SQUEEZING THE WATER FROM THE SLIP,

and to this end the paste is pumped from the bins and into a peculiar press which is represented in Fig. 4. This may be compared to a series of heavy wooden trays set up on end and held together by strong iron bands. Between each pair of trays is a cloth bag, and with each bag a supply pipe communicates. A powerful force pump drives the slip into the bags under a heavy pressure, and an ingenious valve, which may be weighted as required, regulates the backward tending force, and by lifting at the proper time prevents the bursting of the bags. The result is that a large quantity of water is expelled, and the material emerges a heavy dough. This is worked and kept for some time before using as ageing is said to improve it. The Chinese, by the way, have a tradition that the material for their old porcelain was stored away for a hundred years before use. The French missionaries, translating the words "for a hundred years" into their own language, "*pour cent années*," afterwards corrupted the latter phrase into the word "porcelain."

Passing from the press room to another apartment, we were shown an immense heap of smashed crockery. All this, we were told, is utilized, and in fact made over again. The fragments are ground to a coarse powder under two huge revolving burr stones, each weighing some two tuns. This powder is again ground in an ordinary mill, and in its fine state, is mixed with water to go through the regular process. The operation of

MAKING SEGGARS

next claimed our attention. A "seggar" (Fig. 6) is a tray of common baked Jersey red mud. It has no cover, and its depth varies according to the piece of ware it is to contain, during the baking of the same in the kiln. The clay is mixed to a thick plastic mass in a pug mill and subsequently pressed in molds to any desired form. Baking follows, and the finished seggar emerges looking like a piece of coarse red earthenware.

Leaving the lower stories, we ascended through large brilliantly lighted rooms and past tier on tier of crockery in all stages of manufacture. Scrupulous cleanliness pervaded everywhere, and, save the slight whizzing sound of machinery no noise was heard. The workmen—and, very singular to add, girls too—labored silently, obeying the placards commanding stillness, which, appearing on the walls, reminded us of the stern warning in the old German workshop a century ago.

MOLDING THE WARE.

"The potter's lathe," said our guide, "is obsolete here. We abolished that antique apparatus long since;" and leading us to a long table, he showed us a row of men, each one stationed before a horizontal revolving disk (Fig. 1). This, by a mere pressure of the knee on a lever, which threw friction gearing into operation, could be set spinning around. Beside each man was what appeared to be a number of short tubes (Fig. 5), irregularly shaped and made of the clay dough. The disk or rotating head being at rest, the workman placed thereon a mold, the interior of which was of the exact form of the exterior of a bowl. Into this he inserted one of his dough tubes, and set the disk in motion, pressing the plastic mass with his fingers, at the same time, out against the side of the cavity. Then he brought down into the latter a counterpoised metal blade, as shown in Fig. 1, which was so adjusted and shaped as to remove exactly enough material to leave the bowl of the requisite thickness, and at the same time to form its interior. The article, we were told, is subsequently put aside to dry, and, thus completed, is removed from the mold and is ready for baking.

There are very many objects which do not require the use of the revolving head, and are simply pressed into molds, some by machinery, others by hand alone. The machine used for door knobs, for example, is simply a screw press which forces the clay in the condition of moist powder into a properly shaped die. The knob, however, on emerging, is not everywhere round, and is therefore placed on a horizontal revolving spindle and turned. These operations on the knob are shown in Fig. 2. China heads for nails, casters, speaking tube mouths, and an immense variety of other porcelain goods for the hardware trade are made in similar manner.

(*To be concluded in our next.*)

A New White Pigment.

A Mr. Orr, of Glasgow, has recently taken out a patent for a white pigment, which he has endeavored to obtain by forming a compound of zinc and barium. For this purpose he takes crude barium sulphide, and lixiviates it. The supernatant liquid is then drawn off, and divided into two or more equal portions. To one, an equivalent of zinc chloride is added, and to this again zinc sulphate is added, and afterwards another portion of barium sulphide, the result being an intimate mixture of 1 equivalent barium sulphate and 2 of zinc sulphide. The precipitates, composed of zinc and barium, are collected and pressed to expedite drying, after which they are placed in retorts and brought to a red heat. While still hot, they are drawn into water, preferably cold, which, it seems, has the effect of increasing their density and imparting body to the paint to be made from them. They are subsequently washed and ground in water to a fine powder, or they may be first dried and then ground. The inventor states that, by increasing the number of additions of zinc sulphate, the quality may be varied. The pigment thus prepared is to be used in the ordinary way; and if it does but possess the covering power of white lead, and can be sold as cheaply, it will be undoubtedly a useful product, for zinc white retains its color better than any other white pigment in ordinary use.

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Contents.

(Illustrated articles are marked with an asterisk.)

CROSSING THE BOUNDARY OF THE EXPERIMENTAL EVIDENCE.

It is amusing to see how zealously the non-scientific world insists on the restriction of Science to verified fact, especially when we remember that the sole basis on which its opposition to Science rests is a stupendous hypothesis, not only unverified, but confessedly beyond the reach of human verification, the hypothesis of Divine revelation—something supernatural, superhuman, miraculous.

Professor Tyndall speaks of crossing the boundary of the experimental evidence in pursuit of an explanation of visible phenomena, and straightway a great cry is raised that he is no true friend of Science, or, at best, that he has been betrayed into a false and "unscientific" step in the heat of oratory and by the sympathies of his audience. The speaker disclaims any such apology, assuring his volunteer defenders that he said nothing in heat or haste; that he crossed the boundary deliberately, and said just what he meant to say.

The reply all but breaks the heart of these would-be guardians of the integrity of Science. The admission of imprudence and haste would have simply damaged Professor Tyndall's reputation as a scientist. The avowal of deliberate intention, they fear, will utterly destroy the claims of Science in popular estimation! If years of scientific training and investigation, they say, can produce no better result than to make a professor of Science carry his scientific teachings straight to conclusions in the regions of the absolutely unknowable, what becomes of the boasted virtues of the scientific habit and its supposed effects upon the human judgment and intelligence?

A sufficient reply to this objection would be that one of the chief virtues of a scientific training is, not to keep the mind's action wholly within the bounds of experimental evidence, for that would block all progress, but to enable it to cross that boundary when occasion demands, properly restrained by a knowledge of what is known and a conviction that what is unknown is certain—so far as experience goes—to be in harmony with the known. For this reason the hypotheses of a true scientist are to those of the unscientific or anti-scientific as the speculations of a wise man are to those of a theologian. In the one case the hypothesis, unverifiable though it be, has a basis in reason and reality; in the other it is very apt to fly in the face of fact, and set faith above reason. He would be a curious disciple of Science who should say: "I cannot understand, therefore I believe!"

Fortunately the anti-scientist cannot be unreasonable in all things. In the common affairs of life his mind works like other men's. It is only when his religious prejudices are involved that he kicks at the scientific method. Thus if he should find on his doorstep some morning an infant, with no discoverable clue to its origin, he would be as ready as Darwin himself to pronounce it a human child, born of human parents in the ordinary way, and placed there by human hands, though, under the circumstances, not one of these assumptions would be other than an unverifiable hypothesis.

In no case could we think of a true scientist as deciding otherwise. It is quite possible, however, to suppose that an ecclesiastic might hold a different opinion. "What has happened may happen." If one child, as he devoutly believes, came into the world without a human father, it is possible that this might have had a similar origin. Still more, if his church decreed it, he could not deny that the child was, like the progenitors of the human race, according to his theory, a direct product of creative power, with no parent but the Almighty. Under the supposed circumstances, this would be no less possible of verification than the scientist's hypothesis of human parentage; the two differ simply in the fact that the one has all the verifiable facts we have to support it, while the other has all known facts against it. The great virtue of Science training is to keep men from such unsupported vagaries, not to chain them down to demonstrable fact.

In his late review of Haeckel's "Anthropoginie," Professor Huxley touches this point in defense of the hypothesis of development as applied to living creatures, man included, and shows how few scientific problems, even those which have been and are being most successfully solved, have been or can be approached in any other way than by speculations passing the bounds of positively verifiable fact. "Our views respecting the nature of the planets, of the sun, and stars are speculations which are not and cannot be directly verified; that great instrument of research, the atomic hypothesis, is a speculation which cannot be directly verified; the statement that an extinct animal, of which we know only the skeleton, and never can know any more, had a heart and lungs, and gave birth to young which were developed in such and such a fashion, may be one which admits of no reasonable doubt, but it is an unverifiable hypothesis. I may be as sure as I can be of anything that I had a thought yesterday morning which I took care neither to utter nor to write down, but my conviction is an unverifiable hypothesis. So that unverified and even unverifiable hypothesis may be great aids to the progress of knowledge—may have a right to be believed with a high degree of assurance. And therefore, if it is to be admitted that the evolution hypothesis is, in a great measure, beyond the reach of verification, it by no means follows that it is not true, still less that it is not of the utmost value and importance."

The like is true of other current hypotheses in Science, They may or may not be ultimately demonstrated; many of them may be, and in all probability will be, supplanted in time by new hypotheses having a wider basis in verified fact; nevertheless, they are to be accepted provisionally, as giving the best expression and interpretation of phenomena as we know them, and used as "instruments of research" until something better is found. If the world of thought had waited for absolute truth before going ahead, it would never have got even so far as the crude hypothesis of the books of Genesis. To wait is to go to waste. As Professor Huxley has well said: "Active error may advance knowledge in its efforts to establish itself; and nothing is more remarkable than the number of great things, from the discovery of America to that of the antiquity of man, which have been brought about by the attempt to establish erroneous views. But sitting still and being afraid to stir, for fear of making mistakes, is certain to end in ruin, in Science as in practical life."

FOREIGN EXHIBITORS AT THE CENTENNIAL.

So far from there being a prospective lack of foreign exhibitors at the Centennial, it now appears that so many desire to avail themselves of the advantages offered that it will be impossible to accommodate all in the spaces allotted. The commissioners of several nations have already made requisition for greater areas than have been set aside for their respective countries, and applications, they state, are being constantly received. The German Empire, it is said, will make by far the finest display, both in kind and extent; Austria will follow closely, and her products, comprising the exquisite articles of *vertu* from Vienna, Moravian cloths, Bohemian glass, and Styrian and Carinthian iron, will together constitute an exhibit of great industrial interest. The marked eagerness with which each nation desires to secure prominent representation is noticeable on the part of the small countries, some of which have been assigned in couples to certain spaces. Thus, Holland objects to being assigned floor space conjointly with Denmark, and asserts through her commissioner that she can fill every inch of the space allowed, alone. Hungary will probably insist on a separate department, and refuse to be overshadowed by the Austrian display. Norway declines to be joined with Sweden, and both Scandinavian countries assure very interesting exhibits of iron, furs, and matches. Denmark offers a good display of Copenhagen manufactures, besides collections illustrating the manners, customs, and industries of Greenland and Iceland.

France will also crowd her space with silks, velvets, lace, jewelry, and the thousand productions in which her artisans are unrivaled. It is said that the French display will be the best organized and regulated in the Exposition. Italy has not yet appointed a commission, but it is understood that she will shortly do so. Her exhibit will be principally mosaics, cameos, corals, statuary, Venetian glass, Genoese silk, and other specimens of industrial art. Fine displays from Greece and Portugal are expected, and Switzerland has promised a complete exhibit of her watches, mathematical instruments, lace, and wood carvings.

Russia is holding off, and as yet her government has made no overtures toward participation. It is rumored that this position will be maintained, and that the country will be represented solely by voluntary contributions sent by individuals.

England and all her colonies are manifesting a largely increased interest in the enterprise, and leading manufacturers are well advanced in extended preparations. The Canadian government has appropriated $250,000 to pay expenses of the Dominion commission, and British India, Australia, New Zealand, and the Cape of Good Hope have promised full displays. All of the South American countries have applied for space, and the commissions of several are already organized. Brazil and Chili will take the lead in point of extent of exhibits, but from all contributions are expected, far larger than those sent by them to previous World's Fairs. Mexico, the Central American States, and Hawaii are likewise preparing. In the East, from Egypt and Japan magnificent displays have been promised; Turkey, Persia, Siam, and China are as yet unheard from.

Altogether, the prospects are that the Centennial will outshine all previous expositions in the completeness of the exhibits which each country will furnish. This is well evidenced by the ready response which all have made to the invitations sent them to participate, and the celerity with which they appointed commissions and set about the necessary preparations. The combined foreign exhibits will occupy 340,432 square feet out of the 485,000 feet available. The United States has 123,160 square feet, and there is an area of 21,408 square feet reserved for contingencies.

AMERICAN PORCELAIN.

We commence on the front page of this issue an elaborate illustrated article detailing all the various processes of the manufacture of porcelain as practised in this country. There is no question but that this industry has become a very important American manufacturing interest, and one which, before many years, will enter into sharp rivalry with the work of European producers. It holds the unfortunate position now, however, of being practically unrecognized. That is to say, the popular prejudice is so strong in favor of foreign goods that American wares have to be and are largely sold as French or English products in order to induce people to buy them. This is alike destitute of sense or justice. The fact remains that porcelain from our own factories is bought and liked, and therefore no valid reason exists why it should not be put on the market for what it is. We are gratified to notice that a meeting of the pottery trade, held in Philadelphia a month or two ago, recognized this very plainly, and the convention voted, among other resolutions, to the effect "that we have sufficient talent in this country to originate new designs, more elegant and suitable to the wants of the American people, and that such procedure on our part will the sooner enable us to give our products the stamp of a national product and a distinct character."

We also wish to direct especial attention to the fact that we import kaolin from England, and that none, as we are informed, has as yet been discovered in this country suitable for the finer porcelain. There are beds, we believe, in Brandon, Vt., but the clay is put to base uses in adulterating paper, paint, and other products. We have no record of its being tested for porcelain. There is a tariff of $5 a tun on the imported material, from which our citizens reap no benefits, and which offers a further incentive to discover the kaolin. It seems to us that, unless some effort in this direction shortly appears, it would be good policy to encourage the industry by remitting the tariff altogether, and entering the kaolin free as a raw material.

In our inspection of the machinery, at the establishment described, we were impressed with its simplicity and efficiency everywhere except in one particular. That was in the means used for making the small articles, such as nail heads, castors, and other hardware trimmings, of which the factory produces an enormous quantity. The reader will find the apparatus illustrated in Fig. on page and it will be perceived to consist merely of a screw press, which forces the damp powder into a die, the latter being removed by hand and filled for each article. There is very clearly work for an inventor here; and it seems to us that a little ingenuity could speedily contrive an apparatus which would fill the die, hold it in place, and run down the screw, automatically. Now it requires one workman to each machine. With suitable apparatus, one man ought to control half a dozen if not more, and produce the articles far more quickly as well as of more uniform shape.

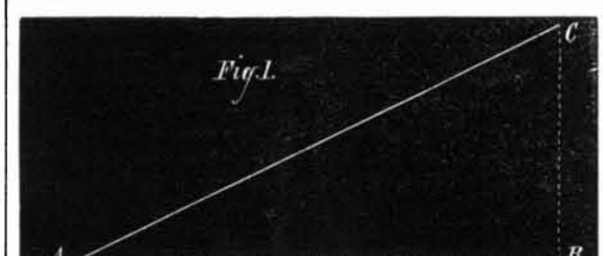
We notice that the Potters' Association offer three prizes of one hundred, fifty, and twenty-five dollars respectively, for the handsomest design of pottery ware to be exhibited at the Centennial. If we may judge from the efforts being made at the factory visited by us, our American potters are thoroughly imbued with a spirit of emulation, not of course to gain the small sums above mentioned, but to produce a display at the Centennial well calculated to arouse the world to a sense of the progress we have made in the ceramic art. We were shown some remarkably beautiful vessels, of unique shape, the exteriors of which were molded with national emblems and bas reliefs of events in American history, which when complete will, we think, compare favorably with some of the finest vases and other evidences of skill produced by European factories.

A VARIABLE SCREW.

A correspondent asks how to lay out an increased twist on a wooden cylinder. We do not know that this information is published in a form that is generally accessible to our readers; and as the construction is also applicable to the guide plates for screw propulsion, we here present it in simple form.

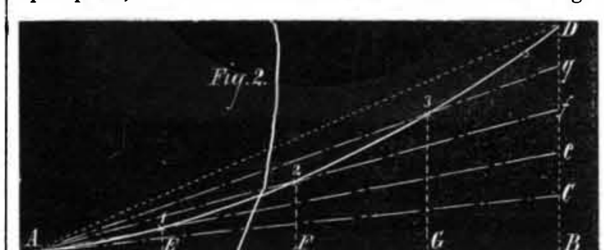
The line forming the intersection of any two faces of a screw thread is called a helix, and can be described, on a cylinder having the same diameter as the thread, by the motion of a point which goes around the cylinder, and, at the same time, advances in the direction parallel to the axis. If all the helices of the intersections of the faces of the screw are determined, we have the boundaries of the thread, and it is the method of making the determination that our correspondent desires to have explained. The pitch of a helix is the distance that the generating point moves along the cylinder in passing once around it. If this axial motion is the same for all parts of the revolution, the helix has a constant pitch; but if the motion varies at different parts of the revolution, the helix is said to have a variable pitch—increasing if the axial motion of the point is greater for each successive equal interval of the revolution, and decreasing if the axial motion continually grows smaller. The simplest manner of drawing either of these helices is by the aid of a graphical construction; and the methods employed in the three cases are represented in the accompanying sketches:

1. Helix with constant pitch, Fig. 1: Provide a cylinder of the same diameter as the required helix. Draw a horizontal line, A B, equal to the circumference of the cylinder; and at the point, B, erect a perpendicular, B C, equal to the pitch; connect the points, A and C, by a straight line; cut out the figure so constructed, and wrap it around the cylinder, with B C parallel to the axis. Then A C will be the required he-



lix, which can be traced on the cylinder by using the edge, A C, of the paper as a guide. If the helix is to be constructed for only a portion of a revolution, make A C equal to that fraction of the circumference, and B C equal to that fraction of the pitch. Similarly, if the helix is to make several revolutions, A B must be the length of the circumference of the cylinder multiplied by that number of revolutions, and B C, the pitch multiplied by the same number.

2. Helix with increasing pitch, Fig. 2: Provide a cylinder, as before, and make A B equal to the circumference. Erect a perpendicular at B, and make B C equal to the initial pitch of the helix, and B D equal to the sum of the initial and final pitch divided by two. Divide C D into any number of equal parts, and A B into the same number. Draw straight



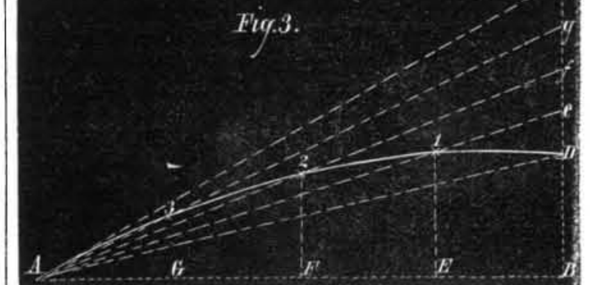
lines to A, from the points of division of C D, and perpendiculars to A B from the points of division of that line; mark the points in which these perpendiculars cut the correspond ing lines drawn from the points of division of C D, and draw a curve, A 1 2 3 D, through these points and A and D, cut out the figure, and wrap it around the cylinder as before, when the required helix can be traced with A 1 2 3 D as a guide. If the helix make more or less than one revolution, A B must be made equal to the length of the same part of the circumference of the cylinder, B C to the same part of the initial pitch, and B D to the same part of the half sum of the initial and final pitch. In the figure, only a few points of the guide curve are constructed, as it is merely given for the sake of illustration; but in any practical case, it is well to construct as many points as convenient. Some examples are added to still further illustrate the construction.

Example 1.—To construct the guide for one revolution of a helix, 4 inches in diameter, and with pitch increasing from 4 to 12 inches: A B is 12·566 inches, B C is 4 inches, and B D, $(4+12)\div 2$, or 8 inches.

Example 2.—Guide for a helix making six revolutions, having a diameter of half an inch, starting with a pitch of 3 and ending with a pitch of 15 inches. In this case, A B is $6\times 1·5708$, or 9·425 inches, B C is 6×3, or 18 inches, and B C is $6\times(15+3)\div 2$, or 54 inches.

Example 3.—Guide for the circumferential helix of one blade of a screw propeller, the diameter of the screw being 18 feet, one eighth of the pitch being used, and the pitch expanding from 24 feet at the forward edge of the blade to 32 feet at the after edge. A B is $\frac{1}{8}$ of 56·549, or 7·069 feet. B C is $\frac{1}{8}$ of 24, or 3 feet. B D is $\frac{1}{8}$ of $(24+32)\div 2$, or $3\frac{1}{2}$ feet.

3. Helix with decreasing pitch, Fig. 3: The guide is constructed in a similar manner to that already described. A B is the circumference of the cylinder on which the helix is to be drawn; B C, perpendicular to A B, is the initial pitch, and



B D is equal to half the sum of the initial and final pitch. Divide C D and A B, each into the same number of equal parts, and mark the points of intersection of lines drawn from the divisions of C D, to A, with the perpendiculars erected at the corresponding points of A B. A curve, D 1 2 3 A, drawn through these points and D and A, will be the guide, by means of which the required helix can be traced upon the given cylinder.

THE METALLURGY OF IRIDIUM.

When it was decided to make the standard meter, of which a description appeared in our issue of September 10, of an alloy of platinum and iridium, the preparation of the latter metal presented the greatest difficulty. Platinum resists the action of oxygen, and is only acted upon by aqua regia; for its fusion it requires the highest heat attainable by the oxyhydrogen blowpipe. The alloy of osmium and iridium, in which form the latter is only found in Nature, is unaffected either by aqua regia or the blowpipe. Small grains of iridosmine are found mixed with the sand in which platinum ore is found. This mixture of platinum, sand, and iridosmine was first treated with aqua regia, which, of course, dissolved the platinum, leaving the iridosmine in small grains and scales, mixed with sixty to seventy-five per cent of sand. By fusing this mixture with litharge, silica and a little charcoal, the same unites with the litharge and silica to form a glass; the iridosmine, being heavier, falls into the reduced lead below. It is isolated in metallic granules by dissolving the lead in nitric acid; next the iridium must be separated from the osmium.

Iridosmine can only be attacked and rendered soluble by treating it with alkalies combined with powerful oxidizing agents. For this purpose, it must be reduced to a fine powder, which cannot, however, be accomplished by pulverization in a mortar, for the iridosmine is very tough and hard. The object was accomplished by fusion with zinc, with which it forms an alloy. On distilling off the zinc, it is left in the state of a very fine powder. This powder is heated with nitrate of baryta as a flux, whereby it is converted into oxide of iridium and osmate of barium. The resulting mass is soluble in nitric acid; and when the solution is distilled the osmic acid, which is volatile at 212° Fah., is obtained in large, white crystals. This operation requires special caution, as the osmic acid is very poisonous, the most so of any known substance. It, therefore, has to be kept in tubes hermetically sealed.

The red liquid, which remains after distilling off the osmic acid, contains nitrate of baryta and oxide of iridium. The latter is precipitated by adding baryta. The precipitated oxide of iridium is dissolved in aqua regia and precipitated by the addition of sal ammoniac, in the form of a double chloride of iridium and ammonia, $NH_4Cl + IrCl_2$. When ignited, this yields the crude iridium sponge, which also contains some platinum, ruthenium, and a little rhodium. This is refined by fusion with saltpeter, which oxidizes the ruthenium and other metals. The resulting mass is treated with water, which dissolves the ruthenate of potash with a yellow color. The residue is fused with lead, which separates the metals. On cooling, pure iridium crystallizes from the lead. The lead is dissolved by nitric acid, and the platinum by aqua regia, which does not attack the iridium.

The invention of a method of working up iridosmine, although somewhat difficult and dangerous, so as to obtain the iridium in a metallic state for the preparation of very refractory alloys, will probably render valuable a hitherto waste product in the working of platinum ores.

The dangerous character of its companion, osmium, of which it is said that twenty pounds would kill all the inhabitants of the world, will prevent its finding a use in the arts.

New Screw Propeller Experiments.

We have alluded to the experiments of the veteran screw propeller inventor, Mr. Griffiths, who has shown that in some cases there is a loss of 60 per cent of engine power in the use of screws. He now proposes, as an improvement, the use of small screws, one at the bow and the other at the stem. The British Admiralty have placed the Bruiser steamer at Mr. Griffith's disposal for trial of the new plans, and the results, which may soon be expected, will be studied with interest.

AT the New Albany (Ind.) Plate Glass Works, the other day, several men were standing on an elevator, steadying a very heavy load of plate glass, worth some $2,500, when the cog wheel which propelled the windlass broke suddenly, just as the elevator reached the topmost floor, and the men and their charge were precipitated together a distance of thirty feet. The glass was broken in fragments, which almost buried the men. Three of the latter were seriously wounded.