily be effected by drilling three holes of about a quarter of an inch in diameter in the steel die, and fitting into each of these openings a steel plug or type with sunk figures engraved on their ends, giving on one the date of the month, on the next the month of the year, and on the third circular steel type the last two figures of the year. This plan would be most simple and efficient, would take less time and money to inaugurate than the more elaborate plan that had been devised; but while pleased and proud at the clever and simple suggestion of the young lady, her future husband saw also that all his more elaborate system of piercing dies, the result of months of study, and the toil of many a weary and lonely night, was shattered to pieces by it. He feared to disturb the decision that Sir Charles Presley had come to, as to the adoption of the perforated stamp, but, with a strong conviction of the advantages of the new plan, felt in honor bound not to suppress it, whatever might be the result. Thus it was that he soon found himself again closeted with Sir Charles at Somerset House, discussing the new scheme, which he much preferred, because, as he said, all the old dies, old presses, and old workmen could be employed, and there would be but little change in the office—so little, in fact, that no new superintendent of stamps was required, which the then unknown art of making and using piercing dies would have rendered absolutely necessary. After due consideration the first plan was definitely abandoned by the office in favor of the dated stamps, with which every one is now familiar. In six or eight weeks from this time an Act of Parliament was passed calling in the private stock of stamps dispersed throughout the country, and authorizing the issue of the new dated ones.

Thus was inaugurated a system that has been in operation some forty-five years, successfully preventing that source of fraud from which the revenue had so severely suffered. If anything like Sir Charles Presley's estimate of £100,000 per annum was correct, this saving must now amount to some millions sterling; but whatever the varying amount might have been, it is certain that so important and long established a system as that in use at the Stamp Office would never have been voluntarily broken up by its own officials, except under the strongest conviction that the losses were very great, and that the new order of things would prove an effectual barrier to future fraud. During all the bustle of this great change no steps had been taken to install the inventor in the office. Lord Althorp had resigned, and no one seemed to have authority to do anything. All sorts of half promises and excuses followed each other, with long delays between, and Mr. Bessemer gradually saw the whole thing sliding out of his grasp. Instead of holding fast to the first plan, which they could not have executed without his aid and special knowledge, he had, in all the trustfulness of youthful inexperience, shown them another plan, so simple that they could put it in operation without any assistance. He had no patent to fall back upon, and could not go to law, even if he wished to do so, for he was reminded, when pressing for mere money out of pocket, that he had done all the work voluntarily. Wearied and disgusted, he at last ceased to waste time in calling at the Stamp Office, and he felt that nothing but increased exertions could make up for the loss of some nine months of toil and expenditure. Thus, sad and dispirited, and with a burning sense of injustice overpowering all other feelings, he went from the Stamp Office, too proud to ask as a favor that which was indubitably his just right, and he adds, "Up to this hour I have never received one shilling or any kind of acknowledgment whatever from the British Government." It is notorious, adds the editor, that some of the most renowned and invaluable inventions of recent years, especially those connected with the navy, have narrowly escaped rejection by permanent but ignorant officials; and that the authors of the inventions have had to submit to delay, loss, annoyance, and contumely before their processes could be tried, even after their success had been officially demonstrated. Perhaps it is not now so much a question of money, for it is to be hoped that Mr. Bessemer is reaping the due reward of ingenuity and skill in other fields of invention. But even his discoveries in steel making, if they have very properly enriched himself, have, in an infinitely larger degree, added to the wealth of the country, and have given employment to many thousands. Such a man is a public benefactor, and eminently deserves recognition by the state, especially by way of atonement for former neglect and injustice. Military men receive titular honors and a pecuniary reward for slaying a crowd of savages and burning their huts, while the men who have helped to make England what she is, commercially and industrially, are in most cases left to their fate, which may chance to be pecuniary ruin.

Oil Notes.

PENNSYLVANIA.

The total production of crude petroleum for the first three quarters of 1878 was 11,126,037 barrels, against 8,436,867 barrels for the same time in 1877; increase in 1878, 1,689,170 barrels.

The total number of drilling wells completed for the first three quarters of 1878 were 2,333, against 2,699 for the same time in 1877; decrease in 1878, 366.

The daily average production of the new wells completed for the first three quarters of 1878 was 13 2-10 barrels, against 14 2-10 for the same time in 1877; decrease in 1878, 1 barrel.

The total number of dry holes developed in the first three quarters of 1878 were 280, against 476 for the same time in 1877; decrease in 1878, 196.

The total amount of crude petroleum held in the producing regions of Pennsylvania, at the close of the third quarter of 1878, was 4,599,362 barrels, against 2,503,657 at the same time in 1877; increase in 1878, 2,095,705 barrels.

The amount of crude petroleum represented by outstanding certificates on the last day of September was 1,705,853 barrels, against 1,317,484 barrels on the last day of October, a reduction during October of 158,127 barrels.

Mr. J. M. Guffey has purchased of Marcus Hulings an undivided half interest in the celebrated Kinzua Creek property (Bradford district). The purchased portion contains 6,400 acres, on which there is a well that was struck in June last, and since that time has been doing from 16 to 18 barrels, and has never been torpedoed. Mr. Guffey looks upon this as one of the best prospective oil territories in the country.

D. W. C. Carroll & Co., of Pittsburg, have kept from 45 to 75 men employed, since June, in the oil regions, building iron tanks, nearly all of which are located in the Bradford district.

WEST VIRGINIA.

The Wheeling *Intelligencer* says: As noticed in our Moundsville letter this morning, extensive preparations have been made to bore for oil on the opposite side of the river at the Union Coal Works shaft. The machinery was brought down from Pittsburg on Tuesday, and is now being put in position by contractors, who have engaged to go down 1,200 feet. It will be recollected that for a long time past oil has been found in the coal shaft, and the company who are putting down the well feel confident that plenty of it exists deeper down. Some parties look forward to the development of the fact that Moundsville is situated in an important oil break, and that oil in abundance will be found on both sides of the river. The progress of the well will be looked forward to with much interest by the people of that vicinity.

MASSACHUSETTS.

The Maverick Oil Works at East Boston have recently made some very extensive additions and improvements, lengthening their wharf and making a variety of alterations in their buildings. They will shortly complete a new cooper shop, wherein, it is probable, they will construct all the tin cans required by the demands of their business.

OHIO.

The oil excitement has broken out afresh in West Mecca, Warren county, Ohio. Oil men, heavily backed with capital, have recently come in from Pennsylvania, and are making things lively in that locality. Eight new wells have been put in operation during the past week. This district is the same where the principal excitement prevailed 18 years ago.

JAPAN.

The Tokio *Times* states that the principal feature of American trade with Japan is the petroleum exports from New York. The enterprise was inaugurated only eight years ago; but the business has so increased that while only 200 cases of kerosene, valued at $600, were exported in 1870, in 1877 366,639 cases were sent to Yokohama, and 128,158 cases to Hiogo, whither none had before been carried direct. The value of these consignments was over $1,000,000.

Several refineries are in operation in Japan, making kerosene from native petroleum.

RUSSIA.

The recent reports concerning the discovery of oil near the shores of the Caspian Sea seem to be fully confirmed. From one of the wells a stream, free from gas and froth, is forced to a height of 75 feet, yielding at the rate of 10,000 barrels a day. It is reported that companies are forming at Odessa, Novo-Tcherkask, Astrakhan, and other cities, for the purpose of obtaining oil. Two large manufacturing concerns, who have their headquarters in New York city, recently received orders for considerable quantities of oil-line pipes, steam pumps, engines, boilers, and other apparatus, to be shipped immediately for St. Petersburg, Russia.

ITALY.

The oil wells of Italy comprise about 5, with a capacity of about 30 barrels per day, of a thick substance of 14 gravity. They are pumped by hand, which, though primitive, is cheaper than steam, for both men and women are employed, the former receiving as compensation for a day's work 1 lira, equal to 20 cents; and the women 60 centessimi, equal to 12 cents of our money. The wells are located in a deep valley, and the oil carried up on the backs of donkeys to a refinery, where it is treated, and yields from 2 to 5 per cent of burning oil.

PERU.

It is proposed to build a pipe line from the refinery on the estates of Henry Meiggs to the shipping port, a distance of about 7 miles. It is stated that oil can be produced at this point for less than 1 cent a gallon, and as the fields have produced from time immemorial, there is no prospect of their early exhaustion.

ONTARIO.

The oil refinery at St. Thomas, Ont., is running day and night; 494 barrels of crude petroleum were brought from Petrolia for it in one week recently.—*Stowell's Petroleum Reporter.*

Railway Notes.

THE new track laid in this country during the year ending September 10, 1878, was 1,160 miles. During the six preceding years the number of miles of track laid was: In 1872, 4,498; 1873, 2,455; 1874, 1,066; 1875, 702; 1876, 1,467; 1877, 1,176.

THE statement made in the recent Narrow Gauge Convention, that standard gauge freight cars weigh ten tons and carry ten tons, is indignantly disputed by users of the latter. One gentleman, having much to do with freight cars, says that the modern freight cars weigh from 17,000 to 18,000 lbs., commonly carry (and that on long hauls) 28,000 lbs., are guaranteed to carry 30,000 lbs., while he has seen them show on the scales 30,000 and 32,000 lbs. of load, and in one case 35,000 lbs. The general tendency for some years has been to increase loads without increasing, but in many cases decreasing, weights of cars; and it seems quite likely that 30,000 lbs. will soon be the standard load. The tank cars used for carrying petroleum have an average capacity—and they are almost always run full—of 30,000 lbs. The Standard Oil Company, which has some 3,000 of such cars, carried on four-wheeled trucks with the Master Car Builders' standard axle, has run them with such loads for years, and only recently had its first case of a broken axle, manifestly due to a defect in the iron.

INTERESTING observations have been made recently on the Cologne-Minden Road, Prussia, on the rusting of iron rails. A pile of rails of odd lengths were laid on sleepers over a bed of gravel early in 1870, and remained undisturbed until the fall of 1877, there being no use for them. It was then found that they were covered with a layer of rust 0·12 inch thick, which had to be removed by striking the rail with a hammer. The cleaned rail weighed only 398·2 lbs., while its original weight was 419·1 lbs., showing that 5 per cent of the rail had been destroyed by rust, which covered the rail quite uniformly. This confirms the observation often made, that rails stacked away are much more liable to rust than those laid down in a track.

ACCORDING to *Le Fer*, at a meeting of directors of the German railroads held at Constance, the following information was furnished in regard to the relative value of the different methods of injecting ties:

1. Railroad from Hanover and Cologne to Minden. Pine ties injected with chloride of zinc; after 21 years the proportion of ties renewed was 21 per cent. Beech ties injected with creasote; after 22 years, 46 per cent. Oak ties injected with chloride of zinc; after 17 years, 20·7 per cent. Oak ties not injected; after 17 years, 49 per cent. The conditions were very favorable for experiment; the road bed was good, and permitted of easy desiccation. The unrenewed ties showed, on cutting, that they were in a condition of perfect health.

2. Railroad "Kaiser-Ferdinands-Nord." Oak ties not injected; after 12 years the proportion renewed was 74·48 per cent. Oak ties injected with chloride of zinc; after 7 years, 3·29 per cent. Oak ties injected with creasote; after 6 years, 0·09 per cent. Pine ties injected with chloride of zinc; after 17 years, 4·46 per cent.

THE annual official reports of the railroads of India place the length of railways there at 7,551½ miles, of which 492½ miles were completed during the year 1877, and 223 miles since the close of the year. There are 806½ miles of double track; 5,912¾ miles are constructed on the 5 foot 6 inch gauge, and 1,638¾ on narrower gauges. The capital outlay on the State lines amounted to £3,122,051, and on the guaranteed lines to £1,374,882, bringing the total capital expenditure, up to the end of October, as regards the State, and to the end of March last, as regards the guaranteed lines, to £113,144,541. The expenditure up to the end of the year may be taken in round numbers at £13,344,500. The revenue from all the open lines was £6,232,888, of which £6,091,532 were earned by the guaranteed lines, with a capital of £95,482,941, and £141,356 were earned by the State lines, on a capital expenditure of £17,661,600. The net receipts from the guaranteed lines exceeded the amount advanced for guaranteed interest by £1,454,591; the year previous there was a deficit of £216,517.

A FRENCH engineer named Duponchel has made a report on the project of a railroad across the Desert of Sahara. The projected railway would run from Algiers to Timbuctoo, a distance of 2,500 kilometers. M. Duponchel stated that the principal portion of the line would rest during nearly its whole extent on layers of sand, and toward the end on primitive volcanic rocks, granite, gneiss, etc. No mountainous obstructions would have to be encountered. The average heat does not appear to exceed 23° or 24° C. (73 2-5° or 75 1-5° Fah.), but account must be taken of the great variations which occur in the 24 hours. For instance, occasionally, a very cold night succeeds a temperature of 40° C. (104° Fah.) in the day time. The great difficulty to be overcome would be the want of water, which is not to be procured in that region. M. Duponchel calculates that for three trains daily the amount of water required would be 4,000 cubic meters, and that the engineering science of the day is quite sufficient to supply even a much greater quantity at the requisite points.

THE government of Costa Rica has advertised for tenders for building bridges on the second Atlantic Division of its railroad. There will be needed 194 bridges. The bridges will vary in length from 3 feet to 1,044 feet, and will be built for a track of 3 foot 3½ inch gauge. They will be of sufficient strength to stand a strain of 2,240 lbs. to the lineal foot, in addition to the weight of the usual freight carried.

THE WERDERMANN ELECTRIC LIGHT.

It has been looked upon as essential that a certain distance should separate the ends of the carbon electrodes used in electric lamps. Every one has accepted this as an axiom. Mr. Werdermann's skepticism has, however, caused him to doubt the axiom, and the result is that he has discarded the electric arc space, and by placing his electrodes in actual contact, has produced a lamp which provides the means of dividing the electric current, and promises to give almost any number of lights from a single machine. Mr. Werdermann's inventions, says the *Engineering*, are secured by patents considerably in advance of those of Mr. Edison, and may in their chief points be explained as follows:

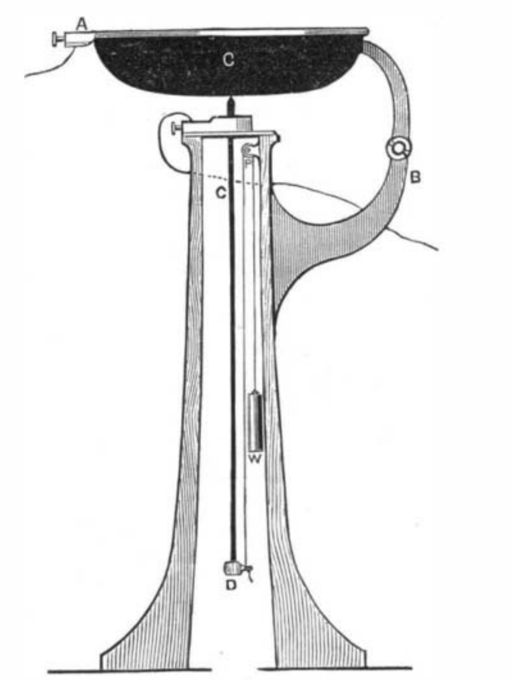


FIG. I

THE WERDERMANN LAMP.

In place of two electrodes of similar form and dimensions, one electrode consists of a large bun-shaped disk of carbon placed with the rounded face downward. The other carbon is a fine rod of carbon of about ⅛ or 5-32 inch in diameter. The upper end of this is pointed and maintained in contact with the center of the lower surface of the disk. This rod is supported by means of a spring collar, which also forms the circuit connection. This is within about ¾ in. of the top of the carbon, so that the ¾ in. becomes incandescent, and the contact between the two carbons being only a point, a small electric arc is produced between the two carbons, while the electricity is at the same time passed on through the carbon disk, and the connections there attached to the next lamp.

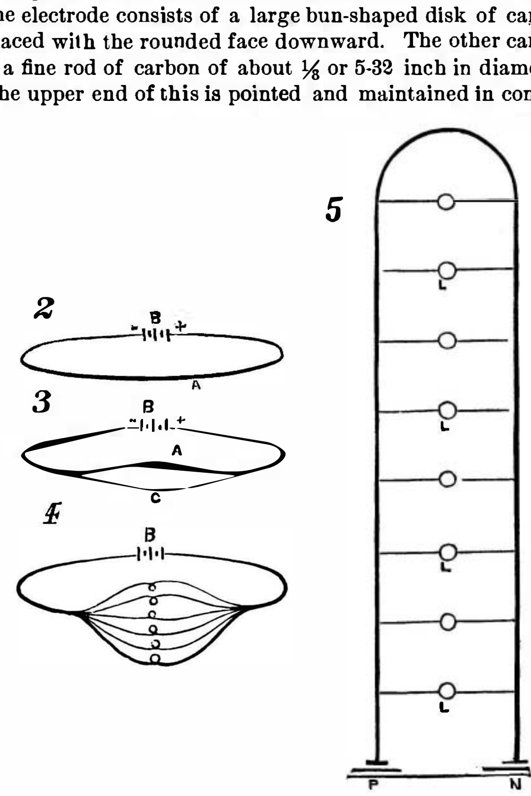


DIAGRAM OF CURRENT.

Referring to our diagrams, in Fig. 1 the upper carbon is shown at C, and the rod carbon at *c*. The former is supported by means of an adjustable jointed bracket, B, attached to the wood stand. The rod carbon is guided by the spring collar on the top of the stand, and to which the connection is made, and is supported by the fine cord running over the pulley, P. This cord is attached to the clasp, D, at the bottom of the rod, and to the balance weight, W, by which the rod is maintained in constant, practical, though not absolute contact with the disk. Round the upper part of the disk is a metal band, A, to which the circuit wire is attached, and the current thus passed on to the next lamps.

At a recent trial of this lamp, the current was derived from a small Gramme electro-plating machine, requiring only 2 horse power to put it in full work. It may therefore be assumed that this was about the limit of the power at work to produce the light. At the commencement of the proceedings two lights were maintained, each stated to be equal to 320 sperm candles. At this rate the two lights would be equal to 640 candles, or 40 full power gas lights, each consuming 5 cubic feet of 16 candle gas per hour. Such gas lights, it may be observed, are not often seen, except in the argand form. The two lights burned with extreme steadiness, there being no undulation or flickering whatever, although there was no glass globe to tone down any variations of luster. The lights were perfectly bare and unprotected, and the place where the trial was made was a workshop of moderate size.

Later in the evening one light was exhibited outside the building, in an open thoroughfare, and the same perfect steadiness was observable. After the two lights had been burning for a time they were extinguished, and the current was sent through a row of ten lamps. The light per lamp was of course reduced, but there was the remarkable fact that ten lights were maintained by a comparatively weak machine, driven by an engine exerting the power of only two horses.

The light of each of these ten lamps was stated to be that of 40 candles, making, therefore, a total of 400. A reduction of light, consequent on the further division of the current, is thus apparent; but for this loss there may be ample compensation in the superior economy of a distributed light as compared with one that is concentrated. In the case of the ten lamps, the light is equal to that of 25 full power gas lights, consuming altogether 125 cubic feet of gas per hour. The extremely small arc due to the peculiar arrangement of the carbons in the Werdermann light has the advantage of offering the least possible resistance to the passage of the current.

This resistance increases much more rapidly than is represented by increase of distance between the carbon points. Hence the electric power with Werdermann's lamp is economized to the utmost in this respect, and it becomes possible—as in the recent experiment—to make use of an electric current large in quantity but of low intensity. The tension being small, there is the less difficulty with regard to insulation. If one lamp or more should be accidentally extinguished, the rest will continue to burn. The whole of the lamps can also be extinguished and relit by merely stopping the current and then sending it on again. No nice and troublesome adjustment with reference to the length of the electric arc is requisite, and simple contact between the point of the rod and the surface of the disk is sufficient for the manifestation of the light.

In respect to duration, a carbon rod 5-32 in. in diameter, and a yard long, obtained from Paris, costs a franc. This, placed in a large lamp, having an estimated lighting power of 320 candles, will last from 12 to 15 hours. The smaller lamps take a carbon of ⅛ in. diameter.

Mr. Werdermann endeavors to make the resistance of the external portion of the circuit equal to the internal resistance, in order to obtain the greatest effect. It is well known that the best results are obtained when the internal and external resistances are equal. The method adopted is that known to electricians as the divided arc, and will easily be understood from Fig. 2. Let B represent the source of the electric current, and A a copper wire connected to the positive and negative poles of the source as in the diagram. The wire, A, has a certain resistance. Suppose, now, we arrange for the current to pass as in the diagram, Fig. 3. By the insertion of the new wire, C, we have lessened the total external resistance and increased the current, as will be seen by reference to Ohm's law. $C = \frac{E}{R + r}$ where C = current; E = electromotive force; R = resistance external; r = resistance internal. The fraction $\frac{E}{R + r}$ increases as its denominator is lessened.

The current passes along the two branches in equal quantities if the resistances of the wires are equal, but inversely as the resistances if they are unequal. Thus, if the branch, A, has a resistance, 9, and C has a resistance, 1, 9-10 of the current will pass through C, and 1-10 through A. Similarly, for any number of branches the current will divide itself according to the resistances. If, then, we have a number of branches, as indicated in Fig. 4, the current will divide itself equally among the branches when the resistances of the branches are equal. This is the arrangement adopted by Mr. Werdermann, as will be seen from the annexed diagram, Fig. 5, in which N and P represent the negative and positive poles of the machine, and L L the electric lamps.

When any one lamp is put out the inventor arranges that an equivalent resistance shall be put into the circuit, so that as a whole the circuit is unaltered, and the other lamps unaffected.