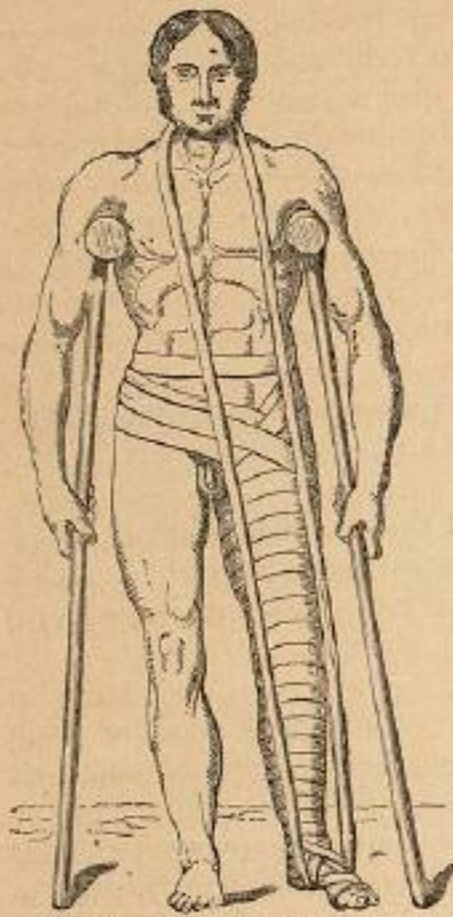


nences and irregularities of the limb are filled up or covered with cotton batting, charpie, down, etc.; strips of pasteboard, or of binders' board moistened and covered also with starch, are now laid alongside the limb,

FIG. 11.



Starch bandages, applied for a broken thigh.

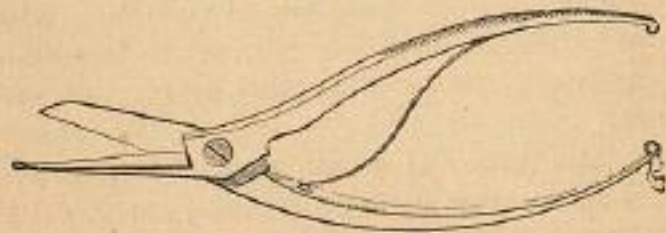
over which again are turned in succession one, two, or three layers of the starched roller; the number of rollers and the thickness of the pasteboard being proportioned to the size of the limb or to the required strength of the splint. The whole is completed by starching the outside of the last bandage.

This dressing will generally become dry within from thirty to forty hours; which process may be expedited by exposing its sides as much as possible to the air, or by the application of artificial heat with bags of dry sand, or with hot bricks. As a temporary support until the drying is completed, some surgeons lay upon each side of the limb additional splints, securing them in place with tapes.

As soon as the bandages are dry, they are to be cut along the front to a sufficient extent to permit of an examination of the limb, and then closed with an additional roller. For the purpose of opening the bandages, both at this period and subsequently, Scutin uses a pair of strong scissors or pliers, such as are represented in Fig. 12.

On the third or fourth day, or as soon as the subsidence of the swelling may render it necessary, the bandages should be cut open through their whole extent, the edges pared off and brought together again snugly with an additional roller.

FIG. 12.



Scutin's pliers.

In 1837, Velpeau substituted dextrine ("British gum"); a kind of glue or jelly obtained by the continued action of diluted sulphuric acid upon starch at the boiling-point. It is prepared for use by dissolving it in alcohol or tincture of camphor, or camphorated brandy, until it has acquired about the consistence of honey; at this point hot water should be

added, reducing its consistence to that of thin treacle, when, after one or two minutes' shaking, it is ready for application. According to F. d'Arcet, the proportions most favorable to the drying and solidifying of the apparatus are, one hundred parts of dextrine, sixty of camphorated brandy, and fifty of water. Malgaigne, to whom I am indebted for this observation of d'Arcet, says, also, in a note, "As regards dextrine, an important point was recently brought practically under my notice, viz., that, as sold in the shops, it is often unfit for making an agglutinative mixture; it forms lumps with alcohol, as starch does with cold water, without cohering; and twice in succession I have been obliged to change the supply at the Hôpital Saint Antoine. The dextrine thus deteriorated is whiter and less saccharine; it crepitates more in the fingers; and on pouring a few drops of tincture of iodine into the solution, there is produced a violet tint, indicating the presence of fecula; while true dextrine, treated with iodine, gives a vinous red, or the color of onion-peel." The addition of one part of common glue to six of dextrine, renders the splint more tough.

Velpeau soaked his bandages with the dextrine before applying them, but, like Scutin, he applied his first roller dry. He used but one bandage, which he carried first from below upwards, and then from above downwards; and he rarely thought it necessary to employ the pasteboard as a collateral support.

Tripolith was first introduced by Skenk as a substitute for plaster in the preparation of bandages. It is a gray powder, composed of lime, silex, and oxide of iron. Lately Langenbeck and other German surgeons, and some of the French surgeons, including M. Poincot, have spoken of it quite enthusiastically. It hardens much more quickly than plaster, and is much lighter, in both of which qualities it resembles dextrine.¹ But Dr. N. S. Nelson, in his inaugural thesis at Harvard, declares that he has experimented with it, and that it hardens too quickly; that it is not, as claimed by Langenbeck, impervious to water; that it is expensive, and as a splint "untrustworthy."²

A mixture composed of equal parts of precipitated chalk and gum-arabic, reduced to a proper consistence by boiling water, applied to rollers while they are being applied to the limb, forms a firm and light splint. It has the advantage also of hardening quickly.

Startin and Tait, of London, recommend paraffine, which, being thoroughly melted, is cooled a little, to render it more viscid, and then rubbed into the meshes of the bandage, during the process of application with a paint-brush.

Morgan, of the Middlesex Hospital, uses the best French glue, dissolved in water, with a little alcohol; while Levis, of Philadelphia, has recommended glue mixed with a small amount of oxide of zinc, the latter being added to hasten the process of hardening.

Silicate of soda, of potassa, or of magnesia, have also been employed in the same manner. Of these the silicate of soda is the least expensive and equally firm, but does not harden as quickly as the silicate of

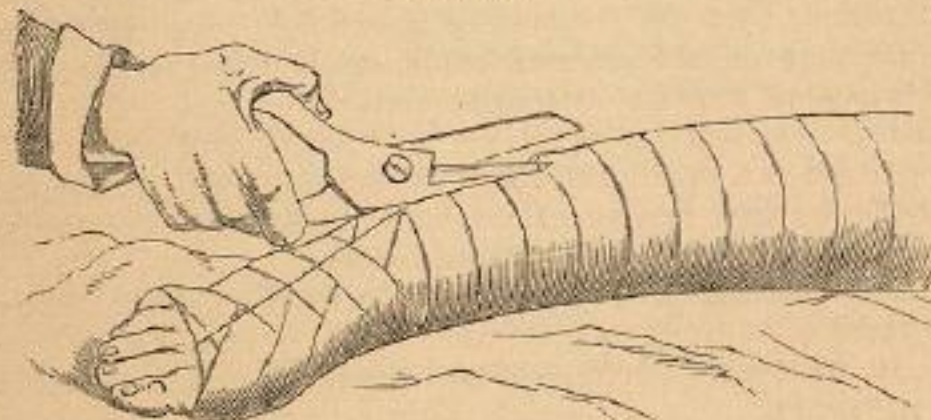
¹ Berliner Klinische Wochenschrift, 1880.

² Nelson, *Annals of Anatomy and Surgery*, April, 1882.

potash. A saturated solution is prepared, and applied with a brush. It forms a light, firm, and neat splint. Wheat-flour paste, if properly made, dries about as quickly as the starch, and is equally firm.

Whatever material is used—whether starch, flour paste, dextrine, paraffine, tripolith, solutions of the silicates, glue, gum shellac, or plaster of Paris—in the construction of what is now usually termed the “immovable apparatus,” or, as Seutin has more lately called it, the “movable immovable apparatus” (“movo-amobile”), in reference to his practice of opening it at an early period, it is still the same apparatus in effect, and is liable to the same judgment—a judgment which we shall find it very difficult to declare, since from the day in which this practice was first recommended by Seutin, to the present moment, it has been constantly experiencing the most extraordinary vicissitudes in the public favor. At one time, and by the most experienced surgeons, extolled as a method unequalled in its simplicity, efficacy, and safety; and at another, and by surgeons of equal experience, denounced as eminently lacking in all the true essentials of an apparatus for broken limbs. These conflicting opinions, which it is impossible to reconcile, have nevertheless some foundation in truth. The immovable apparatus of whatever materials constructed, is under some circumstances a very simple, safe, and efficient dressing, while under other circumstances it is, as we think, eminently unsafe and inefficient. Thus, in all of those fractures which are accompanied with such injury to the soft parts as to render subsequent inflammation inevitable or probable, this form of dressing exposes to congestion, strangulation, and gangrene. Whatever its advocates may say to the contrary, the simple fact is before us that the number of accidents resulting from this practice is out of all proportion with any other yet

FIG. 13.



Opening of the apparatus with Seutin's pliers.

introduced. I myself have met with them in all parts of my own country, and the journals abound with records of disasters from this source.¹ Nor is it a sufficient reply to this statement that with proper care and prudence such accidents may be avoided. We think they could not always be avoided. But admitting that they could, it is still undeniable that in

¹ Amer. Journ. Med. Sci., vol. xxv, p. 460, Feb. 1840; also vol. xxxi, p. 212. Med. Record, Nov. 1, 1873; New York Med. Journ., Aug. 1874, Oct. 1874.

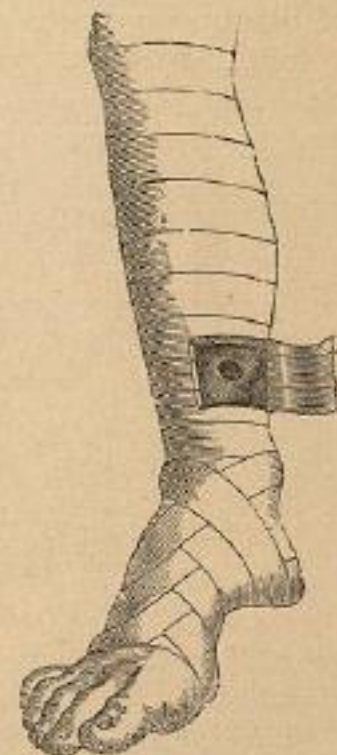
certain cases the immovable apparatus demands extraordinary attention; and what is the need of multiplying our cares when already they are more than sufficient? Many circumstances, over which he has no control, may prevent the surgeon from giving to the limb the full amount of attention which is required; and for this reason that apparatus is the best which, whilst it answers the indications equally well, exacts the least amount of skill and attention on the part of the surgeon.

Immovable dressings are not only liable to become too tight as the swelling augments, but, on the other hand, the surgeon may omit to notice that as the swelling has subsided it has become loose. Portions of the limb may vesicate, ulcerate, or even slough, without the knowledge of the surgeon. If, however, the bandages are frequently opened, and all the proper precautions are taken, it is possible that these accidents may also be avoided, but unfortunately experience has shown that they have not been avoided in too many instances.

The cases, then, to which this apparatus seems to be especially adapted, are a few examples of transverse or serrated fractures in which the bones have not become displaced, and in which little or no swelling is anticipated; and certain fractures which were originally more complicated, but in which a partial union, and the subsidence of the inflammation have reduced them to a more simple condition; and especially is it adapted to cases of delayed union. If now the dressings are applied carefully, the bandage being only moderately tight; and a portion of the extremity of the limb is left uncovered so that we may observe constantly its condition, and at proper intervals the apparatus is opened completely, in order that we may subject the whole limb to a thorough examination; in such cases as I have now indicated, and with such precautions, I admit that the “apparatus immobile” constitutes an invaluable surgical appliance, and one of which no surgeon can well afford to be deprived.

I have also met with examples of compound fractures in which it has seemed proper to apply this dressing; and especially when a sufficient time had elapsed to render it probable that there would be no sudden accession of swelling in the limb. In such cases I have preferred generally to lay the several turns of the roller directly over the suppurating wound in the same manner as if no wound existed, and to make a valvular opening, or window, with the scissors, on the following day, in order to allow the matter to escape, after which the valve may be laid down and stitched, or the piece may be removed entirely, and a new piece of bandage drawn closely around the limb at this point. This may be repeated once or twice daily. If an opening is left by the roller, and no additional bandage or compress is laid over it, the margins of the wound

FIG. 14.



“Apparatus immobile” applied over a compound fracture.

soon become œdematous and protrude, making an ugly-looking and ill-conditioned sore.

Plaster-of-Paris moulds, employed occasionally from a very early period, and more lately recommended by Hendriksz, Hubenthal, Keyl, and Dieffenbach, are not entitled to serious consideration. Heavy stone coffins, they might serve well enough the purposes of interment, but they are wholly unsuited to the purposes of a splint.

Plaster of Paris has, however, been from a later period employed in another form, as an "immovable" dressing. I allude to the so-called "plaster-of-Paris bandages," which were first introduced to notice by Mathiesen, of Holland, in 1852. In 1854, Pirogoff, surgeon in chief of the Russian armies, called attention to the plaster-of-Paris dressing, but in a form differing somewhat from that employed by Mathiesen.

Recurring to the history of the immovable dressing, as briefly narrated in the preceding pages, and as more fully recorded in the medical journals of the next eighteen or twenty years, we shall find that it had steadily declined in public favor, on account of the numerous accidents resulting from its use, many of which became the subjects of litigation in the American courts; so that neither the suggestions of Mathiesen in 1852, nor the great name and influence of Pirogoff in 1854, nor the advocacy of Hunt, of Birmingham, in 1855, nor of Gamgee in 1856, were sufficient to secure for plaster of Paris the confidence of the profession. The period was unfortunate, and surgeons were scarcely willing to give these gentlemen a respectful hearing, inasmuch as they at once recognized these modes of using plaster of Paris as only modifications of the method of Seutin, which, for good reasons, they had just laid aside.

Since Mathiesen wrote, however, a new generation has arisen; a generation of active, able, and hopeful men; with no prejudices of experience to overcome; to whom the "primary bandage" and Seutin's "apparatus immobile," convey no apprehensions of danger; and now again, following this time the lead of the German surgeons, we find these methods in popular favor, both at home and abroad. It will be the part of wisdom, while we observe carefully the experience of the present, to recall the lessons of the past.

At Bellevue, during six or seven years, plaster-of-Paris bandages were used quite extensively, and, after a careful observation of the results in my own wards and in the wards of my colleagues, I find no occasion to recall anything I have said of this, as one form of the immovable apparatus, in the preceding pages; the dangers have not been overestimated, yet I must say that in fractures of the leg, whether simple or compound, when great care is exercised in the management of the case, it is in some respects superior to any other form of dressing. I shall describe the cases to which it is applicable, more particularly, when speaking of these fractures. At the present moment the use of plaster of Paris as a dressing for fractures is very little in favor with most of the Bellevue surgeons, except in fractures of the tibia and fibula.¹

¹ Treatment of Fractures of the Femur by the Immobile Apparatus, by the author. *New York Med. Journ.*, Aug. 1874. A comparison of the results of treatment of 308 fractures of the thigh at Bellevue Hospital, by Frederick E. Hyde, M.D., *New York Med. Journ.*, Oct. 1874.

The manner of using gypsum bandages, generally preferred at Bellevue Hospital, may be thus briefly described. Thin, rather coarse unglazed cotton cloth, torn into strips, is laid upon a table and the dry plaster rubbed into it until its meshes are full. It is then rolled, and made ready for use by immersing it a few minutes in hot water. The limb, being held in a proper position, is first inclosed in soft, dry flannel cloth, and the rollers are then applied. In most cases two or three thicknesses of bandage are found to be sufficient. A more full description of this method, known generally as Mathiesen's, will be found in the chapter devoted to the consideration of fractures of the femur.

Another method of using the gypsum bandages, not generally practised at Bellevue, is as follows: A dry roller is first applied to the limb, or it may be covered with a single piece of cloth of any kind, and the irregularities are filled up and protected with cotton-wool, the same as we have directed when about to apply the starch bandage. The remaining dressings being now at hand and ready for use, we proceed to mix the plaster. For this purpose we must select the fine, fresh, well-dried, white powder. The gray does not solidify well, nor that which has been a long time ground, or is moist. The proportions of water and plaster usually required are about equal parts by weight. For the thigh it may require, perhaps, seven or eight pounds of plaster, and for the leg or arm much less. It is probably a better rule to direct the gypsum to be added to the water until it is of about the consistence of cream. The water should be cold and the gypsum thrown in not too rapidly, at least not more rapidly than it can be thoroughly mixed, otherwise we shall not be able to determine precisely its consistence. If, while applying the paste, it begins to harden in the bowl, we must not add more water, as this will again interfere with its final solidification upon the limb. It must be thrown away and some fresh immediately prepared; or the crystallization may be retarded by throwing in a few drops of carpenter's glue, or a little starch, dextrine, or glycerine. The solidification may be hastened by adding a little salt to the water. When the plaster is good, and it is properly mixed, we may allow ourselves from five to eight minutes in the application. A large paint-brush is the most convenient thing for spreading it, but the hands will do very well in an emergency.

Everything being ready, the limb is to be seized by assistants at both of its extremities and held in a position of steady extension until the dressing is completed, and for several minutes longer, or until the plaster is hard. The surgeon then proceeds to lay a long piece of linen—old sack will answer as well as any—folded three or four times, and saturated with the paste, parallel to the two sides of the limb, around which are to be immediately placed, horizontally and at several points, short and wide strips of the same material. These latter are intended to increase the strength of the apparatus, and to bind on the side strips. Finally, the whole may be painted with the solution. It is very well, however, not to cover the front of the limb, or a narrow strip somewhere in the line of the axis of the limb, with the plaster, as this will not diminish materially its strength, and it will enable the surgeon to open it more easily with the scissors. Pirogoff accomplishes the same purpose by

laying a piece of narrow tape, soaked in oil, along the line through which he wishes to make the section of the splint.¹

Prof. James L. Little, of New York, makes his plaster splints of two or three thicknesses of muslin, or of canton flannel, which, being saturated with fluid plaster, are laid upon the limb previously shaven and oiled, and secured in place with a roller. He advises that the roller shall be removed as soon as the plaster is set and a fresh one applied, which can afterwards be easily removed.²

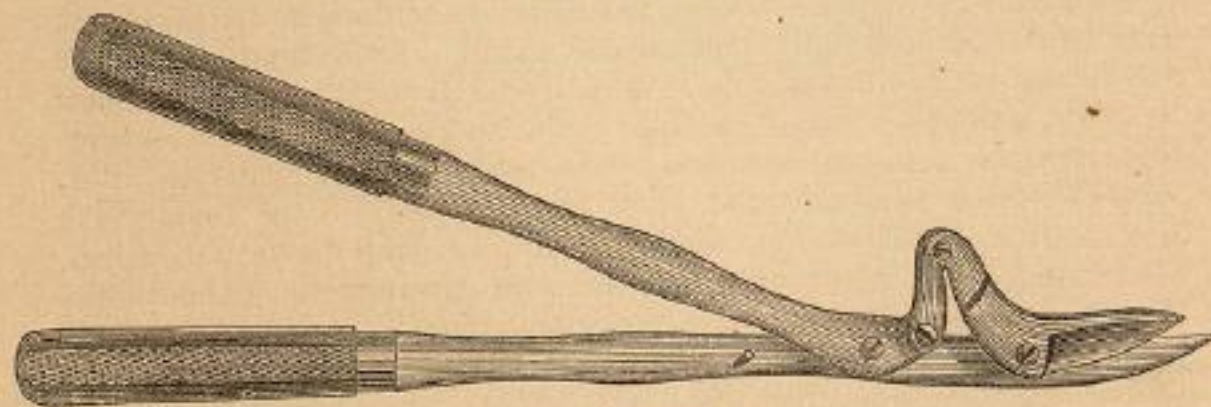
Some surgeons prefer to construct the plaster splint in the following manner: Two pieces of flannel are laid one upon the other, and being stitched by a straight seam along the centre, the inner layer is carefully folded around the limb, and made fast by a needle and thread. Fluid plaster is now spread over the outer surface of the inner layer, and the inner surface of the outer layer, when the two are brought in contact upon the limb, and the whole secured by a roller. After the splint is thoroughly dry it may be cut in front and opened like the cover of a book. Hence it has been called the "book-back" method. It is also known as the Bavarian.

There are other modifications of the methods of using plaster of Paris, which will be more appropriately described in connection with special fractures.

Drs. Wm. A. Byrd, Frank Green, and others have devised simple machines for the purpose of filling the tissue of the cloth with powdered gypsum while it is being rolled.³ Such an apparatus might be very useful in an hospital, as a means of saving time, but it is scarcely needed in private practice.

In removing the plaster we generally employ a shoemaker's knife, softening the plaster as we proceed with a sponge dipped in hot water.

FIG. 15.



Von Brun's plaster-cutter.

As cutting pliers for this purpose, no instrument has been found sufficiently powerful except that introduced by Dr. Victor von Brun, of Tübingen.

¹ Weber on Plaster-of-Paris Bandage, New York Journ. Med., May, 1856, p. 341.

² On the Use of Plaster of Paris in the Treatment of Fractures, by James L. Little, Surgeon to St. Luke's Hospital, etc., Med. Record, Nov. 1, 1873.

³ Med. Record, Oct. 13, 1877, p. 656.

M. J. Lucas Championnière has recently devised an instrument for the same purpose, which Poincot, of Bordeaux, considers superior to any yet invented.

Professor B. W. Dudley, of Lexington, Ky., one of the most successful surgeons in this country, but especially distinguished as a lithotomist, for many years employed in the treatment of fractures nothing but a roller, regarding both side-splints and extending apparatus as not only useless, but absolutely pernicious.¹ This practice, which seems to have originated with Radley, of England, has not found, hitherto, in this country or elsewhere, many imitators.

Still more unscientific and irrational was the practice of Jobert, of Paris, who employed neither side-splints nor bandages, but only extension, in the treatment of all, or of nearly all fractures of the long bones. The side or coaptation splints bring the fragments into more complete apposition, and secure a more prompt and certain union. They ought, therefore, never be omitted, unless the condition of the limb precludes their application.

As to the question of permanent extension in fractures, and the means by which it may be most effectually accomplished, nothing need be said at this time, inasmuch as it relates only to the fractures of certain bones, and to certain forms of fractures; we must therefore refer its consideration to those chapters which treat of individual bones.

In the treatment of *equminuted* fractures, no pains ought to be spared to bring the fragments as nearly as possible into apposition; and if there exists at the same time an external wound, and the fragments are small and loose, they ought to be removed carefully. Nor, indeed, should we be deterred from the attempt to remove them by finding that they are somewhat adherent, if still they are very easily moved about with the finger.

In *compound* fractures, not unfrequently the end of one of the fragments protrudes from the wound, and its reduction may be attended with considerable difficulty. My practice is usually in such cases to attempt the reduction first, by simple extension and counter-extension; but if this fails, a finger is introduced into the wound, and an attempt is made to stretch the skin over the sharp point of bone; or a spatula is used, formed from a piece of wood, or of any suitable piece of metal which may be at hand; finally, but not until all other expedients have failed, the wound is enlarged sufficiently to insure its return. Anæsthetics may be employed, also, to facilitate the reduction.

There are some cases, however, in which the surgeon may feel justified in sawing off the projecting end; as when the periosteum is completely torn from it by its having penetrated a boot, or even sometimes when its extremity is very sharp, and there is reason to suppose that it would prick and irritate the tissues. In these cases, also, surgeons have proposed to secure the fragments in apposition by metallic ligatures or sutures. In a few instances the practice has been attended with success, but in most cases the wires have failed utterly of their purpose, and have only proved sources of additional irritation.

¹ Dudley, Trans. Amer. Med. Assoc., vol. iii., 1850, p. 349.