

to them. After the expiration of two or three minutes they are taken from the bath, washed in clean water, and dried in sawdust. It is necessary that the operation be conducted with as little exposure to the air as possible. Handsome shades are only obtained in the case of brass and tombac—that is to say, copper and zinc alloys. The *Chemical Trades Journal* says the bath cannot be utilized for coloring bronze, copper-tin, argentine, and other metallic alloys.

#### A FATAL THUNDERBOLT AT BOURGES, FRANCE.

AMONG the atmospheric phenomena, storms and the electric manifestations that accompany them offer a very peculiar interest, and necessarily rouse the attention of the meteorologist to the highest degree. During stormy weather thunderbolts are often very frequent and play a much more important role than is commonly believed in the series of disasters and scourges of which mankind is so often the victim on the part of the natural forces.

Lightning produces extraordinary effects, which perplex physicists and which it would be impossible to explain.

We see it fusing metals without burning the organic materials with which they were in contact, displacing heavy objects and tearing fabrics, and that, too, with a character of extraordinary instantaneousness.

A terrible thunderbolt descended near Bourges on the 4th of last May, causing the death of a soldier, and produced under peculiar circumstances, on the subject of which we have made a complete inquiry. We have thought that our readers would read the results of it not without some interest.

On the 4th of May a detachment of eighteen men belonging to the Thirty-seventh Artillery was on its way to the proving grounds in the vicinity of Bourges in charge of Chief Pyrotechnist Beauvais. Suddenly overtaken by a heavy rain storm, the soldiers quickened their pace in order to reach a shelter. All at once there was a burst of thunder of fearful intensity, and all the men were thrown to the ground with the exception of a pyrotechnist who was walking in the rear. The first three ranks arose, but four men remained unconscious. These were lifted and carried to the hospital, where every attention was given them. Three of them were restored to life, but the fourth, Francis Bouveau, succumbed. There was a deep gash in his head, and his chest was all burned.

Fig. 1 gives a representation of the catastrophe, made from a photograph taken especially for *La Nature* and reproduced *en cartouche* in No. 1 of the figure. This photograph represents the spot where the bolt fell on the 4th of May. It is at the entrance of the proving ground. The building to the left is the riding school, and a little to the rear in the background are the barracks of the Thirty-seventh Artillery. The men, who posed shortly after the occurrence in the order in which they were marching, are the same ones that figured in the catastrophe. Those behind were particularly affected.

All the men, at the moment the thunderbolt descended, fell face forward. The chief pyrotechnist, Beauvais, who may be seen to the right, outside of the file, and behind, was quite seriously affected. He says that he felt a violent shock at the nape of the neck and in the leg, with a burning sensation. The others who were taken to the hospital gave a similar account. None of the pyrotechnists struck by the lightning saw the flash, but an officer who was in front and was facing them says that the bolt presented itself in the form of a triple flash.

Dr. Dodion, adjutant of the Thirty-seventh, had a photograph taken of the effects of the victims that were destroyed by the fluid, and this interesting picture we reproduce in Fig. 2.

Pyrotechnist Bouveau was struck in the head, and his cap was torn to pieces, the crown and band being held together only by a narrow strip. The hair of his head as well as that of his whole body was entirely burnt off. The discharge passed around his right ear, then over his shoulder, ripped open his sternum, reached his left hip obliquely, passed to his scrotum, followed the interior surface of his left leg, tore his drawers, tore away some of the posterior eyelets of his

gaiter in stripping off a piece of leather (which was not recovered), and then passed through his shoe to the heel. The latter was provided with a rim of iron, as may be seen from Fig. 2. This formed an excellent contact with the wet ground, but, as the fluid met with a resistance in the leather of the heel, it loosened it at the point, P. Upon examining the photograph with a magnifying glass, we clearly distinguish all these details, as well as the raggedness of the torn parts, resembling a succession of very irregular saw teeth.

A few storms have also occurred during the present month of June, and thunderbolts have struck here and there, and made numerous ravages. On the 14th of June, lightning struck two houses at Narbonne, and, on the same day, burned a dwelling at Betaille in the department of the Lot. At Couzon, in the same department, lightning killed a woman and seriously injured a little girl. On the same day, at Balaruc, near Cette, it struck twice and killed one of the inhab-

made of any leakage through them. If it were possible to make an experiment at or near the center of the earth, so as to be beyond the reach of gravitational force, an electrified body might be left for hours in a gas without any visible means of support, and observations then made to determine whether any loss of charge took place through surrounding gases. Under existing circumstances, the loss of charge which always does take place on electrified bodies cannot readily be traced beyond that through the suspension or support that holds them. Even in moist air the loss of charge has not yet been brought home to the aqueous vapor. Prof. Boys exhibited before the Physical Society of London, in April, 1889, a pair of electrified gold leaves, suspended in moist air by a short hook of quartz. The loss of charge appeared to be about 25 per cent. in five hours. A glass hook, under the same conditions, would have allowed the charge to disappear, it was said, within one minute.

If any perfectly insulating solid could be found,

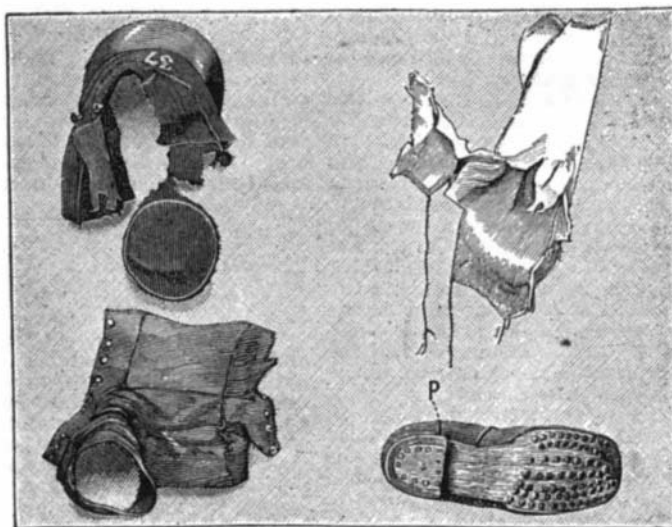


FIG. 2.—PORTIONS OF THE CLOTHING OF THE VICTIM STRUCK BY LIGHTNING—CAP, LOWER PART OF DRAWERS, GAITER, AND SHOE.

itants, Mrs. Errere, who happened to be in the middle of a field. Two days afterward, violent storms occurred in the departments of Gard and Aude, and lightning struck in several places. At Cuxac d'Aude, it killed a young man 28 years of age. Finally, it may be added that a dispatch from Chicago apprises us that, on the 16th of June, two men and a woman were killed by lightning in Lincoln Park. It struck the monument erected therein to the memory of General Grant. Some fifty persons, out for a walk, overtaken by a storm, had taken shelter in the galleries of the monument. When the bolt fell, every one was prostrated, and three persons did not rise again.

Such thunderbolts are, in most cases, scarcely mentioned in the local papers, and yet they are always accompanied with facts worthy of being recorded, and which, were they known, would supply elements of observations of great value to physicists and meteorologists.—*La Nature*.

#### INSULATION.\*

By THOMAS A. EDISON.

To telegraphy the insulation of the circuits is so vital a matter that at the risk of making history repeat itself, and of recounting an oft-told tale, a short paper on the subject may be tolerated.

As a class, gases are the best insulators; next liquids, and solids last of all. The insulation of gases is so good that no determination appears yet to have been

\* A paper read before the Railway Telegraph Superintendents' Association, Denver, Colo., June 15 and 16.

telegraphists would soon discover any surface leakage from their wires through the air, for the surface of a No. 8 B. & S. wire is 224 square feet or 20.8 square meters per mile.

The loss of charge which takes place convectively into the air over any sharp point in an electrified body is a phenomenon of a different nature. There the layer of atmosphere over the point is continually being torn by the magnitude of the forces brought locally to bear upon it, and the particles of moving air carry away the charge.

Some liquids have also a very high insulation, notably most mineral oils. Animal and vegetable oils are by no means so good, or, at least, there is greater difficulty in obtaining them in a highly insulating condition. Water, contrary to prevailing notions, is quite an insulator. In the purest distilled water resistances as high as seven megohms per cubic centimeter have been recorded; that is to say, a block one centimeter cube of water pressed between two opposite conducting plates as electrodes would offer a resistance of seven megohms; but the least trace of impurity brings the resistance down.

Ice at  $-12^{\circ}$  C. has been measured at 2,240 megohms per cubic centimeter. There are two conditions of surface upon which bare wires miles in length, laid on the ground, have been worked telegraphically—one over the dry desert sands of Africa, the other over dry ice in the far North. Sea water has a resistance of about 30 ohms per cubic centimeter at  $5^{\circ}$  C. It would appear probable that liquids cannot conduct without electrolytic decomposition. A microscope will show that one microampere decomposes the drop of water it traverses.

One of the most important and promising modern theories of chemistry is based upon the assumption, in accordance with a considerable array of facts, that solutions only conduct by the transfer of atoms or ions to the electrodes, each carrying an electric charge, and the conductivity of a liquid measures on this hypothesis the number of uncombined or dissociated ions permeating its mass. These free ions are the porters carrying the charge, and the conductivity of the liquid depends upon the number available and the speed with which they can migrate.

Liquids, too, have, as a class, the quality of elastic insulation to high tensions, which is an important feature to the electrical engineer. Air for the first few centimeters will break and allow a spark discharge to occur when the pressure reaches from 10,000 to 50,000 volts per centimeter (25,400 to 127,000 volts per inch), according to the shape and condition of the electrodes, but resin oil is said to stand about 75 times the pressure of air per centimeter without disrupting.

The following is a list of actually observed resistance in commercial samples of well-known insulating substances. The results are given in megohms per cubic centimeter at or near  $18^{\circ}$  C.:

Paraffine wax . . . . .	110,000,000	megohms.
Heavy paraffine oil . .	8,000,000	"
Olive oil . . . . .	1,000,000	"
Lard oil . . . . .	350,000	"
Creosote . . . . .	5.4	"
Stearic acid . . . . .	350,000,000	"
Sperm oil . . . . .	0.077	"
Benzine . . . . .	14,400,000	"
Balsam copal . . . . .	211,000	"
Benzole . . . . .	1,820	"
Oil of wood tar . . . .	1,670,000,000	"
Crude ozokerite . . . .	440,000,000	"

All transparent solids are insulators, but of course the opposite statement is not true that all opaque solids are good conductors. There is now good evidence for believing that the process by which light is propagated, the mechanism by which it is transmitted

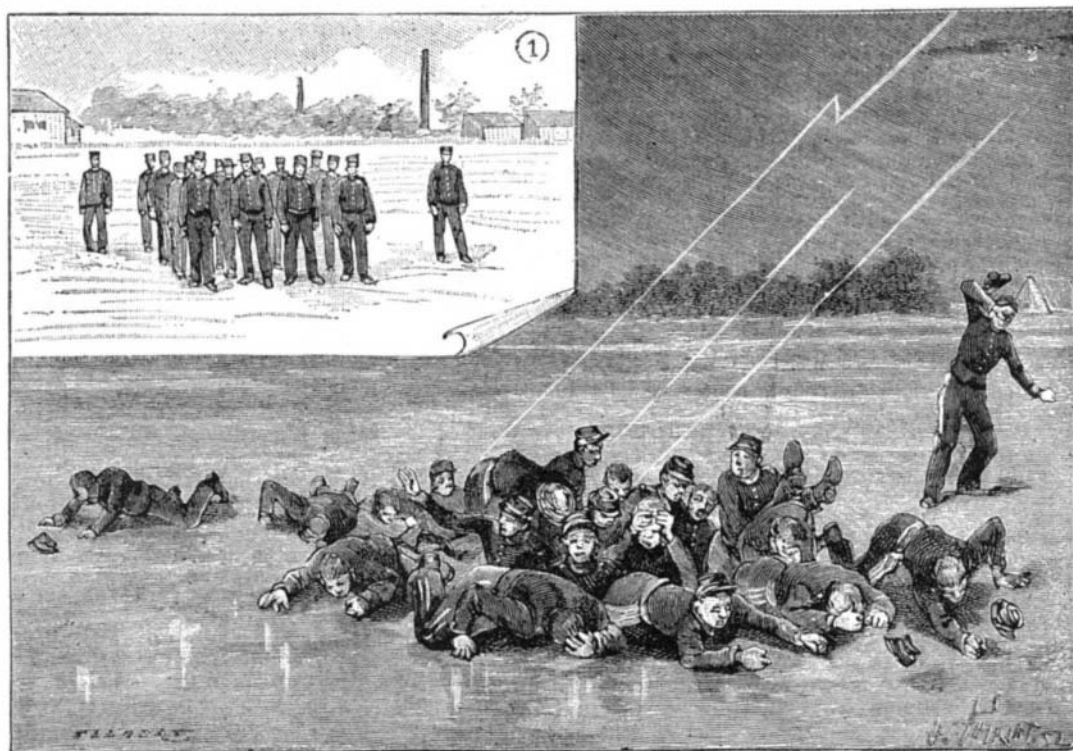


FIG. 1.—A FATAL STROKE OF LIGHTNING AT BOURGES.

1. Detachment of the 37th artillery before the catastrophe. 2. Men of the same detachment knocked down by the thunderbolt.

through space, is purely electromagnetic, and the magnetic vibrations passing through a conductor would generate electric currents and be absorbed in the substance as heat, that is to say, it would be opaque to the light, failing to transmit the energy.

The difficulty with solids is not so much to find insulators, for the great majority of solid substances freed from moisture are poor conductors, but to find an insulation of suitable mechanical qualities. Glass, porcelain, and mica seem to be almost the only practically available insulators that will support considerable stresses, and these for many structural purposes are far weaker than is desired. In American telegraphy glass is almost the universal insulator, but in Europe, particularly in the south and west, the atmosphere is so much more humid and glass so hygroscopic that no circuit of any length could be operated with glass insulators except in dry weather. Porcelain or vitrified stoneware insulators are used instead, and in quite a variety of forms.

Practically speaking, the insulation of a line is never that of the material forming the insulators, but always that of their surfaces and the films of dust and moisture that may have become incrustated thereon. The most perfect insulators are those which have underneath the hood a cup filled with oil, in such a manner that the current leaking from the wire to the ground has to pass over the oil, or else through the substance of the insulator itself. These insulators are certainly more expensive, and require to be refilled with oil at intervals, but they will defy weather and keep the insulation nearly as high in fog as in sunshine.

When a long, leaky wire is opened at the distant end, and tested for insulation, the insulation per mile always appears to be somewhat more than it is for any actual mile, since the more distant portions of the line are tested with a reduced pressure, owing to the leakage over the nearer portion. When the wire is grounded at the far end, and its conductor resistance measured, the leakage will on the other hand make the apparent resistance per mile too low. But if the conductor resistance is reduced in a given ratio, say as 100 to 95, the insulation will be overindicated in the exact inverse ratio of 95 to 100, provided that the insulation of the line is uniform. So that if a wire's conductor resistance at its temperature of observation is known to be 10 ohms per mile, but appears by leakage over the whole length to be 9 ohms, then if the insulation per mile apparently measures 400,000 ohms, it will be really 360,000, and each mile taken separately might be expected to measure 360,000. As is well known, telegraph lines work better up to a certain point if the insulation is rather low. A wire has to be emptied of its charge between the impulses of the key sufficiently far to keep the relays from sticking. If the insulation is perfect this quantity has to be cleared through the ends to the ground, but if the line leaks it can escape more readily at all points.

The longer the line, the more essential good insulation necessarily becomes. The insulators are perhaps nevermore carefully tested than those intended for the long circuits on the Asiatic plains. It was at one time customary to test each insulator before it went out by taste. The insulator was immersed nearly to the rim head downward in the water, and a battery of 100 cells was connected with one pole to the water and the other to the insulator stalk through a particular kind of key. The operator first rested his moistened finger on this key and then applied his tongue to it. If he tasted no current the insulator was passed out as satisfactory. The test was sensitive and expeditious, and saved the care and handling of a galvanometer.

The insulation of a wire is a definite term and stands for a definite property so long as it is not necessary to measure it very accurately. There is usually no difficulty in finding the insulation of any overhead wire within 5 per cent. at any one time, and two observers measuring the line from the same end with different instruments would generally agree in their results to that limit; but as higher degrees of accuracy are attempted (a condition that fortunately does not practically occur), the difficulty of obtaining concordant results may increase rapidly. A resistance coil of wire at a uniform temperature can have its resistance measured to within one-fiftieth of one per cent. if necessary, but a leakage resistance is essentially liable to variation. The atmospheric conditions may be altering, or there may be polarization, or inductive disturbances from neighboring wires, or a combination of conditions that may set close measurement at defiance. It is generally advisable to employ galvanometers for this purpose, that, even if sensitive, are slow of movement and dead beat. The only instances in which accurate measurements of insulation are possible and necessary are in connection with subterranean or sub-aqueous wires. Jute and paper, dry or saturated with compound, are rapidly coming into use for subterranean wires sheathed in lead, while for long cables under water, India rubber and guttapercha are invariably employed. With conductors highly insulated by these methods, the insulation can be measured much more closely, and is definite for a given temperature of the core, but even in this case the current that will flow from a battery into the wire freed at the distant end is not all leakage. A considerable portion may be stored up in the insulating substance, and be returned from the wire to ground after the battery has been removed. This "polarization" is particularly noticeable with guttapercha and India rubber covered wires, and their insulation may be apparently 50 per cent. greater after three minutes of charging than at the end of the first minute. In specifications it is usual to call for a certain insulation per mile at 75° C. and after a definite interval of charge.

The insulation obtained from a given thickness of covering depends on the diameter of the wire as well as on the quality of the cover, for a large wire supplies a larger leaking surface. Also if an insulating coating of a certain thickness produces an insulation of 100 megohms per mile, doubling that thickness will not double the insulation, because the leakage will take place with greater relative facility through the greater surface of the second coat. The exact increase of insulation will depend upon the diameters of first coating and wire.

When a wire is well and homogeneously insulated, its insulation resistance at a given duration of charge or period of electrification will appear to be the same with different battery powers or voltages applied, but

if, on the contrary, it contains any small faults or defects, it will generally show less insulation with increasing testing pressures. This often forms a criterion as to the reliable insulation of a long cable. The insulation in an ocean cable under the pressure of great depth, and near the temperature of melting ice that deep oceans approach, might be 15,000 megohms per nautical mile at the fifth minute. With a small incipient fault the insulation might still reach 3,000 megohms per mile and seem excellent, but it is probable that when tested with five cells and with fifty cells, the insulation resistance in the latter case would not appear so high. It would also probably be different with the zinc or copper pole to line.

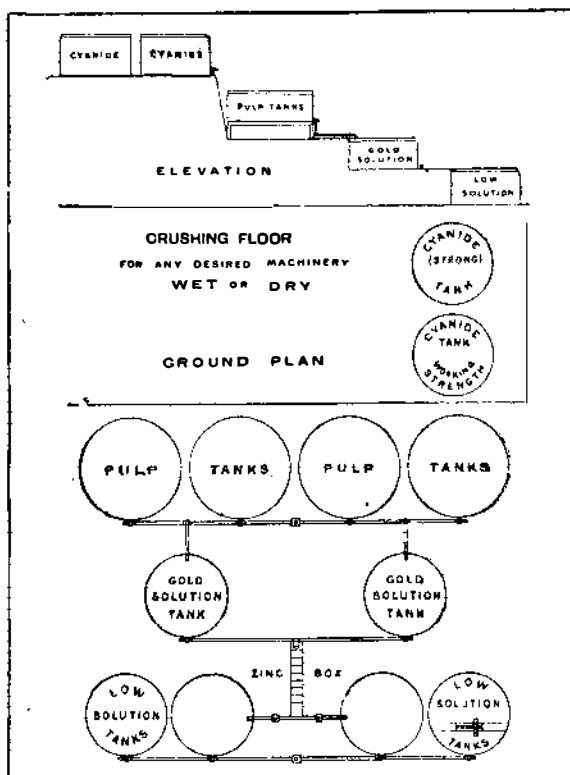
The only value that can attach to a high measured insulation is the assurance it conveys that no flaws exist in its covering or supports, and will therefore remain in good signaling order unless disturbed. In fact a very high insulation as we have seen actually tends to retard signaling. Mechanical security from the loss of insulation is the great desideratum rather than a very high degree of insulation itself.

[FROM THE MINING AND SCIENTIFIC PRESS.]

## THE CYANIDE PROCESS FOR WORKING GOLD AND SILVER ORES WITHOUT AMALGAMATION.

The MacArthur-Forrest process originated in England, and the English metallurgists have had longer experience in the promotion of the process in other fields of operation. The Gold and Silver Extraction Mining and Milling Co., of Denver, Colo., introduced the process in this country, and put up extensive works where practical working tests of ore are carried out.

The cyanide process is a system by which the ore, after being crushed by stamps or other appliances, is treated in tanks or vats with a solution of cyanide of potassium, by which the gold is dissolved. The solution carrying the gold obtained from the ore is then passed through boxes or filters containing zinc and the gold precipitated. The cyanide solution is then returned to a receptacle for repeated use.



CYANIDE PLANT IN SHASTA COUNTY, CAL.

This, in brief, is the process now attracting so much attention among mining men. The great value of the process lies in the fact that the sulphurets are treated without separation from the ore, at the same time, thus saving the usually subsequent operations of concentration, roasting, and chlorination. All that is required for a plant is the crushing appliances and suitable outfit of tanks, boxes, or tubs for the solution.

There are so many thousands of mines, the ores of which carry sulphurets which will not pay by the chlorination process, when all the other expenses are considered, that it did not take very long for the cyanide process to attract attention when once brought to public notice by practical tests on a good scale.

That cyanide of potassium would dissolve gold has long been very well known. In most standard chemistries, cyanide is mentioned for such a purpose, its properties are understood, and it is in daily use as a gold solvent in certain arts. But its practical applicability to metallurgical operations on a large scale has not been shown until very lately.

Whatever may be the merits of the controversy on the subject of patent rights in connection with this process or system, there is no doubt of one thing, which is that the MacArthur-Forrest patentees deserve the credit of first introducing and practically applying, on a large scale, the cyanide process for working ores.

The miners of this country, with sulphurets of low grade, have long been on the lookout for a method which would displace that of chlorination. Not but that chlorination returns a high percentage and is satisfactory from a metallurgical point of view. But it is too expensive for low-grade ores. This cyanide process can, under certain circumstances, displace it, and permit the working of ores of a lower grade than those adapted for chlorination.

The cyanide process is not a panacea, but works with certain classes of ores, and those classes of ores are the most abundant in this State and elsewhere. Where there are certain metals present it does not do well. But in most instances it appears to accomplish the object at a less cost than the processes previously in vogue.

The process has gone far beyond a laboratory experi-

ment, and in one case, at least, works capable of treating 75,000 tons a year are in operation, which last year yielded from tailings nearly 20,000 ounces of gold. And this at a mine which is one of the best equipped for treating ore in the world. Any process which can show such a result would be worthy of investigation by miners elsewhere. But not only that, for there are other works in operation in different parts of the country nearer at home, the managers of which all speak favorably of the system as worked by them. Again, well-known metallurgists who have investigated the process indorse it for certain classes of ores, and these classes, as stated, are those which we have most abundantly.

Mr. A. B. Paul, general manager of the Calumet mine, writes of the process as follows:

It being generally known that the Calumet Co. was the first to introduce the MacArthur-Forrest process into California, on any practical working scale, my time has been considerably taxed in answering letters from very many mining men, not only in California, but elsewhere, all inquiring as to the practicability of the process, etc.

It may be information to many to state that in South Africa thirteen mills are now operating the process with great success, and that mills are already in operation in Colorado, Utah, Montana, Dakota, and California. At the Needles, in San Bernardino County, a 100 ton mill is in course of erection. Being among the first in this country to accept its merits, I fancy, by this time, I know something about it, and hence presume to speak.

The MacArthur-Forrest process is the use of a weak solution of cyanide of potassium. The strength of cyanide should be, as testing your ore will show, the proper per cent. for extracting the highest per cent. of the precious metals, say from one-half of one per cent. to one and one-half, then treating your ore for a given length of time with this solution. Time for treatment according to the character of your ore and metals, how much base and what kind. To get at this correctly, a few tests are necessary, but it is easily worked out. And here it is proper to state that time is more the factor of per cent. than a high per cent. of cyanide. You never want to use a high per cent., as this speedily attacks the base metals, while a lower per cent. attacks the gold and not the base, hence the lowest per cent. you can use to get the gold the better. We have many tests on this point, and all clearly establish this fact. I have failed in per cent. of extraction on some ore, and then by a few experiments gained high per cents. from same.

It is a process of study, but once you get time and per cent. determined, then there is no failure in your extraction from that especial ore, no matter to what extent you may go. So true has this been with our working, on a small and large scale, that taking any ore from any mine, I would not hesitate to build a 50 ton mill on a simple test of 50 pounds, if the per cent. of extraction was satisfactory.

There are two modes of having action from the cyanide on the ore—one is by agitation and the other is by time and percolation.

Agitation of ore in the solution more speedily dissolves the gold, at the same time it triturates the material, so as to make slums, and thus what is gained by agitation you lose when filtering the solution. Revolving barrels, or settlers, as used at times in silver mills, make good agitators. The percolating plan is the use of large tanks, whereby the ore rests in the solution, and in time is percolated off into reservoirs. Agitators take attention and power; percolation, less attention and no power, besides, agitated material must be discharged into filtering tanks and allowed time to draw off.

At Calumet, we first used agitators as per instructions, but after trying percolating gave it the preference, and are now pushing for enlarged capacity on this plan. This mode of working is being generally adopted in South Africa, presumably by Mr. MacArthur's instructions. From my S. A. correspondent I learn that they are now constructing all mills for this way of operating the process. The new mill of the Shasta Co. is also changing to the percolating plan. The Mercer Mill, of Utah, was the first in this country to start on the percolating plan, on a scale of 30 tons per day, and made a big success from the very start. All percolated solution, whether from agitators or tanks, contains cyanide, gold and silver in solution; consequently, all vessels receiving the same should be perfectly tight, as you presumably are handling valuable liquid, and for this reason iron tanks are to be preferred to wooden.

This percolated solution is now transferred to the precipitating box, of size according to the valuation of ore and quantity to be treated. The box used at Calumet is 14 feet long, with 14 apartments. These boxes have wire screens on the bottom, and are filled with zinc shavings four inches deep. The boxes are so constructed that the solution is made to pass through the body of shavings, which precipitates the gold and silver in a dark, blackish powder. By this part of the process a given part of the zinc is destroyed, but this is of no particular moment, as the loss is but trifling in dollars and cents. The Calumet Co. are soon going to change these wooden zinc boxes for white iron-stone chinaware, as made by the Toronto Pottery Works, Toronto, Ohio. Wood absorbs too much gold and cyanide.

The process is very simple and easily worked, when you have your plant right and start right on the per cent. of cyanide and time for your especial ore. It wants, however, to be handled intelligently, and it requires something more than mechanical skill to operate it properly. It is a process where brains and knowledge do not come in competition with "influence" or muscle. As to reducing ore, it is as yet an unsettled question whether it is best to crush wet or dry, all points being considered. The majority of the mills are crushing their ore dry. The Calumet Co. has started out a new lay, which I think will be the winning one; to wit, crushing by stamps and running the cyanide solution through the battery instead of water. In other words, crush your quartz in the solution, thus you combine agitation, percolation, and expedition.

This, though a new deal, suits us, and thus far no disadvantages present themselves that override the advantages gained. This plan has been in operation over four months, with no discouraging features, while