steel plate is placed on the top of each casting immediately the mold is filled, and over this a bed of sand is placed, and speedily and firmly pressed down.

As soon as the ingots have solidified, and while they are still glowing, the molds are lifted off them by means of an hydraulic crane, and afterwards the ingots are picked up by tongs attached to the same machinery, and are carted away, all red hot, to the hammer shops, where they are thumped and rolled or otherwise tortured into their required forms of rails, tires, and plates.

Correspondence.

The Inverse Rotation of the Radiometer an Effect of Electricity.

To the Editor of the Scientific American:

In a former communication to the SCIENTIFIC AMERICAN, I endeavored to show that the direct rotation of the radiometer was an effect of electricity. Before attempting to explain the inverse rotation, it will be necessary to state briefly some new facts which my electroscopic researches have led me to establish.

In order to ascertain the electric state of their inner surfaces, I exposed, to solar radiation, glass receivers such as are used for the air pump. By means of the proof plane and electroscope, I found that this surface was electrified negatively, and even to a greater degree than the exterior. This excess of energy I attribute to the numerous reflections from the interior. If, however, we hold one of these electrified receivers near the Böhnenberger electroscope, taking care that it does not come in contact with it, the electroscope at once indicates the presence of positive electricity. As both the outer and inner surfaces are negatively electrified, this phenomenon must be attributed to the electricity developed in the interior of the glass itself by its molecular polarization and feeble conductivity. The following experiment confirms this explanation If we remove from the exterior, by means of the proof plane, a portion of the negative electricity, and then approach, as before, the globe to the electroscope, a remarkable increase of positive electricity is at once shown. The same results are observed in the radiometer.

I next examined the electric state of the exterior of the radiometer globe when placed in partial obscurity and moistened with ether. There are no signs whatever of electricity, as long as the inverse rotation continues; but as soon as the direct rotation commences—on account of the obscure radiations given forth by the surrounding bodies—positive electricity manifests itself and rapidly increases. While in this state, I exposed the radiometer to solar radiation, and I found that this positive electricity remains quite a long time, and that, notwithstanding the positive charge on the exterior, the direct rotation continues with its usual rapidity.

The fact last mentioned enabled me to determine by experiment the electric state of the inner surface of the radiometer globe. Only two suppositions can be made in regard to it: either the electric state of the inner surface is dependent, by means of molecular polarization, upon the electric state of the exterior, or it is independent. In the first supposition the interior face is electrified positively when the exterior is electrified negatively, and *vice versâ*. The second supposition may be divided into three hypotheses, for we can admit that the interior is constantly, under the same circumstances, either neutral, or negative, or positive. Hence we have in all four hypotheses, *à priori*, namely: 1. Inner surface is dependent upon electric state of exterior. 2. Inner surface is independent and neutral. 3. Inner surface is independent and negative. 4. Inner surface is independent and positive.

Now of these four hypotheses, the fourth alone is verified by experiment. This I have established as follows: In one series of experiments I charged the exterior of the radiometer with positive electricity by exposing it to solar radiation. In a second series I charged the same surface with positive electricity by exposing it to solar radiation after moistening it with ether. Each experiment comprised two operations. I touched a certain number of times the exterior of the glass globe with the proof plane, and I carefully observed the electroscopic signs of the Böhnenberger electroscope when brought in contact with the proof plane; then I approached to the electrometer the glass globe which had been partially discharged by the preceding experiment, and I again observed the signs given by the electroscope. In the case that one of the first two hypotheses expresses the real state of the inner surface of the radiometer under the influence of radiation, on approaching the glass globe we should have, in both series of experiments, electroscopic signs of equal intensity for equal electric changes of the exterior surface, manifested by the equality of those of the proof plane. Now this does not take place. In my experiments on the approach of the globe, the electroscopic signs in the second series surpass in intensity those observed in the first series. These results agree perfectly with the fourth hypothesis, but are in open disagreement with the third. Any one can easily see this, with a little attention, by considering the layers of electricity produced in the interior of the glass walls by molecular polarization. The fourth hypothesis is, then, the true one, and the inner surface is electrified positively.

The explanation of both the direct and inverse rotation follows naturally from these facts and those communicated in my former note. For, since the inner surface, when exposed to luminous or calorific radiations, is electrified positively, the direct rotation is a necessary consequence of the attractions and repulsions which this positive electricity exerts upon the free electricity of the vanes. This rotation continues when the radiometer is surrounded by light, because a perfectly homogeneous layer of electricity upon the inner surface is almost impossible.

The inverse rotation occurs in two circumstances: 1. When the instrument, having been exposed to radiation which produces a direct rotation, is allowed to cool slowly. 2. When the radiometer at the ordinary temperature is cooled suddenly, for instance, by moistening it with ether.

In the first case, the electricity, which the globe acquires when exposed to radiation, disappearing very slowly, as experiments show, an inversion of the movement can be produced by an inversion in the signs of the electricity of the vanes. In fact, in accordance with the principle of reciprocity, the emission of the radiations gives rise in the vanes to a development of electricity equivalent and contrary to that which absorption has produced there. By this development of electricity, the vanes would return to their neutral state if the electricity produced by absorption had not passed in part from the vanes into the rarefied gas of the globe. Now this passage took place with a greater energy as the rotary movement of the vanes had renewed more frequently the mass of air in contact with them. Hence the electric effect of the emission will be to change the signs and to diminish the charge of free electricity of the vanes. In the second case, where the cooling is produced by moistening the exterior, the globe remains in its neutral state. For, as I have above remarked, during the whole time of the inverse rotation the cooled surface of the globe gives no sign of electricity. It appears that the cooling itself is not capable of producing electricity, but that the passage of a radiation through the surface is absolutely required. In these conditions, the vanes become charged with negative electricity upon the dark, and positive electricity upon the bright, side, by reason of the emission, at the same time that the radiations, given forth by the vanes and absorbed by the inner surface of the glass globe, electrify the latter positively. Thus the electric theory of the radiometer explains quite well the principal phenomena which have been observed up to the present time. I hope to make, hereafter, a study of all the particular movements which different observers have published in the *compte rendu* of their experiments. I will only say now that the most remarkable of them, namely, the rotation of the radiometer globe when an obstacle is put to the rotation of the vanes, as discovered by Schüster, is in entire conformity with the above theory, while it constitutes a very serious objection to the hypothesis of mechanical impulsion by radiation. JOSEPH DELSAULX, S. J.

11 Rue des Récollets, Louvain, Belgium.

Petroleum as a Lightning Conductor.

The destruction of oil by lightning this year has been remarkable, amounting to 242,412 barrels, from January 1 to July 31 of this year, or rather from April to August; there were no fires from this cause in January, February, or March, two in April, none in May, four in June, and five in July. It is scarcely necessary to inform our readers that the oil destroyed is in closed-top iron tanks, and the lightning, striking these, explodes the gas that collects in the space above the oil, scatters the oil, and sets it on fire, and in this way often communicates to other tanks in the immediate vicinity. The theory most commonly received in the oil regions of the cause of such frequent lightning strikes is that the gas, which, it is well known, is continually escaping from the oil in these tanks, rises to some distance above the tanks, acts as a conductor, attracts the lightning, and the damage is done. One peculiar feature in the history of these accidents is, so far as we have been able to learn, no iron-topped tank has been struck, but in every case wooden-topped ones. We have made special inquiries on this point with the uniform result given. So far, attempts to protect tanks with lightning rods have been failures; at Dilks' Station, a number of rods, supposed to be ample protection, were placed about the tanks, but they were no protection against this summer's bolts. It may be interesting, to those not acquainted with the oil business, to state that, in losses occurring in this way, all the oil in the pipe line to which the tanks belong is assessed *pro rata* for the loss; that is, the law of general average, so well known in marine law, is applied in this case.—*Stowell's Petroleum Reporter.*

REMARKS:—If it were possible to carry the rods entirely above the rising gas, then the rods would be a complete protection. But the probabilities are that the rods mentioned were either immersed in an atmosphere of explosive gas, which the lightning necessarily ignited before it reached the rods, or the rods, like the majority that are put up, were not properly connected with the earth, consequently could not protect anything. A lightning rod not sufficiently joined to the earth is of no more use in conducting lightning than is a pipe with one end stopped up to conduct water.

We wish that some of our readers would give us the particulars of the rods at Dilks, describing especially the nature of the ground connections.

Explosive Agriculture---Dynamite vs. Plows.

The agents of M. Nobel, the well known inventor of nitroglycerin, have lately found a novel use for dynamite in grape culture, which suggests further possibilities. The explosive was not used for its chemical effect, but in a purely mechanical way, literally to "shake up" the earth and allow the free percolation of water and the access of air to the roots of the vines. To this end holes were made in the soil about ten feet in depth, and at points where no roots of the vines were likely to be injured. Then cartridges of dynamite were introduced and exploded, and the result was that, for the entire depth noted, the earth was made loose and friable. The ground, in short, was not only rendered in better condition than could have been effected by plow and harrow; but every phylloxera, so the writer says, on roots of the vines was killed. The quantity of dynamite used is not stated, but it is likely to have been but small, just enough to shake the soil without blowing up the vines.

It seems to us that the use of dynamite in agricultural operations need not stop here. Instead of breaking up old pasture lands with the plow with great labor, the farmer might bore holes here and there, drop dynamite cartridges, blow them up, and in a second find his soil loosened and all noxious worms and insects therein destroyed. Dynamite, however, is a dangerous material, and hardly one of which to counsel the indiscriminate use; but nevertheless it might prove a profitable venture for engineers and powder and nitro-glycerin manufacturers, and others who may safely and lawfully be trusted with the explosive, to offer their services in breaking up land for farmers.

PRACTICAL MECHANISM.

BY JOSHUA ROSE.

SECOND SERIES—Number XII.

PATTERN MAKING.

We may now commence a series of examples, accompanying each example with the explanations and considerations necessary to, and governing the method of, the construction chosen. Fig. 86 represents a drawing of a gland for which a pattern is required. Now this is a very simple pattern, and yet there are at least six different methods of making it, any of which may be followed, as will appear more clearly to the reader by his glancing over Figs. 87, 89, 90, 92, 93, and 94. The first question is how to determine which method is the most suitable. Let us suppose the pattern maker to be uninformed of the purpose the casting is to serve, or how it is to be treated: in such a case he is guided partly by his knowledge of the use of such patterns, and a consideration of being on the safe side. The form shown in Fig. 87 would suggest itself as being a very ready method of making the pattern; by coring out the hole, it can be made parallel, which the drawing seems to require. The advantage of leaving the hole parallel is that less metal will require to be left for boring, in case it should be necessary; because, if the hole is made taper, the largest end of the bore will require to have the proper amount of allowance to leave metal sufficient to allow the hole to be bored out true, and the smaller end would, therefore, have more than the necessary amount: while just the least taper given to the exterior would enable the molder to withdraw the pattern from the mold. Made in this way, it would be molded as shown in Fig. 88, with the flange uppermost, because almost the whole of the pattern would be imbedded in the lower part of the flask, the top core print being all that would be contained in the cope; and even this may be omitted if the hole requires to be bored, since the lower core print will hold the core sufficiently secure in small work, unless the core is required to be very true. The parting of the mold (at C D, in Fig. 88) being level with the top face of the flange, much taper should be given to the top print (as shown in Fig. 87), so that the cope may be lifted off easily. Were this, however, the only reason, we might make the top print like the bottom one, providing we left it on loose,

Fig. 86.

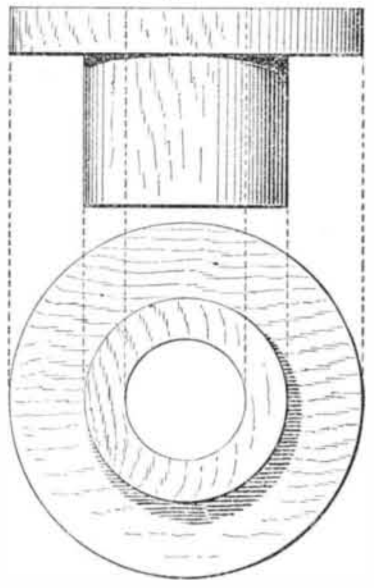
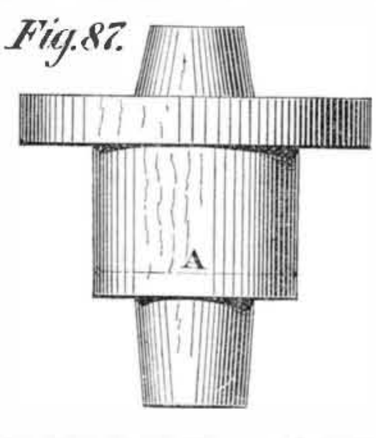


Fig. 87.



or made it part from the pattern and adjust to its place on the pattern by a taper pin; but another advantage is gained by well tapering the top print, in that it necessitates the tapering of the core print at that end; so that, when the two parts of the mold are being put together, that is to say, when the cope is being put in place, if the core has not been placed quite upright, its tapered end may still arrive and adjust itself in the conical impression, and thus correct any slight error of position of the core. The size of the core print should be, at the part next the pattern, the size of the core required; for if the extremities are made of the size of the core, and the taper or draft is in excess, there will be left a useless space around the core print, as shown at A B in Fig. 88, into which space the metal will flow, producing on the casting, around the hole and projecting from the end face, a useless web, which is called a fin, which will of course require to be dressed off the casting.

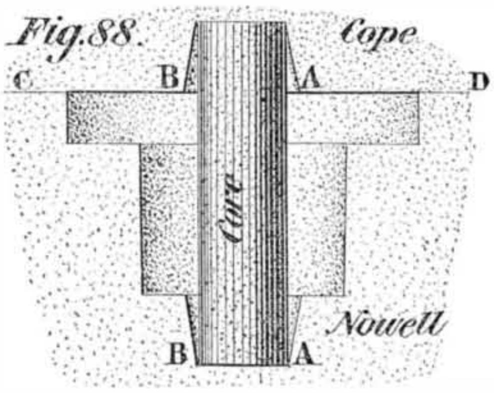
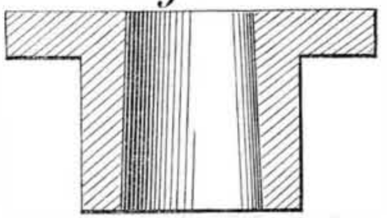


Fig. 88.

We will now suppose that our piece, when cast, is to be turned under the flange and along the outside of the hub or body, and that the hole also is to be bored. In this case the pattern made as above would still be good, but could be much more easily made and molded if it has to leave its own core, its shape beingas shown in Fig. 89: because the trouble of making a core is obviated, and the core is sure to be in the center of the casting, which it seldom is when a core is used. We must, however, allow more taper or draft to a hole in a pattern than is necessary on the outside; about one sixteenth inch on the diameter for every inch of hight on work of moderate size is sufficient. The allowance for boring should be one sixteenth inch at the large end of the hole, providing the diameter of the hole is not more than five or six inches, slightly exceeding this amount as the diameter increases; whereas, if the pattern had been made with core prints, an allowance of one eighth inch for small, and three sixteenths inch for larger, work would be required. These are the advantages due to making the pattern leave its own core. We have still to bear in mind, however, that, if the casting require a parallel hole, a core must be used; and furthermore, if the hole is a long one, we have the following considerations: The separate dry sand core is stronger, and therefore better adapted to cases where the length of the hole greatly exceeds the diameter. Then again, if the hole require to be bored parallel, it can be more readily done if the hole is cast parallel, because there will be less metal to cut out. The casting also will belighter, entailing less cost, providing it has to be paid for by the pound, as is usually the case. Themolderis given more work by making the core; but the saving in metal and in turning more than compensates for this, provided the length of the hole is greater than the diameter of the bore.

Fig. 89.



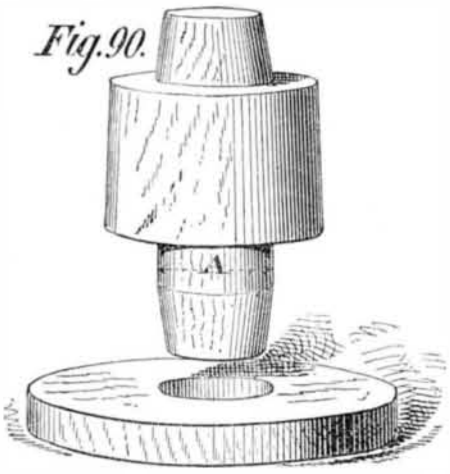


Fig. 90.

Let it now be required that the casting is to be finished all over, such as for a gland for a piston rod. It would, in that case, be preferred that, if the casting should contain any blow or air holes, they should not be on the outside face of the flange, and this will necessitate that the piece be molded the reverse way to that shown in Fig. 88: that is to say, it must be molded as shown in Fig. 91, with the flange downwards; for it may be here noted that the soundest part of a casting is always that at the bottom of the mold; and furthermore, the metal there is more dense, heavier, and stronger than it is at the top, for the reason that the air or gas, which does not escape from the mold, leaves holes in the top of the casting or as near to the top as they can, by reason of the shape of the casting, rise. The bottom metal also has the weight of the metal above it, compressing it, and making an appreciable difference in its density. It must, therefore, be remembered that faces requiring to be particularly sound should be cast downwards, or at least as near the bottom of the mold as they conveniently can. Following this principle, our gland will require to be molded as shown in Fig. 91, P P representing the line of the parting of the mold; so that, when the cope is lifted off, the loose hub, A, will rise with it, leaving the flange imbedded in the lower half of the mold. It is evident that in this case the pattern must be made as shown in Fig. 90, the body and core prints being in one piece and the flange in another, fitting to an easy fit on to a parallel part on one end, and adjoining the core print, as shown at A. For glands of moderate size, this method is usually adopted, and it answers very well for short pieces; but in cases where the length of the body approaches, say three diameters, the horizontal position is the best, and the pattern should be made as shown in Fig. 92, 93, or 94. Even in short pieces, when the internal diameter approaches that of the external, this plan is the best, because it is difficult for the molder to tell when his core is accurately set in position.

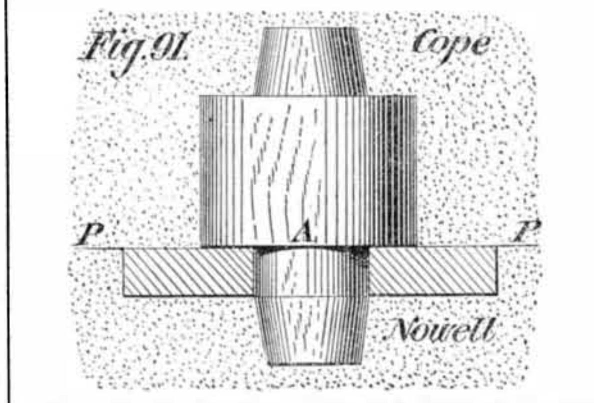


Fig. 91.

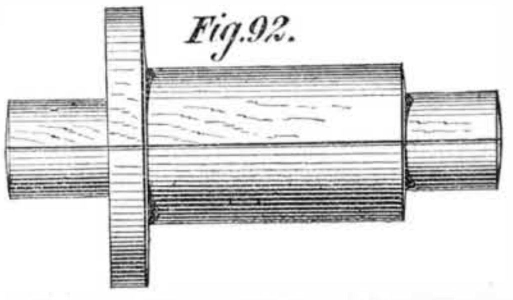


Fig. 92.

For a pattern to be molded horizontally, Fig. 93 shows the best style in which it can be made. Its diameters are turned parallel; the required draft is given by making the rim of the flange a little thinner than at the hub, and by making the end faces of the hub and the core prints slightly rounding. If the hub is very small, as, say, a half inch or less, and the flange does not much exceed it, the pattern may be made solid, as shown in Fig. 92; but if the hub be small and the flange large, it should be made as shown in Fig. 94.

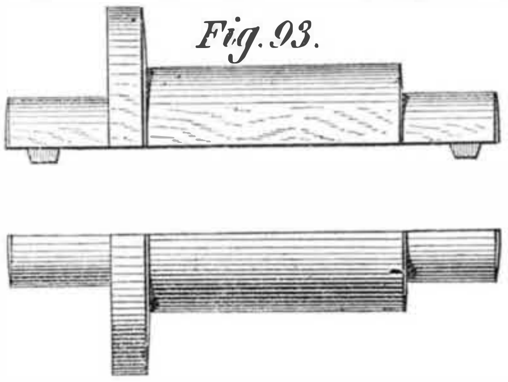


Fig. 93.

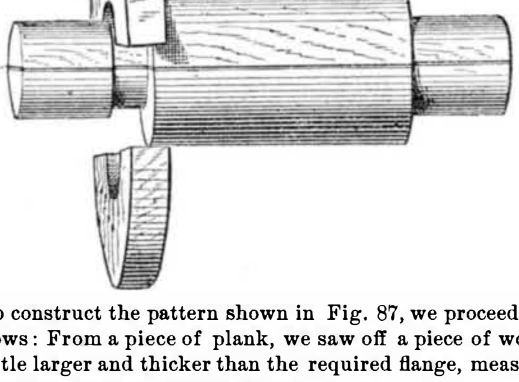


Fig. 94.

To construct the pattern shown in Fig. 87, we proceed as follows: From a piece of plank, we saw off a piece of wood a little larger and thicker than the required flange, measuring with a contraction rule, that is to say, a rule specially made for the pattern maker, and having its measurements larger than the actual standard ones in the proportion of one eighth inch per foot: so that a foot on a contraction rule is $12\frac{1}{8}$ standard inches, and an inch is $1\frac{1}{96}$ standard inches. The reason for this is that, when the metal is poured into the mold, it is expanded by heat; and as it cools, it contracts, and a casting is, therefore, when cold, always smaller than the size of the mold in which it was made. Brass castings are generally said to be smaller than the patterns in the proportion of one eighth per foot, and cast iron castings one tenth inch per foot; and so, to avoid frequent calculations and possible errors, the contraction rule has the necessary allowance in every division of the foot and of the inch. It is not, however, to be supposed that the possession of such a rule renders it possible for the pattern maker to discard all further considerations upon the contraction of the casting; because there are others continually stepping in. Such, for example, is the fact that the contraction will not be equal all over, but will be the greatest in those parts where the casting contains the greatest body of metal. If we are required to make a pattern for a brass, such as shown in Fig. 95, its bore being six inches in diameter and its length ten inches, we shall find that the diameter of the casting will be less at A B than can be accounted for on the basis of a contraction of one eighth inch per foot; and furthermore, the projection in the middle of the brass, which is sometimes provided instead of flanges to prevent the brass from moving endwise in the box, will cause the sides of the hexagon to cast hollow in their lengths; so that a straight edge, placed along the bevel from C to D, would touch the brass at each end, and not in the middle.

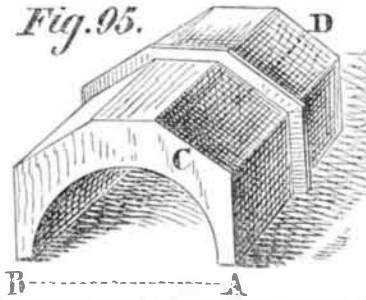


Fig. 95.

In the smaller sizes of patterns, however, such as those of 6 and less inches in diameter, there is another and a more important matter requiring attention, which is that, after a molder has imbedded the pattern in the sand, and has rammed the sand closely around it, it is held firmly by the sand and must be loosened before it can be extracted from the mold. To loosen it, the molder drives into the exposed surface of the pattern a pointed piece of steel wire, which he then strikes on all sides, causing the pattern to compress the sand away from the sides of the pattern in all directions; and as a result, the mold is larger than the pattern. In many kinds of work, this fact may be and is disregarded; but where accuracy is concerned, it is of great importance, especially in the matter of our example (brasses for journals), for they can be chipped and filed to fit their places much more rapidly than they can be planed, and it is necessary to have the castings as nearly of the correct conformation as possible. In cases where it is necessary to have the castings of the correct size without any work done to them, the shake of the pattern in the sand is of the utmost importance. If he is required to cast a piece of iron 3 inches long and 1 inch square, supposing the pattern were made to correct measure by the contraction rule, the molder, by rapping the pattern (as the loosening it in the mold is termed), would, by increasing the size of the mold above that of the pattern, cause the casting to be larger than the pattern: that is to say, it would be longer and broader, and therefore, in those two directions, considerably above the proper size, since even the pattern was too large to the amount allowed for contraction. The depth, however, would be of correct size, because the loosening process or rapping does not drive the pattern any deeper in the mold. It follows that, to obtain a casting of as nearly the correct size as possible, the pattern must be made less in width and in length than the proper size, to the amount of the rapping; and to ensure that the molder shall always put the pattern in the sand with the same side uppermost, the word "top" should be painted on the face intended to lie uppermost in the mold. The amount to be allowed for the rapping depends upon the size of the pattern, and somewhat upon the molder, since some molders rap the patterns more than others: hence, where a great number of castings of accurate size are required, it is best to have two or three castings made, and alter the pattern as the average casting indicates. For castings of about 1 inch in size, the patterns may be made $\frac{1}{32}$ inch too narrow and the same amount too short; but for sizes above 6 inches, allowance for rapping may be disregarded.

In patterns for small cast gears, the rapping is of the utmost consequence. Suppose, for instance, we have 6 rollers of 2 inches diameter, requiring to be connected together by pinions, and to have contact one with the other all along the rollers: if we disregard the allowance for rapping, the pinions will be too thick, and we shall require to file them down, entailing a great deal of labor and time, besides the rapid destruction of files.

Garden Bulbs.

Now is the time when bulbs should betaken up and stowed away, as the leaves of the plants become ripe and brown, and the roots will die if the plants remain too long in the ground. The bulbs should be put away in the shade to dry for a few days; then the tops, roots, and rough skin should be removed, and the bulbs put in paper bags, properly labeled. Bulbs that have flowered in water should, as soon as the flowers begin to fade, be removed and planted in earth, where they will get a little nourishment for the future good of the bulb; but even then the bulbs is weakened, and bulb will not flower as well in water twice, though they will serve for planting in the garden.