Correspondence.

The Iron Horse.

To the Editor of the Scientific American:

In your issue of June 12, you refer to the $5,000 prize, offered by the president of a horse railroad company in Philadelphia, for a substitute for the horse for working street railroad cars. The conditions required are that the device shall be acceptable to the company, that is to say, it must be satisfactory to at least two thirds of the members of the company; and that the company shall have exclusive control of it. To reach the first condition, an engine must be constructed in the most simple and substantial manner, at an expense of at least $3,000, exclusive of the mental work and the plans of the inventor; this would be a low estimate for the first machine, provided such could afterwards be furnished at $2,000 as a standard article of manufacture. The engine must then be placed upon the track and run any where from six months to a year, two years perhaps, or until it is found possible or impossible to satisfy two thirds of the members of the company, all at the expense of the inventor; and the cost will probably amount to from $800 to $1,500, in addition to the $3,000 for the engine.

If the invention proves to be more economical and satisfactory to the company, and less objectionable to the city authorities and the general public than the present horse system, the inventor receives $5,000, provided he deeds his entire interest in the invention to this company.

Doubtless the president and directors of this road are men of good sense and generous impulses, and would be willing to furnish the successful inventor with a free ticket home in addition to the $5,000 prize, and would also pass his name along to posterity. I think, however, that the $5,000 is offered as a reward for the use of an invention on their line only; if so, it is a very fair offer, and would enable the inventor to get a tolerable recompense for his invention eventually.

Were it not for an unaccountable prejudice against the use of steam cars on public thoroughfares, horse railroad companies would have a successful substitute for their horses in the shape of an improved steam car or light locomotive. A steam car has already constructed and tried which is competent to answer fully every reasonable condition as a substitute for horses on street railroads; all that is need to ensure its success is that the manufacturers on their part shall proportion the machinery a little better, and employ more thorough workmanship, and that the city authorities and the public on their part shall remove their prejudices and give a lively countenance and support to the enterprise, and the thing is done. Steam cars and light locomotives will soon become a more economical, successful, and satisfactory institution in our cities than the present system of horse cars.

The products of combustion from the improved furnaces of these light machines will prove to be far less annoying and deleterious to health than the products of combustion from the mass of diseased horse flesh now required to do this work. With horses, the process of consumption and contamination goes on continuously night and day, work or no work, until death; with engines it ceases with the hours of work.

Worcester, Mass. F. G. WOODWARD.

The Iron Horse.

To the Editor of the Scientific American:

As one of many inventors and patentees to whom you allude as engaged upon this problem, I did not fail to note the proposition of Mr. Flower on page 340, or your comments on page 369, vol. XXXII. You have therein very fairly stated the problem in most of its bearings, but one point I think was omitted. The problem, as I understand it, is not merely to obtain the power of one, two, or three horses, but to obtain that power with the condition of endurance throughout many consecutive hours. For instance, I am informed that it requires twelve horses to draw a street car sixteen hours. Hence, in one sense, the requirements of a street car come within the limits of "ten, fifteen, or twenty horse power," within which you give the opinion of the SCIENTIFIC AMERICAN that the locomotive is preferable. Again, while as you say the horse is easier to raise than to build a locomotive, the cost of twelve horses is considerably more, at present prices; and the stokers will agree that coal for the engine is cheaper than oats for the horses. And to whatever evils the iron horse is subject, including priming, running away, and premature dissolution by explosion, he is not, thus far, subject to the epizoötic; yet his introduction will not lessen, but rather increase, the usefulness of the most universally useful animal in the world, as the locomotive has already done.

When analyzed, this problem is but a form of an old contention, or rather emulation, as to which can work best and most effectively, cheap labor or expensive skill; and however doubtful the result may now seem, the conditions of the problem are rapidly changing. F. H. RICHARDS.

New Britain, Conn.

A Handy Life Preserver.

To the Editor of the Scientific American:

Nearly every man has his own life preserver. It is not generally known that, when a person falls into the water, a common felt hat can be made use of as a life preserver. By placing the hat upon the water, rim down, with the arm around it pressing it slightly to the breast, it will bear a man up for hours. Any one doubting the above can take an old hat, and try it in a bucket of water, or when bathing, and he will soon be convinced

Charlotte, Mich H. J.

The Mechanical Force of Light.

To the Editor of the Scientific American:

Has it occurred to you that the remarkable discovery of Dr. Crookes, the mechanical or repulsive force of light, may offer a satisfactory solution of a great cosmic problem? I am one of those who believe that matter never had a beginning and can never have an end, any more than time ever had beginning or can have end, or than space has a beginning and an end; nor do I believe that, when a planetary system has passed through its incalculable cycles of formation, and through the decadence of its central source of light and heat, and becomes barren and desolate, it will for ever remain a dead system. I think you have struck the keynote of the problem in your suggestion that the tremendous repulsive force, of the sun's light upon the planets, combines with the centrifugal force of revolution to prevent them from approaching and finally falling into the sun. No other hypothesis is tenable, for we are certainly not receding from the sun, as we assuredly would be were it not for the attraction of gravitation; and the fact that we are not receding, while at the same time the incalculable repulsive force of the sun's light must inevitably tend to make us recede, shows that the centrifugal force of our revolution around the sun is not of itself sufficient to continue our distance from the sun, but that the added force of light repulsion is necessary to maintain that distance. Now by decadence of the source of light, the dying out of the sun's forces (which is inevitable), this repulsive force will be removed, and the desolate planets of our system must with equal inevitability fall into the sun; for as this light force is assuredly necessary to keep the planets from the sun, so to remove it must precipitate them, in due course of time, into the central mass.

The forces that would thus be generated, of light and heat, have already been estimated; and it seems clear to me that, in the instant conversion of these solid bodies into the disintegrated, vaporous, expansive substances which would result from these collisions, is found the material for a new system, beginning and passing through all the cycles of time and formation through which astronomy has shown that our present system has passed. There may be other forces than the centrifugal and light forces which keep the planets from the sun, and whose removal, by decadence of the sun, will precipitate "the eternal smash;" but as neither force nor matter can be lost, and as it is childish to assume that the cosmic system was destined to begin and end with a single formation of suns and planets, so it is inevitable that, from some such cause as that which I have inadequately foreshadowed, the operations of the Universe which we now witness will continue for ever; in ever changing forms, it is true, but absolutely without end.

Washington, D. C. W. E. SAWYER.

The Mechanical Force of Light.

To the Editor of the Scientific American:

In a recent number of your paper, Mr. R. L. Taylor showed that the motive power of light was known 30 years ago. In Rees' "Cyclopædia," a work published at least 70 years ago, I find the following: "Some writers have attempted to prove the materiality of light, by determining the momentum of its component particles, or by showing that they had a force, so as, by their impulse, to give motion to light bodies. M. Homberg imagined that he could not only disperse pieces of amianthus and other light substances by the impulse of the solar rays, but also that, by throwing them upon the end of a kind of lever, connected with the spring of a watch, he could make it move sensibly quicker: whence, and from other experiments, was inferred the weight of the particles of light. But M. Du Fay and M. Mairan made other experiments of a more accurate kind, which exhibited no such effects as M. Homberg imagined. However, Dr. Priestley informs us that Mr. Mitchell endeavored to ascertain the momentum of light with still greater accuracy, and that his endeavors were not altogether unsuccessful. Having found that the instrument which he used acquired, from the impulse of the rays of light, the velocity of one inch in a second, he inferred that the quantity of matter, contained in the rays falling upon the instrument at that time, amounted to no more than the twelve hundred millionth part of a grain. In the experiment, the light was collected from a surface of about three square feet; and as this surface reflected only about half what falls upon it, the quantity of matter contained in the rays of the sun, incident upon a square foot and a half of surface, in one second of time, ought to be no more than the twelve hundred millionth part of a grain, or, upon one square foot only, the eighteen hundred millionth part of a grain. But the density of the rays of light at the surface of the sun is greater than at the earth in proportion of 45,000 to 1: there ought, therefore, to issue from one square foot of the sun's surface, in one second of time, in order to supply the waste by light, one forty thousandth part of a grain of matter, that is a little more than two grains a day, or about four millions seven hundred and fifty-two thousand grains, which is about six hundred and seventy pounds, avoirdupois, in six thousand years; a quantity which would have shortened the sun's semi-diameter no more than about ten feet, if it was formed of matter of the density of water only. Priestley, *ubi supra*, page 389." C. M. BRADBURY.

24 Bollingbrook street, Petersburgh, Va.

Grasshoppers in the West.

To the Editor of the Scientific American:

In No 24, of your volume XXXII, page 369, I find, in an article regarding grasshoppers, this remarkable statement: "The size of the locust is from that of a flea to that of a house fly." As this statement does injustice to the great and growing States of Missouri, Kansas, and Nebraska, States which are as fertile as the valley of the Nile, I submit the following for your consideration:

1. I send you a box of grasshoppers by express, to give you visual proof of their size, varying in length from 1 to 2½ inches. This will convince you that your fleas and house flies must be very large. The statement you published in regard to the size of our grasshoppers is nothing less than a libel on the fair fame of this part of the Great West, and you must retract or suffer the consequences of your calumnious reports. Even our grasshoppers are indignant to learn that they are as small as fleas and house flies.

2. The section of country now completely devastated by these grasshoppers is about 100 miles square, with this city near the northeast corner of the square. Fields of wheat, barley, corn, etc., of 160 acres are laid waste in a single day by this hungry and devouring plague.

3. The number of the grasshoppers can be expressed only by infinity, with one million as the unit; no arithmetician can compute their number. Some farmers have been killing them by the bushel and by the wagon load, before they were able to fly. They are now beginning to fly, and the whole air is as full of these insects at mid-day, say from 9 o'clock A.M. till 5 o'clock P.M., as with snow flakes during a snow storm in winter, and having a similar appearance.

4. Not the farmers only, but all classes of people are sufferers by this grasshopper scourge. Even railroading is much hindered by the grasshoppers, and trains of cars are often stopped by them, as they are so numerous. In sorrow, I speak only the truth.

5. Having regard for the truth, I send you the above and also the box of grasshoppers. If you doubt my statements, then come and see. R. R. C.

St. Joseph, Mo.

[Our correspondent errs in declaring us in error, as our previous remarks were based on the ocular proof of specimens of hoppers forwarded to us, and the statements of the journals published in the immediate vicinity of the insect raid. We referred, however, to the young locusts, as, is obvious from the means mentioned for their extinction, as of course, after their wings had grown, the insects would find no difficulty in clearing such obstacles as ditches and streams. The box of hoppers, which we have duly received, furnishes very excellent evidence that the insects in our correspondent's neighborhood are fully of the size stated by him, but certainly do not disprove the fact that there was a period in their history when their dimensions did not exceed those of the flea or the house fly.—EDS.]

The Colorado Potato Beetle.

To the Editor of the Scientific American:

From various articles in yours and other papers, I gather that the Colorado potato bug has so far proved rather more than a match for the proverbial Yankee ingenuity. Will you allow me to suggest a plan by which I think it probable this destructive insect may be got rid of?

I take it for granted that the bug preys upon the plant in one year, deposits its eggs in the ground during the autumn, and that they are hatched next year, and, in their turn, feed upon the plants, and so on. Further, I have read that this insect travels over new land at about 60 miles per annum; but this of course is over land well stocked with the potato plant, its special food.

My plan is to divide the territory of the United States into imaginary strips of land, north and south, each fifty miles wide. These may be numbered for reference. In the year 1876, I would propose to confine the growth of the potato to the strips of land numbered 1, 5, 9, 13. In the next year, 1877, the potato would be grown only on the strips numbered 3, 7, 11. In 1877, therefore, the insects in the strips of territory 1, 5, 9, 13, will have to travel over fifty miles of ground before meeting with any food; and this I think it probable they would fail to do, and would therefore perish. If, however, the insects should be able to traverse this distance without food, the strips would have to be made wider. In 1878, the strips 1, 5, 9, 13 would again be planted with the potato. The cultivators of the strips 2, 4, 6, 8, etc., would probably feel aggrieved by the inability to grow the potato for 2 or 3 years; but some arrangement might be made, of an equitable nature, to meet their case. It is evident that the adoption of this plan would necessitate the carriage of potatoes over a maximum distance of 25 miles for the supply of the inhabitants of the non-potato-growing strips; but the question appears to be either the extinction of the bug or of the potato plant. The plan, if attempted, would no doubt require the management of a geographical department of the United States, who would easily arrange and advertise a list of places for 1876, 1877, and 1878, in which the potato should be grown, and in which it should not; and I doubt not the agriculturists of the United States would be willing to give the plan a fair trial.

THOMAS A. COTCHETT.

2 Craig's Court, London, England.

Possible Recovery of the Lost Elgin Marbles.

Out of seventeen cases of marble sculptures taken by Lord Elgin from the Acropolis in Athens in 1802, twelve reached the British Museum, and the remainder were lost, with the ship in which they were stored, by the foundering of the vessel during a severe storm off the Island of Cerigo. M. Makoukas, a resident of that island, has recently informed the Archæological Society of Athens that the marbles are now plainly visible, lying on the bottom of the sea at a depth of about 96 feet, and it is stated that prompt measures will be taken for the recovery of the valuable relics.

It is interesting to observe that the appliances by which these archæological treasures will be regained have sprung into existence since the marbles have reposed in the depths of the sea. Seventy-three years ago, the diver's dress and the vulcanized rubber of which it is made were unknown, and the works of ancient art have had to remain in their watery prison until, in the progress of inventive skill, means have developed themselves, by which their liberation, once presenting insurmountable difficulties, is now rendered a comparatively easy proceeding. Lord Elgin gained possession of the marbles through a firman of Sultan Selim III. Greece was then but a province of Turkey; the battle of Navarino had not been fought; and before achieving its independence, the country for many years after remained under the rule of the Turk, who at his pleasure bestowed upon foreigners the relics which, by modern Athenian archæologists, are deemed of priceless value.

Mineral Wool.

The utilization of blast furnace slag recently discovered bids fair to be of some importance. It is stated that if a jet of steam be injected into a current of fluid scoriæ, fine, supple, and elastic filaments are obtained. With certain slags these are of a brilliant white and resemble cotton thread. The material is remarkable for its non-conductibility of heat, and hence may be profitably used for covering boilers and for other purposes in which it is desirable to prevent radiation.

PRACTICAL MECHANISM.

BY JOSHUA ROSE.

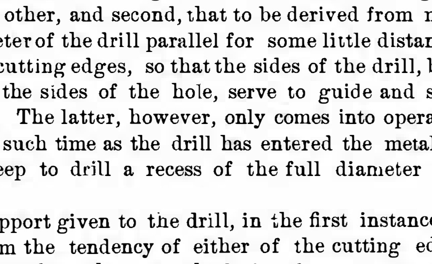
NUMBER XXVII.

DRILLS AND DRILLING.—FLAT DRILLS.

A drill is, all things considered, the most effective tool employed by the machinist; for while its cutting edges are necessarily of decidedly undesirable angles and form, it sustains the very roughest of usage, and yet will bear more strain in proportion to its strength than any other cutting tool. The reason of this is that it is supported by the metal upon which it is operating, and is thus prevented from springing away from its duty. This support may be of two kinds, first, that due to the wedge shape of the main cutting edges, one to the other, and second, that to be derived from making the diameter of the drill parallel for some little distance behind the cutting edges, so that the sides of the drill, by contact with the sides of the hole, serve to guide and support the drill. The latter, however, only comes into operation at and after such time as the drill has entered the metal sufficiently deep to drill a recess of the full diameter of the drill.

The support given to the drill, in the first instance cited, arises from the tendency of either of the cutting edges to spring away from the cut, which is, of course, counterbalanced by the opposite cutting edge having the same tendency, but in an opposite direction, so that between the two the drill is held to a central position; and also from the tendency of the drill point to force itself forward (by reason of the pressure behind it) as far into the cone formed by the end of the hole as possible, as the end of the hole and the cutting end of the drill are two cones, one being forced into the other. In a drill properly ground (that is, having its cutting edges at an equal angle to the center line of the length of the drill, and the cutting edges of an equal length from the center or point of junction of the cutting edges) both the cutting edges and the sides of the drill act as supports and guides, tending to sustain it under the strain and keep it true. If, however, the drill is not ground true, the strain upon it becomes very great, because the whole force of the cut is then placed upon one cutting edge only, and is continuously tending to thrust the point of the drill outwards from the center of the hole being drilled, hence cutting a hole larger in diameter than the cutting part of the drill, that is to say, a hole whose diameter will be twice that of the radius of the longest cutting edge of the drill, measured from the center line of the length of the drill. If, under such conditions, one side of the drill bears against the sides of the hole, as shown in Fig. 98, A being the metal and B the drill, there will be

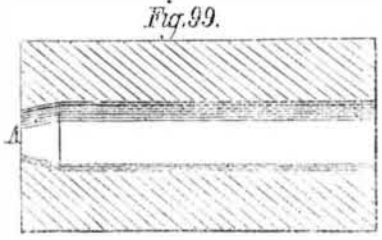
Fig. 98.



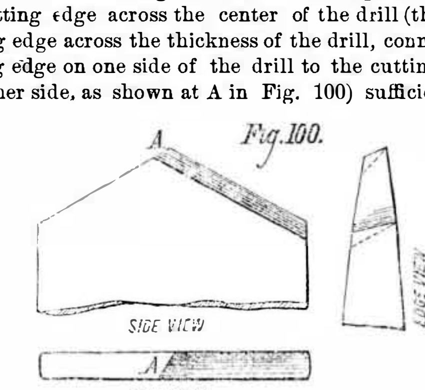
created two opposing forces, independent of the strain necessary to sever the metal, one being the endeavor of the point of the drill to keep to the center of the hole, because of the conical shape of the end of the hole and point of the drill, and the other being the endeavor of the cutting edge to force the drill to one side and the point of the drill out of the center of the hole. And as the pressure of the side of the drill against the side of the hole will tend to force the drill to revolve true with that side of the drill so that the point of the drill will revolve in a circle and not upon its own axis the result will be a hole, neither round, straight, nor of any definite diameter, as compared to the diameter of the drill.

Drills that are a trifle too small for the required size are sometimes purposely ground a little out of true so as to cause the hole to be larger than the drill, but the action of such drills is distorted, and it is impossible to estimate exactly how much deviation is necessary to the required increase of diameter of the hole. Part of the power driving the drill is lost, the loss being due to the creation of the above opposing forces, and the drilling operation is slow by reason of only one edge of the drill performing any cutting. Hence, the feed of the drill being only half as rapid as it should be, it is an unmechanical expedient and a loss of time, especially if the hole is to be drilled clear through the metal: for in that case, as soon as the point of the drill emerges through the metal and the drill is therefore released from its influence, the cutting edges will gradually adjust themselves to the hole, and drill the remainder of the hole to the size of the diameter of the drill, the hole when finished appearing as in Fig. 99. Thus the end, A, of the hole will require to be filed out, entailing in all more loss of time than would be required to make a drill of the proper diameter.

Fig. 99.



The importance, then, of taking especial pains to grind a drill true being apparent, we may next consider how thick the point of the drill should be. It is here that the main defect of the drill as a cutting tool lies, for it is impossible to make the cutting edge across the center of the drill (that is, the cutting edge across the thickness of the drill, connecting the cutting edge on one side of the drill to the cutting edge of the other side, as shown at A in Fig. 100) sufficiently keen



to enable it to enter the metal easily, without grinding the angles of the two cutting edges very acute, as shown, in the edge view of Fig. 100, by the dotted lines, which would so weaken the cutting edges as to cause them to break from the pressure of even the lightest feeding. The only alternative, then, is to make the point of the drill as thin as is compatible with sufficient strength; and this will be found to be of about the following proportion:

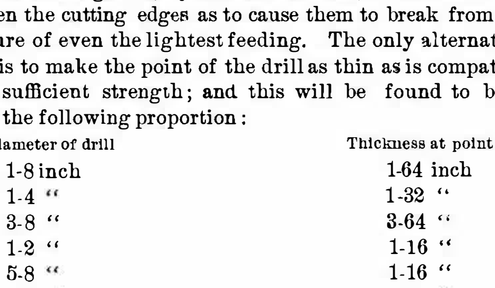
Diameter of drill	Thickness at point
1-8 inch	1-64 inch
1-4 "	1-32 "
3-8 "	3-64 "
1-2 "	1-16 "
5-8 "	1-16 "
3-4 "	1-16 "
7-8 "	1-16 "
1 "	3-32 "

The flat face must be made gradually thicker as the full diameter of the drill is reached.

The angle at which to grind the end of the drill is governed to a large extent by the kind and degree of hardness of the metal to be drilled, the angle shown in Fig. 100 being suitable for wrought iron, steel, or unusually hard cast iron; while, for common cast iron or brass, a little more angle may be given. But no definite angle can be given for any metal, because of the varying conditions under which a drill performs its duty. From these considerations we find that the effectiveness of a drill arises from the support rendered to it by the work, which more than compensates for the want of keenness inherent to its form of cutting edge.

Thus far, however, we have been considering the ordinary flat drill in its most simple form. For use on steel, wrought iron, and cast iron, we may improve the cutting qualifications of the drill by bending each side of the cutting bevel edges forward, thus forming what is termed a lip drill, as shown in Fig. 101. Such a drill will cut with much greater ease and rapidity, because the angle, of the two faces whose

Fig. 101.

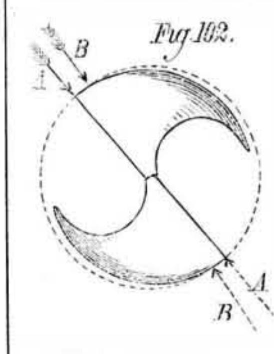


junction forms a cutting edge, is much more acute, while the cutting edge is, at the same time, well supported by the metal behind it, which advantages are to be obtained in no other way. The cutting edges of this drill are similar to those on the twist drill.

TWIST DRILLS.

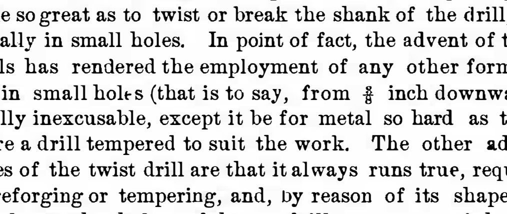
Twist drills are not, as is usually supposed, of the same diameter from end to end of the twist, but are slightly taper, diminishing towards the shank end. The taper is usually, however, so slight as to be of little consequence in actual practice. Neither are twist drills round, the diameter being eased away from a short distance behind the advance or cutting edge of the flute backward to the next flute, so that, were we to grind the cutting end square or level, instead of conical, it would appear as in Fig. 102.

Fig. 102.



The object of this is to give the sides of the drill as much clearance as possible. The part of the diameter from A to B, on each side, is left of a full circle, which maintains the diameter of the drill and steadies it in the hole. If, from excessive duty, that part from A to B should wear away at the cutting end of the drill, leaving the corner of the drill rounded, the drill must be ground sufficiently to cut away entirely the worn part, otherwise it will totally impair the value of the drill, causing it to grind against the metal, and no amount of pressure will cause it to cut. The advantage, over other drills, possessed by twist drills lies first in that the cuttings can find free egress, which effects a great saving of time, for plain drills have to be frequently withdrawn from the hole to extract the cuttings, which would jam between the sides of the hole and the sides of the drill, and the pressure will frequently become so great as to twist or break the shank of the drill, especially in small holes. In point of fact, the advent of twist drills has rendered the employment of any other form for use in small holes (that is to say, from ⅝ inch downwards) totally inexcusable, except it be for metal so hard as to require a drill tempered to suit the work. The other advantages of the twist drill are that it always runs true, requires no reforging or tempering, and, by reason of its shape, fits closely to the hole, and hence drills a very straight and smooth hole. It is also not liable to be influenced so much by an air or other hole or soft spot which may exist in the metal being drilled. These qualifications render the twist drill a very superior tool for the finer classes of work, and for such purposes as drilling metal away to form a key way or slot; for in the latter case, the holes may be drilled so closely together that they will run one into the other, as shown in Fig. 103, A being the piece of metal, and B B, the holes. A com

A Fig. 103.



mon flat drill is incapable of performing such work. The twist drill will not, however (in holes of a moderate depth, that is to say, holes whose depth is not more than four times their diameter), do so much duty in a given time as a common drill, especially if, in iron or steel, the latter be slightly lipped: the reason being that the latter, stronger in proportion to its diameter, will stand more strain, and may therefore be fed much more rapidly in all cases wherein the depth is not too great to permit the cuttings from finding egress before becoming jammed in the hole.

FEEDING DRILLS.

Much more duty may be obtained from a drill by feeding it by hand than by permitting the gearing of the machine to feed it, because, in hand feeding, the sense of feeling indicates to the operator how much cut the drill is capable of standing, and he can therefore vary the rate of feed, keeping it up to the maximum obtainable on the degree of hardness of the metal being drilled. Dullness of the cutting edges, hard or soft spots in the metal, or any other variation in the condition of the drill or in the metal being drilled, is at once perceived by hand feeding. Drilling machines have, it is true, several degrees of feed, but the fact is that the human hand can feed the drill at any rate that can be obtained by means of machine gearing; and having behind it the human mind, it is enabled to accommodate itself to the numerous and variable conditions against which no provision can be made in automatic feed gearing. No positive rate of feed, either for any particular size of drill, or for any definite kind of metal, can be given, because of the always present variations in the degree of hardness of the metal to be cut, and furthermore because, in the case of iron and steel, the facility of supplying the cutting edges with oil seriously affects the attainable rate of feed to the drill. If, for instance, the hole is being drilled horizontally, as in a lathe, and is very deep, so that it is difficult to freely supply the cutting end of the drill with oil, the feeding must proceed slowly or the cutting edges of the drill will soon become destroyed. Here, also, it may be well to state that, if oil be supplied to a drill cutting cast iron or brass, it will cause the cuttings to jam between the sides of the drill and the sides of the hole, until the pressure becomes so great as to either stop the drilling machine or lathe, or else twist or break the drill. The rate of feed, and the speed at which the drill should revolve, depend upon the hardness of the metal under operation, although not to a very great extent, except in the event of the metal being unusually hard, in which case the drill should revolve very slowly; for not much latitude in the degree of hardness of the drill is permissible, for fear of impairing the strength of the drill.

TO FIX labels on tin, use French polish or a solution of shellac in naphtha or alcohol.