

VAN DE WARKER (E.)

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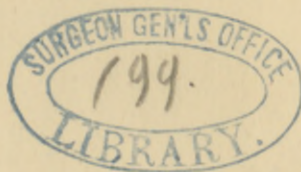
VERSIONS AND FLEXIONS OF THE  
UTERUS

A THEORETICAL AND PRACTICAL STUDY  
OF THE PESSARY

BY

ELY VAN DE WARKER,

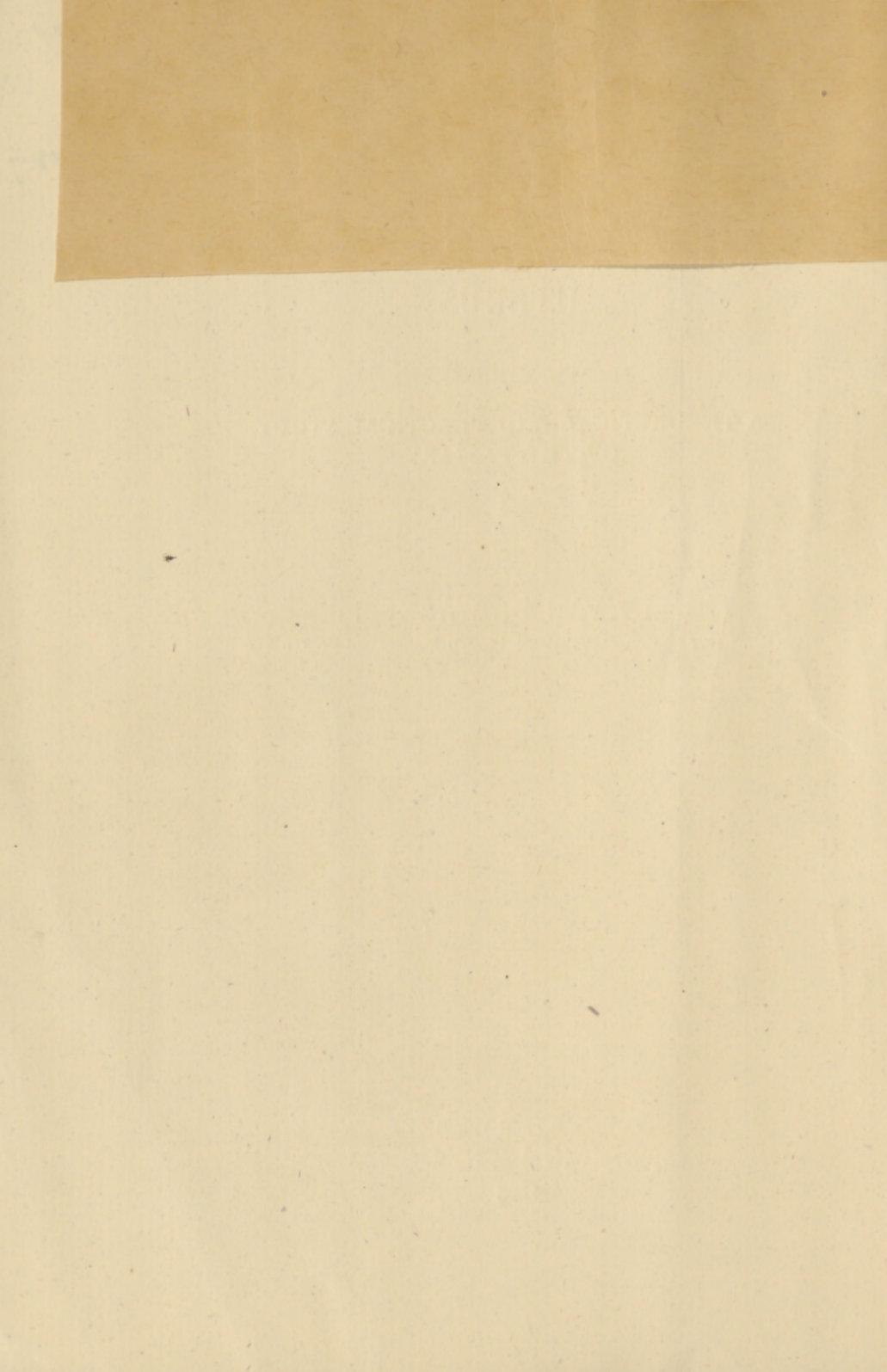
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REPRINTED FROM VOLUME VII.

Gynecological Transactions

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## MECHANICAL THERAPEUTICS OF VERSIONS AND FLEXIONS OF THE UTERUS.

BY ELY VAN DE WARKER,  
*Syracuse, N. Y.*

THE mechanical therapeutics of uterine displacements is yet unsettled. No department in gynecology has been the object of greater interest, and no department of surgery in general has stimulated an equal inventive activity. With all this array of invention the mechanical problems involved are not advanced, nor the question of utility in any manner settled. It is doubtful if in the whole range of gynecology a subject can be brought up that will elicit such hostile criticism on one side, and such cordial approval on the other; but among the avowed friends of mechanical therapeutics there is even more irreconcilable conflict as to the mere forms of appliances, so that while the inflammatory and mechanical schools of pathology stand at opposite poles of science and practice, the former is yet more hopelessly divided against itself.

There must be some reason for this state of affairs among a class of men, of whom I think I may say, that they are the peers of any for close and conscientious observation. It is possible that this difference among those who practice mechanical reposition of displaced uteri comes from over-confidence in their methods, and the disappointment that is sure to result from this mental attitude. As a method of treatment a pessary can be no more blindly relied upon than a splint in a case of fractured limb. It requires to be used with intelligence, watchfulness, and with due regard to the conditions, changeable and obscure

as they often are, which demand its use. Do pessaries generally accomplish the purpose for which they are employed? This question is always in order, and brings us into the strife waged between the hostile schools. I have here proposed the problem from its mechanical stand-point, and in this view of the subject it must be answered. Whatever may be your theory of uterine pathology, if in any case a pessary has been applied, have you fixed for yourself an ideal standard of mechanical effect, and has this standard been reached? Dealing, as we are here, with mechanical agencies, and from which we ought to expect results that may be formulated with precision, it is singular how difficult it is to reach this ideal standard. My opinion is that this uncertainty results, in the first place, from expecting too much from the use of the pessary, and in the second place, from selecting an improper agent for want of more clearly defined ideas upon the absolute limitations imposed upon the action of pessaries, and which must govern the mechanical results to be attained. That this confusion of ideas concerning these absolute limitations is one of the causes of failure is proved by the vast number of appliances invented, and the constant revival of obsolete forms of instruments to accomplish two simple mechanical results,—the straightening and lifting the uterine body either forward or backward.

It is for the purpose of demonstrating this part of my subject that I have been careful to illustrate this monograph with nearly every form of pessary for the correction of versions and flexions of the uterus, to serve both as a guide and a warning to all who wish to invent a pessary.

These illustrations are well worth study. They express to us graphically the history of a phase of thought. They show to us how the minds of many men seeking a single object halt at the same point, or revolve round a common centre. We can see in this apparent confusion of forms a common thought which links together the various groups, and a little study will show us that the members of these groups, into which I have divided them, are not different



instruments, but simply different expressions of the same form.

In studying the mechanical principles involved in the theory of the pessary two things must be clearly defined: First, the limits imposed by the uterus and its appendages upon the mechanical agencies acting upon it; and, secondly, the action of the mechanical forces under these limitations. These limits, both in their mechanical and uterine relations, are fixed and absolute. They are not to be evaded by skill, or ingenuity, and ought to be clearly understood. One is, however, reluctantly forced to conclude that the majority of pessaries are invented either in ignorance or defiance of these limits, and as if the only restriction upon their action was that of gravity.

And first, the limits imposed by the uterus and its appendages. Given a flexed or versant uterus, the problem is to restore it mechanically to a position which approximates the normal, or if that is not possible, then to a sufficient extent to relieve symptoms. Now the normal position has never been, and cannot be, defined, simply for the reason that it is one of movement, not of stability. To be more exact, we may say that the mean of this mobility is the normal, but in reality we cannot apply this mean position to any one woman any more than we can apply the average expectation of life to any given healthy individual. The difference between what is called a version and a normal movement, which may be equivalent to it in angular displacement, lies in the fact that the abnormal position is one of stability independently of the forces which induce changes of uterine position, and to which the healthy organ is responsive in a normal manner. A version, then, is a position of immobility not from fixation but from habit. If we restore this position to one that approximates the normal mean we restore its mobility, and if this restoration is effected by mechanical agencies it must be with reference to this natural endowment of the organ.

The correction of a flexion or version of the uterus mechanically, with certainty, comfort, and safety to the sub-



ject, depends in the first place upon a few fixed and absolute conditions which cannot be violated. I enumerate them:—

(a.) The limits imposed by uterine mobility.  
 (b.) The limits imposed upon the action of pessaries by the vagina.

(c.) A pessary must be adjusted with proper regard for the safety of the pelvic soft parts.

(d.) A pessary must be so adjusted as not in any way to retard or arrest the function of any pelvic organ, nerve, or vessel.

These must be considered in order to clear the way for the study of the pessary as a mechanical appliance in its various groups and classes.

(a.) *The Limits imposed by Uterine Movements upon the Action of Pessaries.*—Nothing can be clearer than the statement that every mechanical means of support applied to the uterus must act without restraint upon those movements essential to the normal functions of the organ. If we regard the manner in which the uterus is supported, we shall see that one of the results of this method of suspension is extreme normal mobility in every direction. It is necessary to call attention here to but one fact, namely, that these supports are not attached to any fixed centre of suspension, but are distributed over a large part of the surface of the uterus. The idea of Aran and of those who follow him, that the uterus has a fixed centre of rotation,—an “axe suspenseur,”—must, in view of this fact, be wrong. The uterus has an eccentric or cam-like movement, which may be defined by the expression that as the fundus is elevated the organ sinks in the pelvis, and that it is displaced laterally in a direction opposite to that of its anterior rotation.

In Fig. 1 I have endeavored not to exaggerate this eccentricity of movement. The straight lines 1, 2, 3, express the uterine axes of various abnormal positions, while the dotted line *ee* would express the arc described by the fundus during these movements if the uterus moved upon a fixed centre of rotation. But what I believe to be the fact, that each change of position has its own centre of suspen-

sion, is shown by the lines which represent the arcs described by the vaginal portion instead of the fundus, which latter movement is defined by the shaded line  $1^{\circ}$ ,  $3^{\circ}$ . Thus, the curve *b* expresses the movement in the  $3^{\circ}$  of retroversion, the curve *a* by the  $2^{\circ}$ , and the curve *c* by the  $1^{\circ}$ , while the curve *d* shows the movement of the vaginal portion in the  $2^{\circ}$  of anteversion.

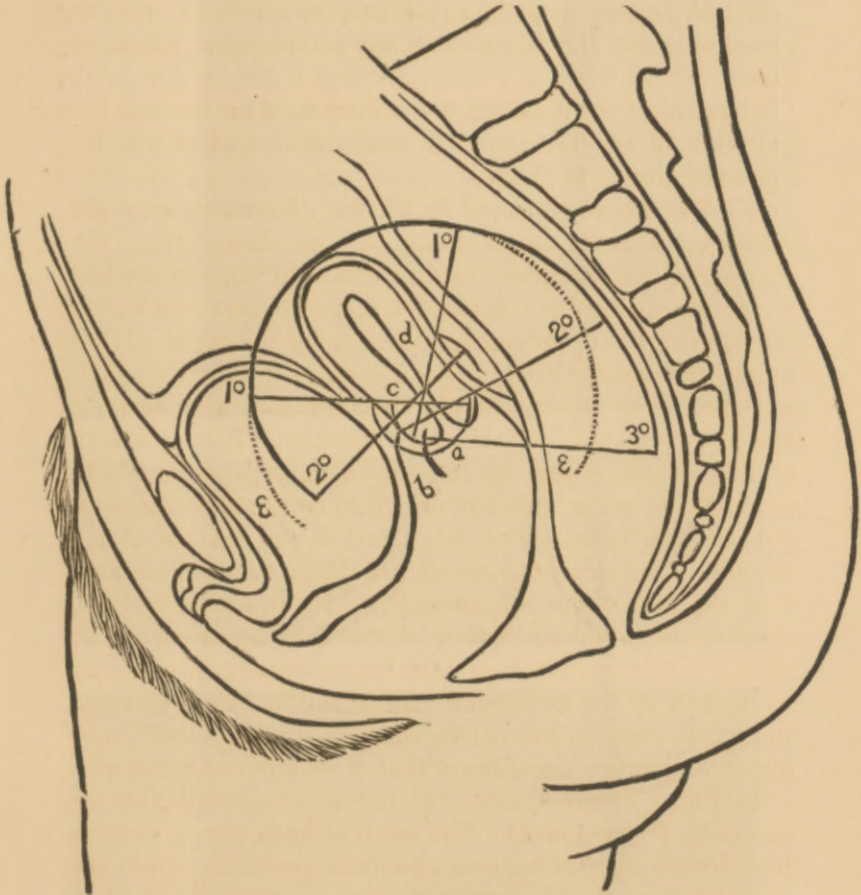


FIG. 1

If the uterus moved upon a fixed centre of rotation it would be comparatively easy to so adjust mechanical sup-



port as to accommodate these movements; but, this not being the case, it is a matter of extreme difficulty.

Of equal importance to the proper application of the pessary are the minor uterine movements. These are the various respiratory movements involved in the acts of respiration, articulation, coughing, and the like; postural movements, and those of walking and abdominal expulsion. Several years ago I gave this subject a careful study by means of the recording mercurial manometer, and which, owing to the medium<sup>1</sup> through which I sought the public, is but little known among those interested in gynecological study. It is almost impossible to give an idea of the character of these movements without reproducing a few of the manometrical tracings published in my former monograph.

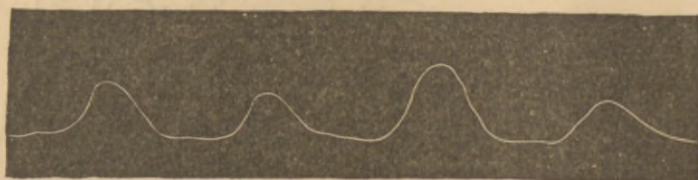


FIG. 2.

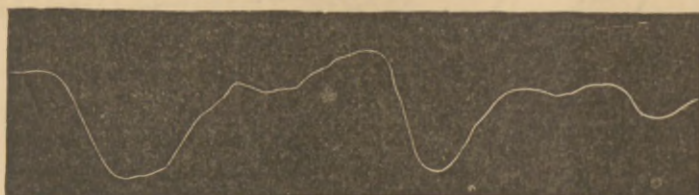


FIG. 3.

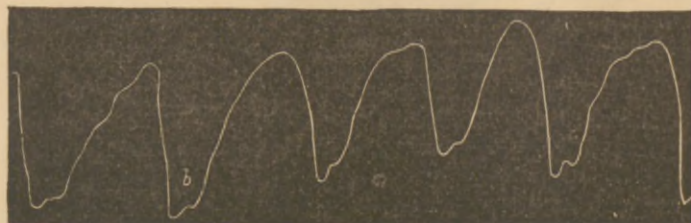


FIG. 4.

Fig. 2 is a tracing of easy respiration movement; Fig. 3 is an articulation curve; Fig. 4 is the record of uterine

<sup>1</sup> *New York Medical Journal*, April, 1875.



movement in the act of coughing, and Fig. 5 that of walking. Fig. 6 represents the movements of the mercury in the manometer during voluntary expulsive effort.

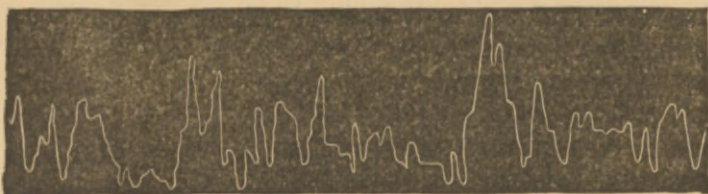


FIG. 5.



FIG. 6.

It is of the highest practical importance in this relation to realize that the mechanical force involved in these uterine movements varies from less than one to about seven pounds, as actually measured by a column of mercury. If we regard the results arrived at by Poppel<sup>1</sup> and Duncan,<sup>2</sup> that the minimum force exerted during labor is equivalent to four to eight pounds, as at all correct, the remarkable fact is forced upon us, that there exists in the average woman, non-pregnant, voluntary expulsive force equivalent to an easy labor, and which she may exert at any time. In view of this fact it is not singular that uterine displacements play so large a part in the sexual disabilities of women, and that their mechanical correction is a matter of difficulty.

<sup>1</sup> *Monatsschrift für Geburtskunde und Frauenkrankheiten*, Bd. 22, S. 8.

<sup>2</sup> *Researches in Obstetrics*.

Much of the pain and tenderness that develops from wearing a pessary are the result of the mechanical restraint imposed upon this free mobility. Even when over-distention or stretching of the vagina is an evident element in the intolerance of the pessary, it is difficult to eliminate the restrained movements of the uterus as a co-factor to this result.

From what the tracings of the manometer have taught me, I should say that at least three quarters of an inch ought to be allowed for unrestrained uterine movement in adjusting the pessary. Anything less than this would be certain to interfere with the movements of the organ, especially in movements of the uterus attending defecation and forced inspiration and coughing. The fact must not be lost sight of anywhere in this paper, that I am speaking only of the mechanical correction of versions and flexions.

(b.) *Limits imposed upon the Action of Pessaries by the Vagina.* — These limits are absolute and cannot be evaded. After we have elevated the uterus mechanically to the limits of the vagina, direct action of the instrument ceases, and if beyond this point any further effect is produced, it is by evoking the operation of other agencies. From the description of many of the version pessaries, it is clear that the inventor and the practitioner who use them expect that by means of a curve, or the pressure of the upper extremity of the pessary, the depressed fundus of a versant uterus may be raised by the direct action of the instrument. But this is impossible. When the upward pressure is arrested by the vagina, it is evident that movement in this direction ceases. What has been accomplished so far has been a lifting upward of the vaginal vault, and to a corresponding degree that of the uterus in its same relative displacement, while the anterior wall is placed upon greater tension than the posterior, being the shorter limb of the vaginal curve. This simple upward pressure would relieve a retroverted uterus just as effectually if the force was applied in front of the vaginal cervix as behind it. This being the condition of affairs when the vaginal limits interpose further up-



ward movement, the vaginal walls themselves become the agents of any further change induced in uterine position by prolonging the upward pressure. To illustrate, let us take the familiar example of the Hodge closed pessary — lever, as it is improperly called, — by which instrument the force is applied to the posterior cul-de-sac, and the uterus lifted until the slack of the posterior vaginal wall is taken up, when, the same force being continued, the vaginal neck is drawn backward, the fundus moving to the same extent forward, if the uterine body is of normal consistency, by the vagina drawing over the upper end of the pessary as though it were a pulley. With this action of the posterior we always find the anterior vaginal wall under more or less tension, which could not be the case otherwise. This law is taken advantage of in nearly all version pessaries in use, but, unfortunately, the action is confounded with a lever instead of a lifting force. In the normal relation of the parts the vaginal roof with the uterus may be raised one inch and a half to two inches, and this not at the expense of the elasticity of the passage, but by the erasure of its folds. Any mechanical elevation of the uterus to this extent must result in absolute fixation, and in a short time become intolerable if not dangerous.

In every application of a pessary the mechanical walls must be regarded as a part of the mechanism involved. I believe this rule to be true in every successful replacement of a version, and it is by bringing into play this pulley-like action of the vagina upon the lower uterine neck that we are enabled to extend the action of a pessary beyond the limits of the vaginal sac. Any attempt by mere force to get a direct action of a pessary upon a depressed uterine fundus is practically violence to the vaginal tissue, and prevents the participation of its walls in the mechanical action of the pessary. This explains the difference in the action of pessaries in retroversions and anteversions of the uterus. In the former we bring into action the posterior vaginal wall upon the uterine neck with great facility; while in the latter, the anterior wall being shorter it draws the uterine



neck forward to a much less extent. This action is also antagonized by the posterior vaginal wall, more or less, depending in a great measure upon the fact whether the anteversion pessary passes into the posterior cul-de-sac or not. In case the instrument places the posterior wall of the passage upon the stretch at the same time lifting force is directed against the anterior wall, the strain of the instrument is in opposite directions, and the lift upon the anterior wall is reduced to nothing. Any instrument devised upon this plan can be compared to nothing else than a man trying to lift himself over a fence by pulling up upon the straps of his boots. The vaginal limits to the action of a pessary are more marked in anteversion than in retroversion, and the same law holds that the fundus cannot be lifted except the cervix be drawn forward to an equal degree. That under the most favorable circumstances this is more difficult than in retroversions is shown by the proneness of the anterior wall to ulcerate under the action of an anteversion pessary.

These remarks are true only of versions, and do not in any way apply to the correction of flexions. We have absolutely no means of redressing flexion mechanically from the vagina alone. I say this after a careful study of the subject extending over many years, and after experimenting with every form of pessary that gave the least promise of success. We may operate with the same results upon the vaginal portion mechanically in both versions and flexions; the cervix moves to the same extent under the operation of the same force in both forms of uterine error. While the fundus is rotated in proportion to the cervical movement in version, and thus the displacement more or less corrected, in flexions the organ makes a partial rotation corresponding in extent to the movement of the cervix, but is still flexed. It may be said in objection to this idea, that vaginal supports of various kinds do relieve the symptoms in cases of uterine flexions. This is true; but this relief is given not by correcting the flexion, but by lifting the uterus, and thus partially relieving the vessels and nerves of

the organ. In proof of this I may mention an experience which I have often verified, that a simple globe pessary will afford this relief better than any of the complicated vaginal pessaries I have ever used, and in which case there can be no question that the flexion remains unchanged. These facts ought to teach us not to attempt to correct a flexion of the uterus by means of any force limited wholly by the vagina.

(c.) *A Pessary must be adjusted with a Proper Regard for the Safety of the Soft Parts.* — Much of the ill repute attached to the pessary comes from the frequently published cases of injury to the vagina due to this instrument. There are two elements in this result of wearing a pessary. The most important one is injury due to an improperly fitted instrument. This is not usually such a misfit as to be intolerable to the patient at once, for in such a case the misfit is its own remedy, but is of such a character that at first no ill effects are noticed, and the patient only becomes gradually aware that mischief is being done. Pressure needs but to be continuous to result in ulceration. A pessary that fills the vagina so closely that no play of the vagina upon the points of bearing is possible may very quickly result in erosion or ulceration. A pessary so large, or of such a kind, as to cause uterine fixation constantly exposes the woman to this danger. It may, on the other hand, be so small that erosion of the vaginal wall may result. The instrument gets out of position and is crowded across the vaginal passage, so that the tissues are confined between the extremities of the pessary on one side and the pelvic hard parts on the other. This question of fit is even more difficult to get a correct idea of than that of selecting a proper pessary to accomplish the object in view. Nothing but practice will enable one to acquire a skilled touch in this matter of a safe and proper fit.

Secondly, a pessary may be of a proper kind, and perfect in its adjustment, and yet do harm by imprudence in its use. Of this nature, no doubt, are many of the cases of injury that we read about. It has not been unusual in my



experience to remove a pessary which the patient had placed by her physician a year or more before. In the majority of cases such a long continuous wearing of a pessary is the result of the carelessness or willful stubbornness of the patient. I remember an instance in my own practice which illustrates this. I was called by my friend, Dr. M. B. Fairchild, to see a patient, who, in consequence of a flexion of the uterine neck, suffered severe dysmenorrhea. I introduced an intra-uterine stem, which gave complete relief to pain and the locomotor symptoms. I left Dr. Fairchild directions about the removal of the instrument, but was surprised by the doctor informing me a year after, that he could not remove the stem, as the patient would not permit it. She dreaded the return of her old symptoms. I wrote her, as she lived at a distance, drawing as vivid a picture as possible of the consequences which might result from her stubbornness. She answered me that she was perfectly well, and she was sure that nothing had happened as I described, because she felt so well in the pelvic organs. It was six months after that I succeeded in getting the stem. Happily no bad consequences resulted from this continued wearing of the stem for a year and a half, and which I am sure was the result of the principle upon which I make and use my form of this instrument.

A patient needs to be informed about the care of her person while wearing a pessary, and to regard herself as constantly under treatment. It is often necessary to give her very plain and positive instructions upon the matter of occasional examinations, and removing and cleaning the pessary. Pessaries are sometimes made of material that requires constant care. Pure gum or soft rubber instruments are very liable to become offensive and cause an irritating discharge, and which, in some patients, unless careful attention is given to hygiene, will result in vaginal erosion.

(d.) *A Pessary must be so adjusted as not in any way to retard or arrest the Function of any Pelvic Organ, Nerve, or Vessel.* — It would hardly seem necessary to give this sub-



ject any place, for the reason that the proposition is so self-evident that no argument can make it clearer ; yet, in the majority of cases, defeat in the use of the pessary comes from this source. An instrument may be theoretically correct as to form, or its form may be entirely wrong, and in both instances be equivalent to the same error through violation of this law. We may know that this condition is being violated by the symptoms resulting from the presence of the pessary ; or, at least, we may assign this as a cause when there is a peculiar wearing sacralgia, fixed, or radiating down the limbs, supra-pubic pain and tenderness, urine incontinence, or dysuria, pain in defecation or in postural changes, and increased general nervous irritability.

All these evidences of pelvic disturbance, except that of the bladder, may result from the violation of one function of the pelvic organs, namely, uterine mobility. As this will be referred to repeatedly later, it need not be taken up here.

The next important organ liable to be disturbed by the pessary is the bladder. Some forms of the instrument which are very useful, like the elastic ring and the original form of the Hodge, are disposed to excite functional disturbance of this organ by the lower end tilting against the base of the bladder or upper urethra. It is remarkable how slight a pressure will do this if it is continuous. Force directed against the base of the organ will cause strangury, and upon the upper urethra will produce incontinence, so that it is not difficult to judge from the symptoms the point that is exposed to pressure. It is frequently one of the difficult points in the fit of a pessary to so shape its lower extremity as to avoid bladder disturbance.

The rectum is rarely disturbed by the pressure of a pessary through its anterior wall, except in cases of fecal accumulation when the rectal contents are apt to lodge above the bow of the instrument, and when strong effort is made at defecation the pessary is sure to be seriously displaced. This is one of the chief causes of expulsion of intra-uterine stems that depend upon small vaginal supports for their retention. I have seen hemorrhoids which were in a great

measure ascribable to the backward pressure of a pessary on the vaginal wall. The simple ring is quite liable to do this, especially when too small, as the upper or posterior part is forced down, and the anterior upward, behind the pubes, thus placing the instrument at right angles nearly to the posterior wall, the hemorrhoidal veins bearing the greater part of the pressure. The same is liable to occur in case of very short vaginas, in spite of the greatest care.

Sacralgia is rather a symptom of erosion, or ulceration at the posterior cul-de-sac, than of undue force. Pressure, from the presence of a pessary, so great as to excite neuralgia of the sacral nerves, could not be borne at all, and thus would suggest its proper remedy. The sacral pain is evidently reflex, of a nature similar to that due to erosion of the cervix. Any form of instrument may excite ulceration of the vaginal walls if allowed to remain too long, as I have already said. I have known dysmenorrhea excited by obstruction to the menstrual flow. Intra-uterine stems are prone to do this when too large, or when the vaginal portion of the stem fits too closely about the os externum. Stems, as made by the instrument makers, are nearly one half too large, as a rule. A sharp or long anterior curve to the Hodge form of instrument may cause the same obstruction by pressing the walls of the vaginal cervix together. A very slight obstruction to the escape of the menstrual flow will excite expulsive pain. This fact must be always remembered, and precautions taken at the first signal of disturbance.

Pain excited in the pelvis during postural changes is strong evidence of an ill-adjusted or improper pessary. This must never be overlooked or made light of, and the patients told, as they often are, that they will get used to it after a time. Even if no physical harm results, moral injury will be sure to follow as the patient is made uneasy and anxious. It is a wise precaution to have the patient put herself in a variety of postural changes, such as sitting, walking, standing, and bending forward, after a pessary is first introduced, in order to test this point, and any complaint attended to at once.



Many pelvic conditions, such as peri- or parametritis, tumors, hematocele, and ovarian tumors and displacements, may act as absolute limitations to the action of a pessary, but they are of such a nature as to require no special mention here.

The variety of pessaries is so great that an attempt to describe them without a proper classification would be vain. One might as well make a scientific description of a family of animals without grouping it into genera and species, as to make a mechanical analysis of pessaries without dividing them into groups and classes.

When I had gathered together my immense material of pessaries, I found that I had entered a new field of research, and that whatever I intended to say and do within the limits of this field may have been said and done before me; still it was all confusion because no one had studied it as a whole, and arranged and grouped its facts. This was altogether a different matter from looking at the pessary singly, or in its purely practical relations. Further, unless one confined a paper of this sort to the limits of a mere catalogue, it would require a volume to separately analyze the mechanical principles of each instrument.

It was a matter of considerable study to adopt a system of classification. An arrangement based purely upon the few mechanical elements involved would not only be difficult, but, as this was in a certain sense a pioneer paper, it was liable to excite considerable controversy, as such a classification would frequently lead me to view an instrument in a totally different manner from the inventor. Finally, I adopted the plan of defining three principal groups by the aid of the very manifest mechanical elements involved, and about which there could be no difference of opinion, and of describing the several classes under these groups by the mechanical results, or uterine changes induced by the presence of the instrument, instead of still further refining upon the minor mechanical principles shown by the various classes in each group.



## CLASSIFICATION OF VERSION AND FLEXION PESSARIES.

GROUP I. — Those pessaries combined with support external to the body.

*Class 1.* The simple intra-vaginal pessary with external support.

*Class 2.* Those that combine a pessary acting by mechanical displacement with support external to the body.

*Class 3.* Those that combine absolute uterine fixation of the cervix with external support.

GROUP II. — Pessaries acting wholly intra-vaginally.

*Class 1.* Those pessaries acting by displacement.

*Class 2.* Those pessaries that move the vaginal cervix by action of the vaginal walls in a direction opposite to the movement of version of the fundus.

*Class 3.* Those which retain the vaginal cervix in a fixed position, and thus prevent rotation of the uterus.

GROUP III. — Pessaries acting within the body of the uterus — intra-uterine stems.

*Class 1.* Intra-uterine stems with support external to the body.

*Class 2.* Intra-uterine stems combined with various forms of vaginal pessary.

*Class 3.* Self-retaining intra-uterine stems.

*Class 4.* Diverticulating intra-uterine stems.

*Class 5.* Intra-uterine stems with simple vaginal attachment necessary for retention.

## GROUP I. — SUPPORT EXTERNAL TO BODY.

CLASS 1. — *Simple Intra-vaginal Pessary with External Support.*

Name.	Form of Displacement.	Plate.	Figure.	Reference.
Priestley.	Retroversion.	XII.	1	Cat. Obstet. Instruments, Obstet. Soc. Lond., p. 180, Fig. 178, 1867.
Priestley, modified by Cutter.	Retroversion.	XII.	2	Thomas, Prac. Treat. Dis. Women, p. 379, Fig. 142, ed. 1872.
The same.	Retroversion.	Text.	7	The same.
Cutter.	Retroversion.	XII.	3	Uterine Ver. and Flex., 1876, p. 20, Fig. 4.

CLASS 2. — *Displacing Pessary with External Support.*

Name.	Form of Displacement.	Plate.	Figure.	Reference.
Priestley, modified by Thomas.	Retroversion.	{ XII. Text.	4 8	Thomas op. cit., p. 379, Fig. 141.

CLASS 3. — *Fixation of Cervix with External Support.*

Name.	Form of Displacement.	Plate.	Figure.	Reference.
Wade.	A. and R. flex. and version.	XII.	5	Amer. Jour. Obstet., 1878, p. 710.
Cutter-Thomas.	Anteversion.	Text.	9	Thomas, op. cit., ed. 1880, p. 423, Fig. 166.
Weber.	Retroversion.	Text.	9a	Tiemann's Cat., Part III., Fig. 428b.

## GROUP II. — INCLUDES ALL THE INSTRUMENTS THAT ACT WITHIN AND ARE LIMITED BY THE VAGINA.

CLASS I. — *Pessaries acting by Displacement.*

Name.	Form of Displacement.	Plate.	Figure.	Reference.
Page.	Retroversion.	Text.	11	N. Y. Med. Record, May 9, 1876.
Pallen.	Anteflexion.	Text.	12	Reynder's Catalogue.
Cole.	Anteflexion.	Text.	14	Med. and Surg. Rep., June 4, 1881.
Cole.	Retroversion.	Text.	15	Loc. cit.
Hitchcocks.	Anteversion.	Text.	13	Trans. Am. Med. Assoc., xv., 104, 105.
Smith, Heywood.	Retroversion.	Text.	16	Prac. Gynecol., p. 108, 1878.
Thomas.	Anteversion.	Text.	17	Thomas, op. cit., p. 422, Fig. 163, 1880.
Gehring.	Anteversion.	Text.	18	St. Louis Med. and Surg. Jour., July, 1877.
Vulliet.	Anteversion.	XIV.	5	Trans. Obstet. Soc. Lond., xvii., 64.
Thomas.	Anteversion.	Text.	{ 19 20	Tiemann's Cat., Part III., p. 89.
Hewitt, modified by Thomas.	Anteversion.	Text.	21	Op. cit., Part III., p. 89.
Hewitt.	Anteversion.	XIV.	1	Hewitt, Dis. of Women, p. 523, Fig. 77.
Hewitt, modified by Beigel.	Anteversion.	XIV.	{ 2 3	Beigel, Die Krankheiten d. weiblichen Geschlechtes, Bd. i., S. 180, Fig. 1, A. and B.
Hewitt, modified by Schultze.	Anteversion.	XIII.	11	Archiv f. Gynäkol., Bd. iv., S. 387, Figs. 1 and 2.
Thomas.	Anteversion.	Text.	{ 22 23 24	Thomas, op. cit., p. 422, 1880.
Thomas.	Anteversion.	Text.	25	Thomas, op. cit., p. 421.
Galabin.	Anteversion.	XIII.	7	Obstet. Trans., Lond., xviii., p. 177, 1876.
Gehring.	Retroflexion.	Text.	28	St. Louis Med. and Surg. Jour., July, 1877.
Gehring.	Anteflexion.	Text.	27	Loc. cit.
Pallen.	Retroversion.	Text.	26	Am. Jour. Obstet., July, 1877.
Studley.	Anteversion.	XIII.	9	Am. Jour. Obstet., Jan., 1879.
Thomas.	Anteversion.	XIV.	8	Thomas, op. cit., p. 363, Fig. 126, 1872.
Clay.	Retroversion.	XIV.	9	Copied from Beigel, op. cit., Bd. i., S. 275, Fig. 92.

# 18 MECHANICAL THERAPEUTICS OF VERSIONS, ETC.

## CLASS 2.—Pessaries that act upon the Uterus by exciting Action of the Vaginal Walls.

Name.	Form of Displacement.	Plate.	Figure.	Reference.
Hodge.	Retroversion.	XIII.	{ 1 2 3	Hodge, Dis. of Women, 415, Fig. a, b, c.
Hodge, modified by Hewitt.	Retroversion.	XIII.	4	Hewitt, op. cit., p. 521, Fig. 74.
Hodge-Smith.	Retroversion.	XIII.	{ 5 6	Thomas, op. cit., p. 446, Fig. 184, 1880.
Hodge-Thomas.	Retroflexion.	Text.	30	Thomas, op. cit., p. 446, Fig. 185.
The same.	Retroflexion.	Text.	31	Same reference.
Chamberlain.	Retroflex. and version.	Text.	{ 32 33	N. Y. Med. Record, viii., 396, 1873.
Carroll.	Retroflexion.	Text.	34	N. Y. Med. Record, March 30, 1878.
Woodward.	Retroflexion.	Text.	35	N. Y. Med. Jour., October, 1876.
Scattergood.	Retroversion.	XIII.	8	Thomas, op. cit., 380, Fig. 144, 1872.
Schultze.	Retroversion.	XIII.	10	Archiv f. Gynäkol., iv., 387, Figs. 1 and 2.
Thomas.	Retroversion.	XIV.	4	Thomas, op. cit., p. 378, Fig. 140, 1872.

## CLASS 3.—Pessaries that fix the Vaginal Cervix and prevent Rotation of the Uterus.

Name.	Form of Displacement.	Plate.	Figure.	Reference.
Hoffman.	Retroversion.	Text.	36	Thomas, op. cit., p. 375, Fig. 136, 1872.
Hurd.	{ Retroflexion. Anteflexion.	XII.	6	Thomas, op. cit., p. 395, Figs. 150, 151.
Woodward.	Anteflexion.	Text.	37	N. Y. Med. Jour., October, 1876.
Fowler.	Anteversión or flexion.	Text.	38	Ut. Displacements Considered, Pamphlet, Youngstown, Ohio, 1881.
Fitch.	Anteversión or flexion.	Text.	39	Ill. State Med. Soc. Trans., 1875, p. 207.
Thomas.	Anteversión.	Text.	40	Thomas, op. cit., p. 421, Fig. 158, 1880.
Schroeder.	Retroflexion.	XII.	7	Dis. Female Sex. Organs, p. 175, Fig. 60.
Studley.	Retroversion.	XIV.	6	Am. Jour. Obstet., January, 1879.

## GROUP III.—INTRA-UTERINE STEMS.

### CLASS I.—Stems having Support External to the Body.

Name.	Form of Displacement.	Plate.	Figure.	Reference.
Simpson	Version and flexion.	Text.	41	Simpson, Obstet. and Gynecol., p. 703, Fig. 27.
The same.	As above.	I.	{ 2 3	Winckel, Die Behandlung d. Flex. d. Uterus, S. 19, Taf. I.
Kiwisch.	Version and flexion.	I.	1	
Valleix.	Version and flexion.	II.	{ 1 2	Winckel, op. cit., S. 20, Taf. I., Fig. V.
Kilian.	Version and flexion.	III.	1	Winckel, op. cit., S. 20, Taf. II. Fig. VIII.
Cutter.	Flexion.	{ Text. IV.	40 2	Cutter, Ut. Versions and Flex., p. 89 (modified).
Beigel.	Flexion.	III.	2	Beigel, Krankh. d. weiblich. Gesch., ii. Bd., S. 243, Fig. 71.



CLASS 2.—*Intra-uterine Stems attached to various Forms of Vaginal Pessary.*

Name.	Form of Displacement.	Plate.	Figure.	Reference.
Detschy's Hystero-mochlion.	Version and flexion.	IV.	1	Schmidt's Jahrbücher, Bd. 83, p. 321 (1854).
The same; another form.	Version and flexion.	VI.	6	Thomas, op. cit. (Wieland and Dubrisay), p. 393, Fig. 149, 1872.
Schultze.	Flexion.	VI.	5	Schultze, Archiv f. Gynäk., Bd. iv., p. 414, Fig. 14.
Schultze.	Flexion.	VI.	7	Schultze, loc. cit., Fig. 15.
Amann.	Flexion.	VI.	2 { A B	Amann, Zur. mechanischen Behandlung d. Versionen u. Flexionen d. Uterus, p. 45, Fig. 7.
Simpson, modified by Martin.	Flexion.	VII.	1	Beigel, op. cit., Bd. ii., p. 244, Fig. 73.
Hewitt.	Flexion.	VII.	2	Beigel, op. cit., Bd. ii., p. 245, Fig. 74.
Winckel.	Flexion.	VII.	3	Winckel, Die Behandlung d. Flexionen d. Uterus, p. 23, Fig. 18.
Winckel, modification of Valleix.	Flexion.	VIII.	1	Winckel, op. cit., p. 23, Fig. 15.
Chadwick.	Flexion.	VIII.	3	Trans. Am. Gynecol. Soc., vol. ii., p. 444.
Cutter.	Flexion.	VIII.	4	Cutter, op. cit., p. 128, Fig. 26.
Schultze.	Flexion.	VIII.	5	Schultze, Archiv f. Gynäk., Bd. iv., p. 413, Fig. 13.
Winckel.	Flexion.	VIII.	2	Winckel, op. cit., p. 23, Fig. 16.
Studley.	Flexion.	VIII.	6	Am. Jour. Obstet., January, 1879.
Hodge, modification of Simpson.	Flexion.	IX.	1	Hodge, Dis. of Women, pp. 411, 415.
Barnes.	Flexion.	IX.	2	Barnes, Dis. of Women, p. 614.
Williams.	Flexion.	IX.	4	Trans. Obstet. Soc. Lond., vol. xiv., p. 308.
Kinloch, modification of Hodge-Simpson.	Retroflexion.	Text.	42	Trans. S. C. Med. Assoc., 1875, p. 261, Figs. 2, 3.
Thomas.	Anteflexion.	Text.	44	Tiemann's Cat., Part III., p. 89, Fig. 411.
Thomas.	Anteflexion.	Text.	45	Thomas, Prac. Treat. Dis. of Women, p. 428, Fig. 169, 1880.
Thomas.	Anteflexion.	Text.	46	Thomas, op. cit., p. 428, Fig. 169, 1880.
Mossman.	Retroflexion.	Text.	51	Letter from Dr. B. E. Mossman, Greenville, Pa.
Thomas.	Lateroflexion.	Text.	52	Thomas, op. cit., p. 452, Fig. 197, 1880.
Van de Warker.	Anteflexion.	Text.	47 48 49 50	N. Y. Med. Jour., vol. xxiii., p. 561, 1876.

CLASS 3.—*Self-retaining Form of Intra-uterine Stem.*

Name.	Form of Displacement.	Plate.	Figure.	Reference.
Unknown.	Anteflexion.	Text.	53	Tiemann's Cat., Part III., Fig. 425.
Squarey.	Any flexion.	IX.	5	Lond. Lancet, 1874, p. 49.
Van de Warker.	Anteflexion.	Text.	6 54	N. Y. Med. Jour., October, 1873.

CLASS 4. — *Spring Intra-uterine Stems.*

Name.	Form of Displacement.	Plate.	Figure.	Reference.
Kiwisch.	Ante or retroflexion.	XI.	{ 1 2 3	Verhand. d. Gesellschaft f. Geburts. 4th yr. Taf., Figs. I., II., III.
Kiwisch-Mayer.	Ante or retroflexion.	XI.	{ 3 4 5	Winckel, op. cit., Fig. VII.
Wright.	Anteflexion.	X.	{ 2 3	Wright, Ut. Disorders, p. 86, Lond. 1867.
Wright - Chambers - Beigel.	Anteflexion.	X.	4	Beigel, op. cit., Bd. ii., p. 248, Fig. 78.
Chambers.	Ante or retroflexion.	X.	5	Obstet. Jour. Gr. Br. and Ire., vol. i., p. 22.
Aveling.	Ante or retroflexion.	X.	6	Trans. Obstet. Soc. Lond., vol. vii., p. 156.
Simpson.	Anteflexion.	X.	1	Lond. Lancet, 1866, p. 531.

CLASS 5. — *Intra-uterine Stems with Simple Vaginal Attachment Necessary for Retention.*

Name.	Form of Displacement.	Plate.	Figure.	Reference.
Simpson.	Ante- or retroflexion.	V.	{ 1 2	Winckel, op. cit., Figs. II., III.
Simpson.	The same.	V.	3	Beigel, op. cit., 240, Fig. 68.
Simpson.	The same.	V.	4	Simpson, Dis. of Women, p. 779, Fig. 141.
Simpson.	The same.	V.	5	Simpson, op. cit., p. 778, Fig. 140.
Lazaruvitch.	Retroflexion.	V.	{ 6 7	Trans. Obstet. Soc. Lond., vol. xi., p. 79.
Schroeder, after Simpson.	Anteflexion.	V.	8	Schroeder, Dis. of Women, Ziemssen's Cyc., Eng. ed., p. 174, Fig. 59.
Peaslee, after Simpson.	Retroflexion.	V.	9	Trans. Med. Soc. S. N. Y., 1866, p. 100.
Tait, after Simpson.	Anteflexion.	VI.	1	Obstet. Jour. Gr. Br. and Ire., vol. i., p. 180.
Conant.	Retroflexion.	VI.	3	Tiemann, Cat., Part III., Fig. 422.
Edwards.	Retroflexion.	VI.	4	Tiemann, Cat., Part III., Fig. 427.
Braun, C.	Ante- or retroflexion.	VII.	{ 4 5	Winckel, op. cit., Figs. XIII., XIV.
Martin, E.	Anteflexion.	VII.	6	Winckel, op. cit., Fig. XV., et Martin, Neig. u. Beug. des Ut., p. 78.
Sims.	Ante- or retroflexion.	Text.	57	Also published.
Van de Warker.	Retroflexion.	Text.	{ 55 56	Buffalo Med. and Surg. Jour., April, 1874.
Donaldson.	Ante- or retroflexion.	Text.	58	Donaldson, Contributions to Prac. Gynecology, p. 61.

This classification may appear complicated ; but take all of Group III. as an example, and we perceive that each of the classes is designed to act upon different principles, either in the correction of uterine distortion or of retention. With these differences I do not see how the classification of this group could be simplified. The same may

be said of Group II., which is exceedingly difficult to classify and describe.

GROUP I., comprising all those pessaries that act upon the uterus by support external to the body, represents one of the oldest forms of version and flexion pessaries. Much of the disrepute historically attached to the intra-uterine stem came from its fatal connection with this means of retention. The theory upon which this group of instruments was based was becoming obsolete, when it was revived by securing a place in Dr. Thomas's text-book.

The simplest form of this group is Class 1, being a simple firm loop passing into the posterior or anterior vaginal cul-de-sac, and retained in place by elastic support connected with an abdominal belt. Its modern form, known as Cutter's pessary, is a survival of an old form (Pl. XII., Fig. 1), which gained no reputation. It was invented by Priestley.

This theory is connected with another principle of mechanical change in uterine position, that of displacement. This constitutes Class 2 (Fig. 8). I apply the term dis-



FIG. 7.

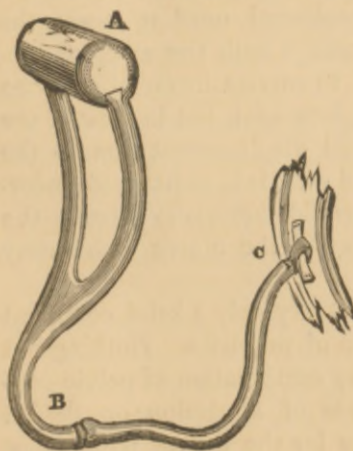


FIG. 8.

placement to the introduction of any mass within the grasp of the vagina, sufficiently large to elevate the vaginal vault and displace the uterus from any position it may occupy in the direction of the least resistance. This implies freely movable walls. In combination with the Priestley form of instrument, the principle of its action is violated, for, the posterior vaginal wall against which the bulbous enlargement A,

Fig. 8 (Pl. XII., Fig. 4) impinges, is fixed by the strong



upward pressure of the external support, while the mass A displaces the cervix forward in the ratio of its bulk, and the posterior vaginal wall antagonizes this forward movement by backward traction in proportion to the upward pressure of the external support. This enlargement of the upper part of the instrument was added, probably, for the purpose of increasing the bearing surface of the loop, seen to better advantage in Fig. 7, and thus obviating one of the dangers of this form of instrument, ulceration of the vaginal wall. It will be seen, however, that, from the counter strain upon the posterior vaginal cul-de-sac, it is exposed to more danger from this form than from Class 1 of this group.

In Class 3 we have presented a still more dangerous instrument (Pl. XII., Fig. 5), in which the upper part is formed into a coil which encircles the cervix, and thus causes absolute fixation. In this form by Wade we have united every bad principle that can be combined in a pessary. In another pessary (Cutter, Pl. XII., Fig. 3) we have nearly the same form with less incarceration of the uterine neck. In this class, in which absolute fixation is the distinguishing trait, we must also include Thomas's modification of Cutter's pessary. In this instrument there is an anterior loop prolonged backward until it meets the descending limbs, which connect it with the external support (Fig. 9).<sup>1</sup>



FIG. 9.

It is designed to correct intractable forms of anterior displacement, but in view of the limits to upward displacement due to the anterior vaginal wall, it is difficult to understand how it could materially change the relative position of the uterus with safety to the part.

There is necessary only a brief comment upon this group of pessaries. Nothing but an extraordinary combination of pelvic conditions would warrant the use of a version or flexion pessary that violates every rule for the proper adjustment of the instrument. Certainly, if the "physician possess

<sup>1</sup> Thomas, *Pract. Treat. on Dis. of Women*, p. 423, 1880.

only little skill in the use of pessaries," he had better employ an internal pessary, but not one connecting externally with a band. This form violates the law of uterine mobility; it interferes with the function of near parts, and by over-tension tends constantly to weaken the vaginal column. The principle involved in the mechanism of this group belongs to the correction of total prolapsus uteri, and even here it is not easy to get the subject to wear the instrument.

A form of pessary that must be classed among those having support external to the vagina is Weber's (Fig. 10). Here the T-shaped part passes in the posterior cul-de-sac, and is designed to correct a retroversion, and is kept in place by the stem passing backward over the perineum and attached to what resembles a pile instrument inserted in the rectum. The idea is an old one. Bond<sup>1</sup> invented a pessary of the same character. Weber's instrument is shown here as a mechanical curiosity, and as an evidence of what absurd things have been, and probably will be again, invented and called pessaries.

GROUP II. includes all the instruments that act within, and are limited by, the vagina, and are the most useful and scientific of all the mechanical means for overcoming a version. Notwithstanding the great variety of outline presented by the members of this group, the mechanical elements involved are few, and we may thus reduce them to comparatively few classes. It is difficult to demonstrate these mechanical elements, and equally so to prove the result of these elements upon uterine position. It is evident that the inventors have in many instances taken a wholly different view, both of the principles of construction and of the effects gained, from myself. And this seems the proper place to ask the indulgence of all my friends who have invented pessaries, and which I may classify and comment upon in a manner that does not meet with their approval.



FIG. 10.

<sup>1</sup> *Am. Jour. Med. Sciences.* April, 1849.



*Class I.*—Those pessaries acting by displacement, reduced to the simplest proposition is that of one bulk displacing another. This implies a more or less fixed point, that of counter-pressure, and the movement of contiguous parts in the direction of the least resistance. We may be able to get my idea of the theory of mechanical displacement from the diagram (Fig. 11). The cube *E, E, E*, is forced up in the elastic tube *A, B, F, G*. The line *C D* represents the direction of the least resistance, and the line *A B* the direction of counter-resistance. It follows, there-

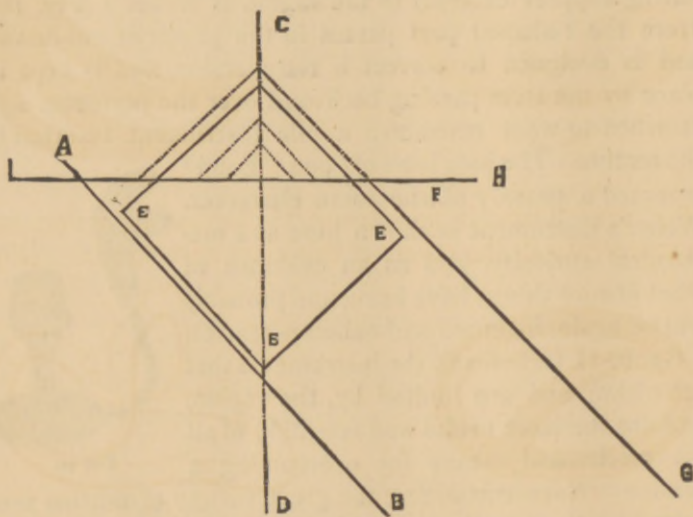


FIG. 11.

fore, that as the line *A B* cannot yield, and as the cube is forced onward, the yielding will be in the direction of *C*, the least resistance; the line *I H* is deflected in a manner represented by the dotted lines corresponding in direction to the upper angle of the cube. The extent of deflection in the line *I H* would be limited by the amount of compensation in the line *F G*, and would be at its limit an absolutely fixed quantity.

The lines *A, B, F, G*, may express the vaginal walls, and



for the cube we may substitute any possible form of pessary that, by mere bulk, will displace the line *I, H*, which expresses the vaginal vault. Theoretically I have represented the displacing force as a cube; in practice it would make no difference what shape the displacing body may have, provided it is of such a shape as to displace or separate widely the vaginal walls. So far as results are concerned, the instrument may as well have been made solid. One of the most perfect of this type is Page's "dumb-bell,"

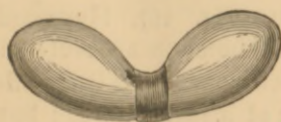


FIG. 12.



FIG. 13.

(Fig. 12). There is no attempt to disguise its action, and it represents all the others of this class here figured. (Fig.

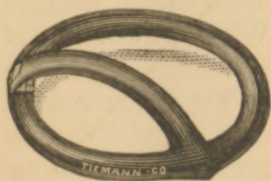


FIG. 14.



FIG. 15.

13), Pallen's anteflexion, and (Fig. 14), Hitchcock's anteversion, act upon the same principle.

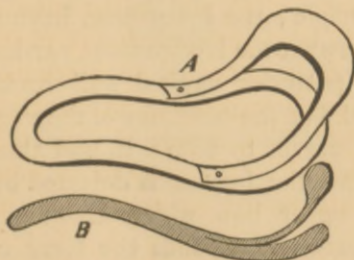


FIG. 16.

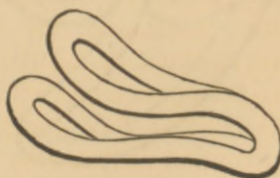


FIG. 17.



FIG. 18.

A more modern type under this class and group has the displacing force acting from its bulk combined with an elastic or spring force. Of this nature are Cole's anteversion (Fig. 15) and retroversion (Fig. 16), Heywood Smith's retroversion (Fig. 17), and Thomas's anteversion (Fig. 18). Under the most favorable circumstances it is difficult to estimate accurately the value of a spring force; but when a force of this nature is concealed in the vagina we have triple difficulties to contend with; we are in doubt as to the tension of the spring, also as to the degree of force opposed to it, and lastly, that this opposing force is constantly, and to an unknown extent, changing in intensity. An elastic force is one that living tissues cannot contend with. They must yield before it. Witness the effect of the elastic ligature in surgery. On these grounds one would say that such an instrument as Fig. 15 represents could not be worn with comfort or safety, especially as the anterior wall is exposed, which is prone to ulcerate under the best conditions.

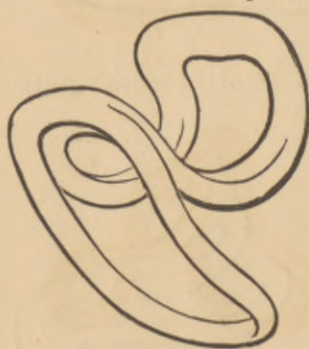


FIG. 19.

Fig. 17, Heywood Smith's, being a retroversion instrument, combines a defective theory with a defective principle; the lower bow, having somewhat the Hodge form, carries the posterior vaginal wall backward, but the tendency of the vaginal cervix to follow it, and thus elevate the fundus, is defeated by the upper bow which crowds it forward and expends the force of

the instrument upon the posterior cul-de-sac.



The antetype of this form of forward displacement pessary is Priestley's, shown in Fig. 19. It is simply an exaggeration of the modern form, and is figured here for its historical interest. The displacement of the anterior vaginal wall is so great that probably it could not be borne but for a few hours.

This displacement theory is generally applied to forward displacements, and is assigned any form of action to suit the idea of the inventor. In theory these instruments are sufficiently correct; but in practice it is surprising to what a limited extent the uterus may be lifted by a displacing force acting upon the anterior vaginal wall. If we conceive the upper angle (*C*) of the cube in Fig. 11, so turned that it will displace the line *FG*, the extremity of the line *G* being fixed, we shall understand how slight will be the deflection that will result. Displacement will result in little more than tension.

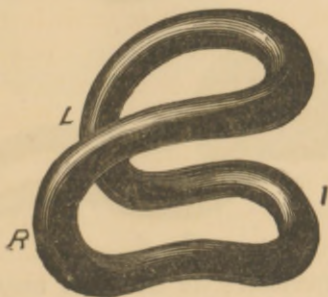


FIG. 20.



FIG. 21.

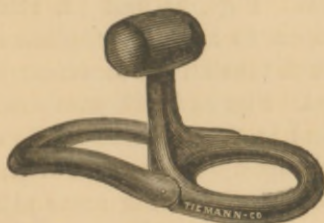


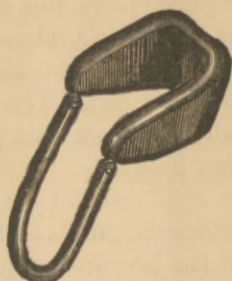
FIG. 22.



FIG. 23.

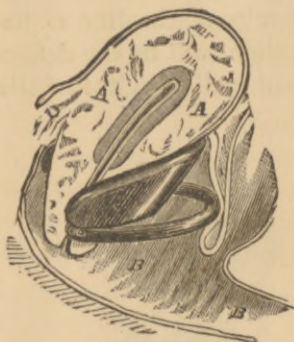


FIG. 24.



For introduction or withdrawal.

FIG. 25.



Pessary in situ.

FIG. 26.



FIG. 27.



FIG. 28.

Fig. 20 is Gehrung's anteversion ; its antetype may be seen in Pl. XIV., Fig. 5, in Vulliet's form, which has also been used in prolapsus, and in which it proved useful for its powerful displacing qualities. Figs. 21 and 22, Thomas's anteversion, must, when open as in Fig. 22, place the anterior vaginal wall under such tension as to defeat the purpose for which it was applied. Fig. 23 is Thomas's modification of Hewitt's pessary, and is the most scientific application of this mechanical principle. We see its original form in diagram in Pl. XIV., Fig. 1, and in the same plate, Figs. 2, 3, Beigel's modification is shown. By comparison with Thomas we see that the latter has diminished lateral displacement by contracting the ascending and descending



limbs, which is an improvement. Fig. 11, Pl. XIII., is a still further modification, that of Schultze, with displacing power greatly lessened by lowering the apex. In Figs. 24, 25, 26, Thomas's anteversion is represented in different positions. Fig. 26 shows the instrument in position, and gives the reader a realistic idea of its displacing qualities.

Another of Thomas's anteversion pessaries is shown in Fig. 27. It is essentially the same as Fig. 24 in action, and is probably the parent idea.

It is defective by fixing the vaginal cervix in its upper portion, when the cervix ought to be allowed to move downward and forward as the fundus uteri is raised. In Pl. XIII., Fig. 7, Galabin's anteversion pessary is shown. Radically it is constructed upon the theory of Hew-

itt's. It is a curious fact that, by curving down the extremity *A*, Gehrung has converted it into a retroflexion pessary. Galabin antedates Gehrung about a year. Gehrung's retroflexion instrument, Fig. 30, and his anteflexion, Fig. 29, are excellent types of this class. For anteversion, Fig. 29 is fully equal to that of Hewitt, or Thomas's, Fig. 27; but for anteflexion, unless in a very relaxed organ, it could avail nothing. Pallen's retroversion, Fig. 28, combines the

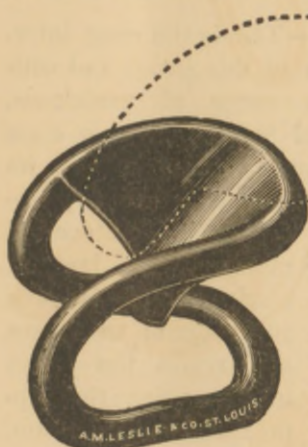


FIG. 29.

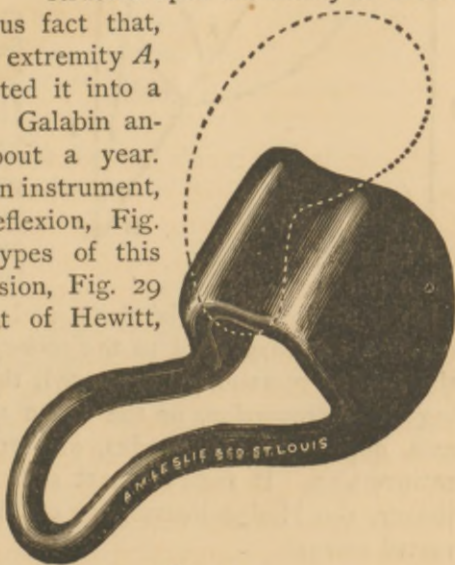


FIG. 30-

Hodge form with displacement. Notwithstanding the difference in form, and the absence of the spring attachment, the effect is that of Heywood Smith's, Fig. 17.

Pl. XIII., Fig. 9, shows Studley's anteversion, which is constructed upon the excellent plan of an adjustable displacement force in the upright tongue, the only instrument of the kind yet constructed.

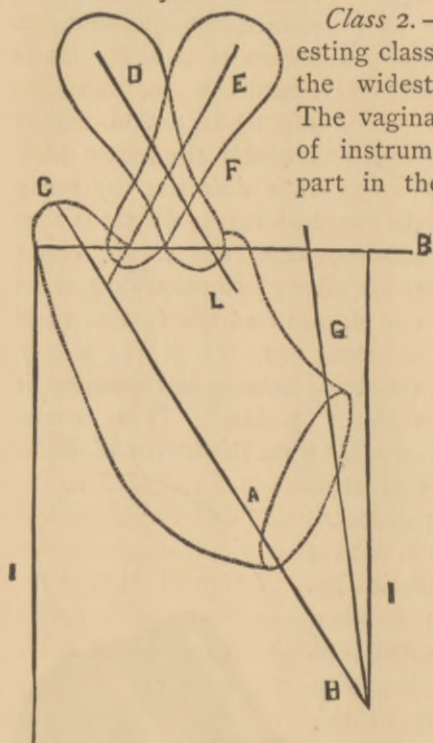


FIG. 9.

*Class 2.* — This is the most interesting class of this group, and with the widest range of usefulness. The vaginal wall is, by this class of instruments, made to play its part in the reposition of a retroverted or anteverted uterus. The law of uterine mobility is taken advantage of to replace and retain the organ in a position that approximates the norm. Hodge disclosed to gynecologists this wide field of uterine mechanical therapeutics. Yet Hodge did not seem to have a clear idea of the principle upon which his pessary acted. If its mechanism was that of leverage it could act

upon the vaginal cervix alone, and, by displacing it, the cervix alone responded to the movement, the position of the fundus remaining unchanged, thus relatively increasing the retroversion, or the organ rotated upon its long axis, depressing the fundus, and actually increasing the retroversion. It seems almost self-evident that, upon this theory, the Hodge instrument could not replace a retroverted uterus.



The diagram, Fig. 31, is an attempt to demonstrate the theory of action of this class of pessaries. Conceive of an elastic tube defined by the lines *B*, *I*, *I*, and that a force within it is acting in the direction of *A C*; if this force is prolonged in the direction of *C* it will deflect the line *B*, as represented by the dotted line at *C*, and thus draw toward it any point upon the line *B* between this point and *C*. Obeying this movement, the line *D L* will assume the position of *E*, turning upon its axis of rotation at *F*. Compensation for the movement of *L* toward *C* is gained by the movement of the line *I* in the direction of *G*. This seems to my mind the only way in which pessaries of this class can operate beyond the limits of the vagina. It is equally evident to me that these instruments are useful only in versions. In case of flexions, the axis of the uterus, expressed by the line *D L*, will respond to the movement of the vaginal cervix, but remain in its distorted condition. The mere rotation of the organ will not straighten it.

First in point of interest are Hodge's instruments in their original form. Pl. XIII., Figs. 1, 2, 3. The instrument represented by Fig. 1 is now but little used. It is more particularly indicated in urethral and *bas fond* irritation of the bladder. Of all instruments of the class, the Albert Smith modification of Hodge is the most universally in use. The form of this modification of Hodge varies very greatly according to the ideas of the author who refers to it, or the instrument makers. Figs. 5 and 6, Pl.



FIG. 32.



FIG. 33.

XIII., and Figs. 32 and 33, showing Thomas's modification of the Smith-Hodge, give a good idea of these changes

of form. Eight other alterations in curve and lateral outline are named and sold, but they do not deserve place here. Chamberlain's pessary, Figs. 34, 35, is the most radical change which the Hodge form of instrument has undergone. It can be worn with considerable comfort, but shows a marked tendency to drop down from its place, owing to the slight grasp of the vagina upon its lower limb. Carroll's instrument, Fig. 36, is a spring pessary, and its central constriction, being firmly grasped by the vagina, gives it great

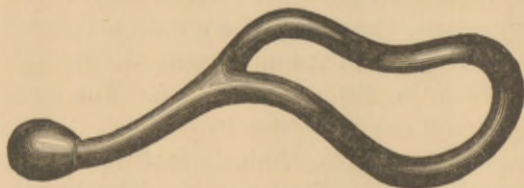


FIG. 34.



FIG. 35.

supporting power. It cannot, in my view of its action, correct a flexion. Woodward's pessary, Fig. 37, must be classed among the modifications of Hodge-Smith. It is simply furnished with a "cross-bar" to give additional support to the uterus. Scattergood's

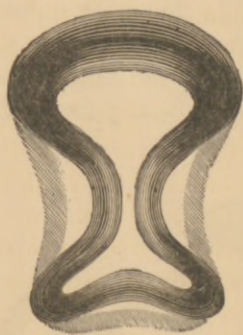


FIG. 36.



FIG. 37.

pessary, Pl. XIII, Fig. 8, has a spring concealed in its lower limbs. Aside from the error of its construction, it easily gets out of order, and becomes foul.



One word as to the general principle of construction of pessaries of this class. A pessary upon the Hodge plan retains its position in proportion to its amount of reversed curve. The Hewitt form (Pl. XIII., Fig. 4), while it corrects the uterine position perfectly, is constantly getting out of place, owing to the slight amount of curve. The same may be said of the Schultze instrument (Pl. XIII., Fig. 10); although the inventor endeavored to secure vaginal grasp by twisting the pessary twice upon itself in its long diameter, yet the general contour is straight, and the pessary easily drops out of place from supra-pelvic pressure. If, however, the curve is too great, it interferes with the traction exerted by the vaginal vault upon the cervix, and puts such a strain upon the walls of the passage that it cannot be borne.

The third class of this group is quite a modern and useful one. The distinguishing trait is the mechanical fixation of the vaginal cervix, so as to limit its lateral and antero-posterior rotations. This class has considerable reputation among those who have a prejudice against the intra-uterine stem of replacing a flexed uterus, and certainly, from their ability to firmly fix the cervix, they come nearer to this result than any other class of vaginal pessary. Many of these instruments combine other mechanical principles, but it is doubtful if these complications add any efficacy to the pessary.

Hoffman's pessary (Fig. 38) would accomplish considerable uterine rectification if it could be retained in proper adjustment. When small it is crowded too far back in the posterior cul-de-sac, and when of full size is not worn with comfort. The uterine neck, even when the central opening is of sufficient size, is pressed down with force enough to retard the circulation, and the discharges of the part add to danger of erosion. Soft rubber is always a bad material for a pessary. Hurd's instrument (Pl. XII., Fig. 6) carries out the same idea in a better way. It is polished and vulcanized, and more easily kept clean, but its effect upon the inclosed vaginal cervix is the same as

the Hoffman. Unlike the latter it is very easily introduced and removed, while the Hoffman is, after being worn some

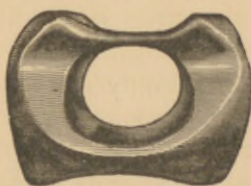


FIG. 38.



FIG. 39.



FIG. 40.

time, held with a vice-like grasp, owing to atmospheric pressure. Woodward's instrument (Fig. 39) is a modified Hodge, with an arched bar in front of the posterior curve which impinges upon the anterior vaginal wall. In very sensitive parts it cannot be borne. Fowler's (Fig. 40) has great reputation, and is a very useful instrument. The bow form is the one represented, and in my own experience is not an improvement. Fitch (Fig. 41) and Studley's (Pl. XIV. Fig. 6) are instances of the endless combinations which may be made on the Hodge form. The fixation in this combination is too great to be used with either comfort or

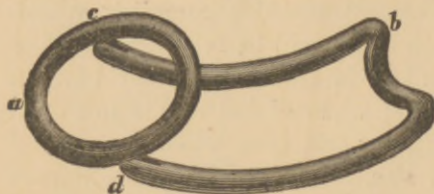


FIG. 41.



FIG. 42.

safety in the majority of cases. Thomas's anteversion (Fig. 42) is another variation of the principle of the Hodge, but fixation is very much less than in the two last examples, on account of the shorter projection into the grasp of the vagina. Schroeder's eccentric ring (Pl. XII., Fig. 7) combines



displacement with fixation, and is given for the purpose of showing the way in which the various groups merge into each other. All the instruments of this class might be used in cases where sensibility and engorgement of the parts are removed, and the case has settled down into hopeless displacement. Even here they are attended with one great drawback. In cases selected as above, the patient ought to be able to remove and adjust her support at her own option. I have found it very difficult to instruct the average woman to do this with this class of pessary.

GROUP III. — This group includes all those instruments known as intra-uterine stems. They are almost exclusively used for the correction of flexions of the uterus. Within their sphere they are theoretically the most perfect, practically the most useful. It is one of the oldest forms for the correction of versions or flexions of the uterus. In 1843 Simpson showed to the Medico-Chirurgical Society of Edinburgh both forms of the intra-uterine stem; while it was not until 1846 that Kilian introduced his elytromochlion. Both these instruments were followed by a numerous progeny. Gynecologists have been loath to abandon the mechanical theory of the intra-uterine stem. They have



FIG. 43.

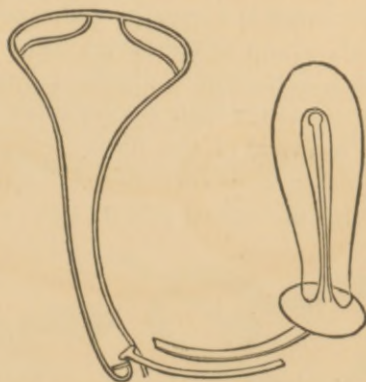


FIG. 44.

thus thought to evade supposed dangers by giving the instrument a great variety of forms. No advance has been made upon the first form of Simpson. To him we owe

the instrument, and to him also we owe its most dangerous variation.

*Class 1* in this Group III. is that form of the intra-uterine which is secured in place by support external to the body. Fig. 43, known as Cutter's, is one of its modern forms. By comparing it with Fig. 44, Simpson's "third form," it will be seen that the variation is not material.

Another slightly modified form of Simpson's instrument, copied from Winckel, is shown in Figs. 2, 3, 4, Pl. I. This author is in error in assigning the instrument of Kiwisch five years priority over Simpson's pessary.<sup>1</sup> Kiwisch's instrument (1847) is shown in Fig. 1, Pl. I.; Valleix (1850), Figs. 1, 2, Pl. II., has an inflatable rubber ring attachment, but it does not act as a guard against the dangerous penetration of the intra-uterine part of the instrument. Kilian (1849), Fig. 1, Pl. III., is of the same dangerous character. Beigel has invented the most inoffensive instrument of the class. It consists of an intra-uterine stem attached to an inflated rubber ball, and the tube through which the ball is inflated is caught up in a belt around the waist (Pl. III., Fig. 2.)

These instruments are figured in the interest of history rather than as being of any practical value. They violate every law governing the use of the intra-uterine stem. This group of pessaries owes its ill-repute to one of this class,—that of Valleix. I know of no good author who recommends their employment. There will probably never be a revival of this form.

*Class 2.* — Intra-uterine stems combined with various forms of vaginal pessary :—

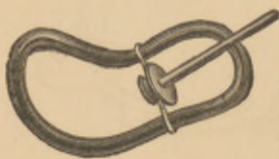


FIG. 45.

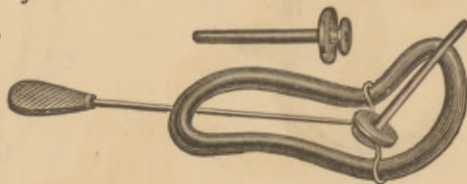


FIG. 46.

<sup>1</sup> *Selected Obstet. and Gynecol. Works of Sir J. Y. Simpson*, p. 706. New York. 1871.



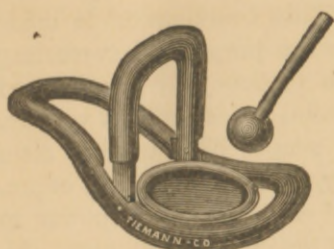


FIG. 47.

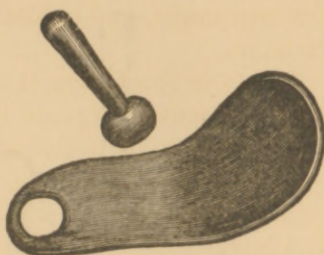


FIG. 48.

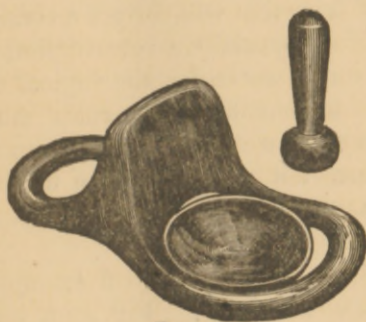


FIG. 49.

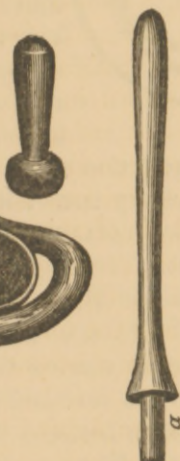


FIG. 50.



FIG. 51.



FIG. 52.

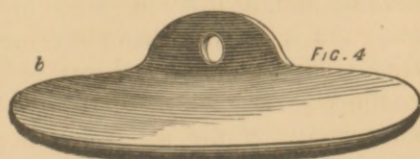


FIG. 53.

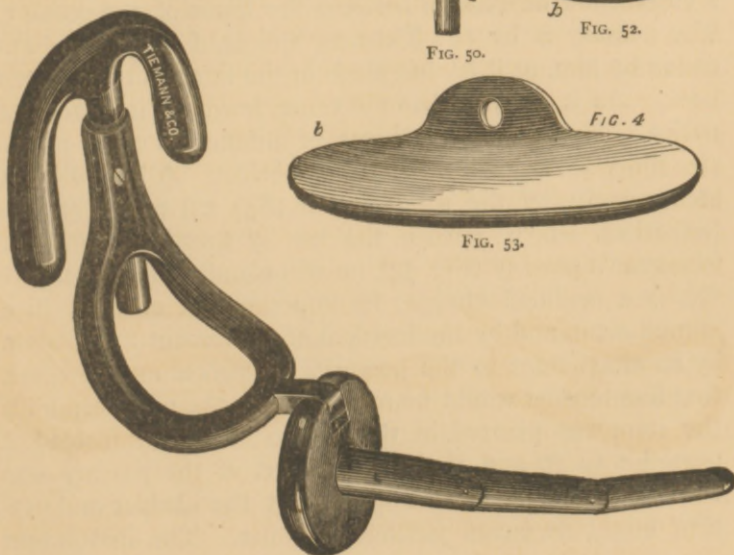


FIG. 54.

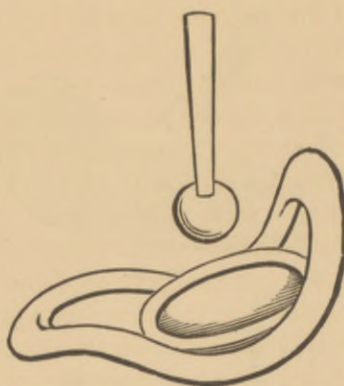


FIG. 55.

This combination is made for the purpose of correcting the tendency of a corrected flexion to result in a version. A simple intra-uterine stem may straighten a flexed organ, but of itself has no power to lift the depressed fundus. Almost any simple vaginal pessary that will correct a version — especially a retroversion — may serve for the vaginal attachment. Two rules must

govern us in the selection of the combined instrument: That the vaginal pessary does not produce undue uterine fixation; and that the intra-uterine stem be not too rigidly attached to the pessary.

Kinloch's instruments (Figs. 45, 46) are good examples of what a pessary of this kind should be. Fig. 47 is very liable to produce undue uterine fixation, but it will be observed that the stem has no fixed attachment, but plays in a cup-shaped depression between the limbs of the pessary. The pessary is by Dr. Thomas, and is, I suppose, abandoned by him, as it has no place in the later editions of his book. As it is offered to the trade, however, it is worth a notice. Thomas's other forms of anteflexion stem pessaries (Figs. 48, 49) are theoretically perfect. A lateroflexion stem pessary by the same author (Fig. 55) meets all the limitations which govern the use of these instruments. Mossman's pessary (Fig. 54), notwithstanding its novel profile, is a modified Hodge; its improvement consists in a jointed stem, and by the freedom of movement to the stem by its attachment to the pessary. It strikes me, however, that less tension would be exerted upon the os externum if the stem was planted in the centre of its disk instead of posterior to it, and if the lower part of the pessary was curved the reverse of the upper part the bladder and urethra might be saved possible pressure. The instrument



deserves trial. Bad examples of this form are seen in Figs. 1, 2, Pl. IX. — the Hodge-Simpson form. In this instance intra-uterine stem and pessary must move together, and the uterus be constantly subjected to a double strain. The Barnes pessary shows a similar instrument with this error corrected (Fig. 3, Pl. IX). The Williams (Fig. 4, Pl. IX.) and Winckel's (Fig. 2, Pl. VIII.) have the stem resting upon a perforated elastic diaphragm. Winckel's pessary, notwithstanding the great size of the ring, can conserve no other purpose than the simple one of sustaining the ring. Studley's pessaries (Figs. 6, 7, Pl. VIII.) have the stems supported by elastic bands crossing from limb to limb of the Hodge-Smith instrument, and are nearly ideally perfect. Schultze's (Fig. 5, Pl. VIII.) for anteflexion, must be an exceeding difficult pessary to adjust, while the larger part of the figure of eight must exert an undue tension on the anterior vaginal wall. Winckel's modification of Valleix's pessary (Fig. 1, Pl. VIII.) must, from the size of the ring to which the stem is tied by strings, rather tend to increase the tendency to retroversion. Chadwick's form (Fig. 3, Pl. VIII.), would evidently serve a very useful purpose when the tendency to retroversion is not strong. Winckel's original form (Fig. 3, Pl. VII.), the Simpson-Martin (Fig. 1), and Hewitt (Fig. 2, Pl. VII.) possess the common error of drawing the vaginal cervix forward, and thus tend to retrovert the uterus, instead of carrying the vaginal portion backward, a movement opposite to that of retroversion. Schultze's form (Fig. 5, Pl. VI.) has the stem attached in too rigid a manner, as well as having the error in construction of those last mentioned. Another form by the same author (Fig. 7, Pl. VI.) for anteflexion has the stem rotating upon a shaft between the limbs of a Hodge pessary, and its movement controlled by an extension of the stem at nearly right angles to it from the under side. Detschy's, of which two forms are given (Fig. 1, Pl. IV., Fig. 6, Pl. VI.), is an exceedingly dangerous form, and too strong language cannot be used in its condemnation. Strong language is happily not required; the instrument is obsolete. Cutter's

pessary (Fig. 4, Pl. VIII.) is a most unfortunate combination, every law governing the proper use of a pessary is violated in its construction. Another form of stem of this class consists of such a vaginal extension of the stem itself that the version is corrected by the same means which removes the flexion. Amann's intra-uterine stem (Fig. 2, *a* and *b*, Pl. VI.) for antelexion has the stem terminate in a flattened disk extending into the vagina parallel to the axis of the stem. After the stem is introduced the vaginal part is wedged backward by cotton, and the uterus maintained in an erect position. The instrument is very perfect in theory, but requires constant attention from the physician to keep the cotton in place. Taken altogether, grouped and classified, it is a stem pessary belonging to Group II., Class I, acting by displacement. My own form of pessary of this class is shown in Figs. 50, 51, 52, 53. A light stem rests before a shelf turned at right angles to a broad disk, *b*. The tendency to anteversion of the uterus after the stem is in position forces the disk *b* against the posterior vaginal wall, thus holding the uterus at about a normal inclination, while the posterior vaginal surfaces give an elastic and yielding support to the disk. The stem has great freedom of movement upon the vaginal attachment. As shown in the cuts, the disk may be given various forms to meet the requirements of different cases. Introduction is very simple; a wire is inserted into the part *D* of the stem (Fig. 50), and the stem is introduced as though it were a sound; after introduction the vaginal attachment is run on the wire as a guide, the end *D* is inserted into the opening of the disk, and the wire removed. The stem is worn with great comfort, especially in irritable bladder. The instrument was published in 1876.

*Class 3, Group III.* The self-retaining form has but few varieties. These instruments are designed for flexion of the uterine cervix, and especially of the vaginal portion. Methods of simple self-retention are out of the question in flexion located at the os internum, or of the uterine body; for, when situated at these points, uterine expulsive effort



is, at times, so strong that every form of intra-uterine stem may be expelled. When the flexed point is at the lower neck, the relative position of the organ above may be normal. This normal, forward inclination permits the os externum to rest lightly against the posterior vaginal wall in such a manner that a light intra-uterine stem may be prevented dropping out. An instrument such as is shown in Fig. 56 is very useful for this



FIG. 56.

purpose, and is worn with the greatest ease and comfort by young girls, who are sometimes the greatest sufferers from flexion of the vaginal neck. Fig. 57 represents a form of my own which I occasionally use. The upper part of the stem is perforated, through which passes a short piece of pure gum tubing. It works very well in cases in which an intra-uterine stem has been worn for some time, and the expulsive irritability of the organ diminished. As flexions at the os internum or uterine body are those forms of distortion in which we simply correct a flexion that we may contend afterward with a version, this, or any other form of self-retaining stem, is contra-indicated. Squarey's instrument is represented by Figs. 5, 6, Pl. IX. The pessary is flexible, and is introduced stretched out as in Fig. 6; by withdrawing the extending force the upper part of the tube expands, as shown in Fig. 5. The pessary has given excellent results in the hands of the inventor.



FIG. 57.

*Class 4. — The Spring, or Diverticulating Intra-uterine Stem.* This class is also a self-retaining form, but it differs so widely from Class 3 that it deserves separate study. While upon the subject of the displacement pessary with spring

action (Group II., Class 1), I referred to the difficulty of estimating the force of a confined spring, and the injury that elastic pressure was prone to inflict upon the soft parts. These objections hold good with double force when this elastic pressure is confined within the comparatively unyielding uterine cavity, and acts upon tissues disposed to resent continuous pressure. How slight this force may be, and yet excite uterine expulsive effort, the elasticity of the small cross-section of tubing in my own self-retaining form has convinced me. I generally found that these were not well borne unless previous tolerance had been gained by the use of the sound, or simple intra-uterine stem.

The idea of holding the instrument in place by elastic separating intra-uterine branches of the stem is an old one. In 1850 Kiwisch invented one of this class, which, regarded across the great space covered by achievement rather than by time, and which divides the present from the past in the history of gynecology, seems an impossible thing to apply to the uterus. Figs. 1, 2, 3, Pl. XI., give a fair idea of the instrument. The dividing branches *a* are drawn together by the cord *k*, operated by a screw at *m*, in the handle *e e*. Fig. 3 shows the handle as removed from the canula *i c*, and Fig. 2 represents the intra-uterine branches spread apart *in situ*. Figs. 4, 5, Pl. XI., exhibits Carl Mayer's improvement, which consists in guiding the cord over the convexity of the branches, instead of the concavity as shown at *k, a*, Fig. 1. The instrument is given here for its historical importance. It is an interesting fact in the history of these two instruments, that their descriptions appear as consecutive articles in the same number of the "Verhandlungen."

Fig. 1, Pl. X., exhibits Simpson's pessary; the springs are compressed for introduction by a ring, and released by drawing upon cords attached to the ring and passing through its vaginal bulb. It is figured full size, and is a powerful instrument. Fig. 2, Pl. X., represents Wright's, and is a much less objectionable pessary than that of Simpson. It is introduced by means of a handle that compresses the



blades, which is figured at *A*. Fig. 3 shows the instrument in position. Fig. 4 of the same plate is Chambers's modification of the last inventor's pessary, still further modified and figured by Biegel. It is difficult to understand the improvement over the original form of Wright's. Fig. 5, Pl. X., is the form of Chambers's. It is introduced by means of the handle *A*, which draws down the flange *C* as the handle is removed. It is well tolerated, and its field of usefulness, like that of all this class, except its Kiwisch and Mayer forms, is in flexions of the lower portions of the uterine neck, where the tendency to version is slight or wanting. Fig. 6 represents Aveling's pessary. The blades are confined by passing through a short canula, and are released by forcing the spring forward by means of the handle *B*. The action of the canula is well shown at *A*. Wright's and Chambers's instruments have been extensively used in England, and are quite well borne. The certainty of retention, especially in cases of dysmenorrhea due to flexion of the lower neck, has tended to make them popular. Other forms of self-retaining stems, or with simple vaginal attachments for retention (Class 5), not rarely become displaced just at the moment when they are most needed. My own experience of these pessaries shows that menstruation, while the instrument is worn, is more profuse and lasts longer than when the simple stem is employed. Careful supervision must be had over the patient while wearing instruments of this class.

*Class 5. — Intra-uterine Stems with Simple Vaginal Attachment necessary for Retention.* This class includes the ideally perfect intra-uterine stem. In all those cases in which a corrected flexion does not result in a version of such a degree that its replacement is required, this form of instrument is indicated. The vaginal part is added to the intra-uterine for the purpose of retaining the latter in position, nothing more. The greatest confusion has prevailed as to the size of the vaginal attachment necessary to accomplish this purpose. The illustrations of this class exhibit the great diversity in size. As a rule, the vaginal

attachment should be no larger than is necessary to retain the stem in position; that is, to resist the force of gravity and the uterine expulsive force. If there is any excess in size over this, normal uterine mobility is restricted, the function of the near parts may be disturbed, or the vaginal part may become displaced by expulsive efforts in defecation.

The form which I have used for many years, and after numerous trials of other instruments, is shown in Figs. 58 and 59.



FIG. 58.

The stem in Fig. 58 is actual size. I have the stems made after measurements of the uterine cavity. Sometimes, but rarely, the stem is made one fourth or three eighths of an inch longer, but never of greater diameter than in the cut. A wire is run into the end *a*, the cervix is exposed by a Sims' speculum, and firmly held by a tenaculum, and the stem introduced in the same manner as a sound. The flange, also actual size,

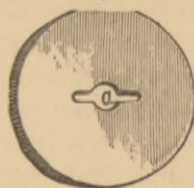


FIG. 59.

is slid over the wire through its central opening *a* until it is placed upon *a* of the stem (Fig. 58). At times difficulty is met in passing the flexed point; in this case a sound with proper curve is first passed and the uterus straightened, and held in that position for a minute or two, when, on the next trial, the stem will probably pass easily into the uterine cavity. If, however, it should not, use the sound a second time. Patience and gentleness of manipulation must be cultivated as an art by the physician who aspires to treat uterine flexions successfully. I have, on very few occasions, used a flange larger than that shown in Fig. 59. It will happen now and then that the flange and stem will get displaced. The remedy is a simple one: replace them, remembering that if a stem is so securely held in place by vaginal attachment that it cannot become displaced it is probably too good a fit, and the patient cannot wear it.



Fig. 60 represents Dr. Sims' intra-uterine stem. I have never used it, and am not aware that Dr. Sims has ever formally brought it before the profession; but the instrument has too many merits to neglect giving it a place in a monograph of this description. It deserves attention for the free motion of the stem upon the retaining portion, certainty of retention furnished by a ring over a solid vaginal part, and is evidently easy to introduce.

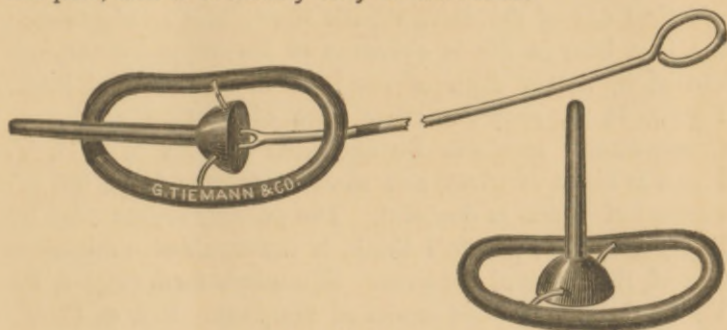


FIG. 60.

Fig. 61 represents Donaldson's pessary. It is a very recent invention, and deserves notice on account of the ingenious attachment of the intra-uterine stem to the retaining portion. The stem is fixed in the centre of a rubber diaphragm, which allows free movement in any direction. Another advantage has been noticed with reference to several other instruments, namely, the superior retaining power of an open or horse-shoe form over a disk or solid retaining part. One disadvantage it possesses in common with all forms of intra-uterine stems in which the stem is a permanent attachment to the retaining part. It is difficult to introduce the latter into the vagina while the former is being introduced into the uterine cavity. In some cases it is difficult to in-

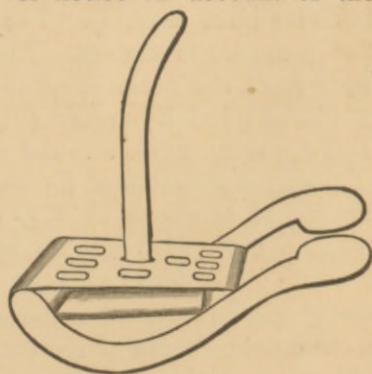


FIG. 61.

introduce even a sound, and in cases in which the vagina is narrow, as in virgins, who are very frequent subjects for intra-uterine stems, there is no room for the retaining portion, which ought, on this account, to be a separate part of the instrument.

Simpson's forms of pessaries of this class are shown in Figs. 1, 2, 3, 4, 5, Pl. V. They are among the oldest forms of the instrument. Indeed, to Simpson we owe the first practical use of the intra-uterine stem; that he abandoned the idea later in life is evidence of his too indiscriminate use of it, rather than of any fault in the method itself. Fig. 4, Pl. I., shows another form of Simpson's pessary. Cazarewitch's pessaries are exhibited in Figs. 6, 7, Pl. V. Fig. 6 is made of glass, and shows a twisted form, the advantage of which is doubtful. The pessary represented by Fig. 7 is hollow, which, I think, is the result of a mistaken idea of the office of the stem. Shroeder's form (Fig. 8, Pl. V.) is closely after the model of Simpson. Fig. 9, Pl. V., expresses Peaslee's pessary. It also follows the model of Simpson (Fig. 3, Pl. V). The second bulb is attached for the purpose of retention. It is a very useful pessary, and holds its place securely. The hinge attachment for retention purposes is useless. The vaginal part is sure to collapse from the pressure of the passage. Conant's (Fig. 3, Pl. VI.) and Edwards's (Fig. 4, Pl. VI.) are examples. Tait's pessary, another model after the design of Simpson, is, from the structure of its bulb, held in place very imperfectly. It is shown in Fig. 1, Pl. VI. C. Braun's stem (Figs. 4, 5, Pl. VII.) has the retaining part in the form of a small globe detached from the stem, and perforated so that it may be attached to the stem. Its distinctive feature is the extreme curve of the stem. Curved stems are worn with great comfort. In very acute and strong flexures it is necessary. The normal uterus is not a straight organ, and the perfectly adapted stem ought to conform to this normal curve. E. Martin's pessary, shown in Fig. 6, Pl. VII., closely follows the model of Braun. In both these pessaries there is evidently no advantage to be gained in the globe form of the retaining part.



Fig. 1.

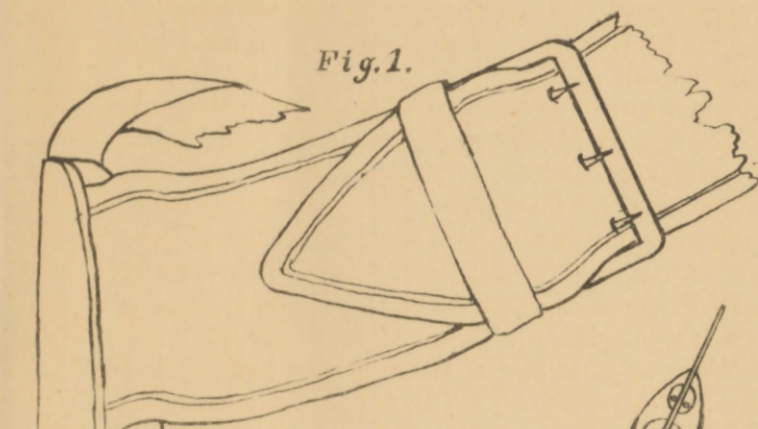


Fig. 2.

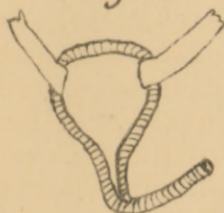


Fig. 4.

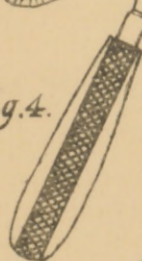
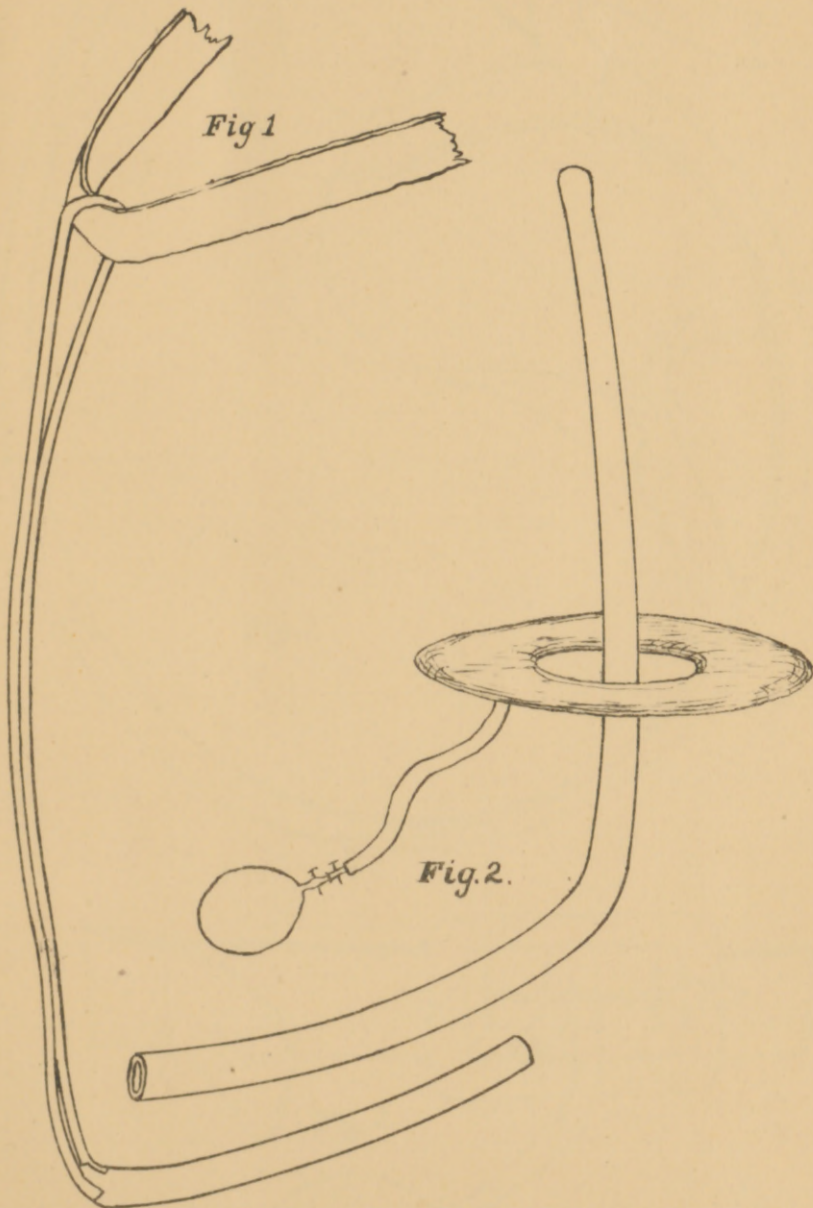


Fig. 3.



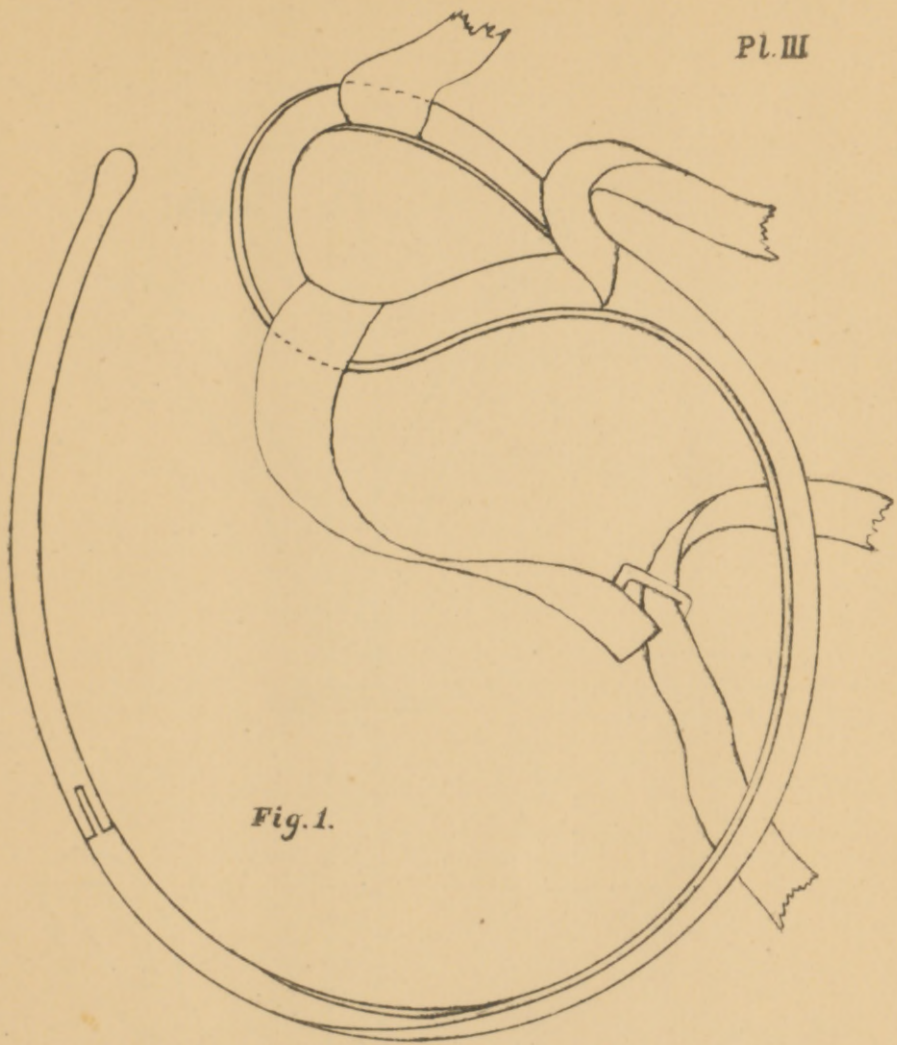




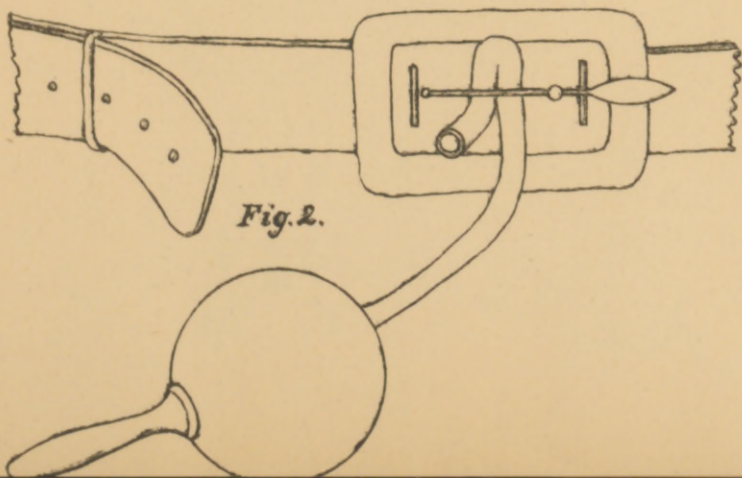








*Fig. 1.*



*Fig. 2.*



Fig. 1.

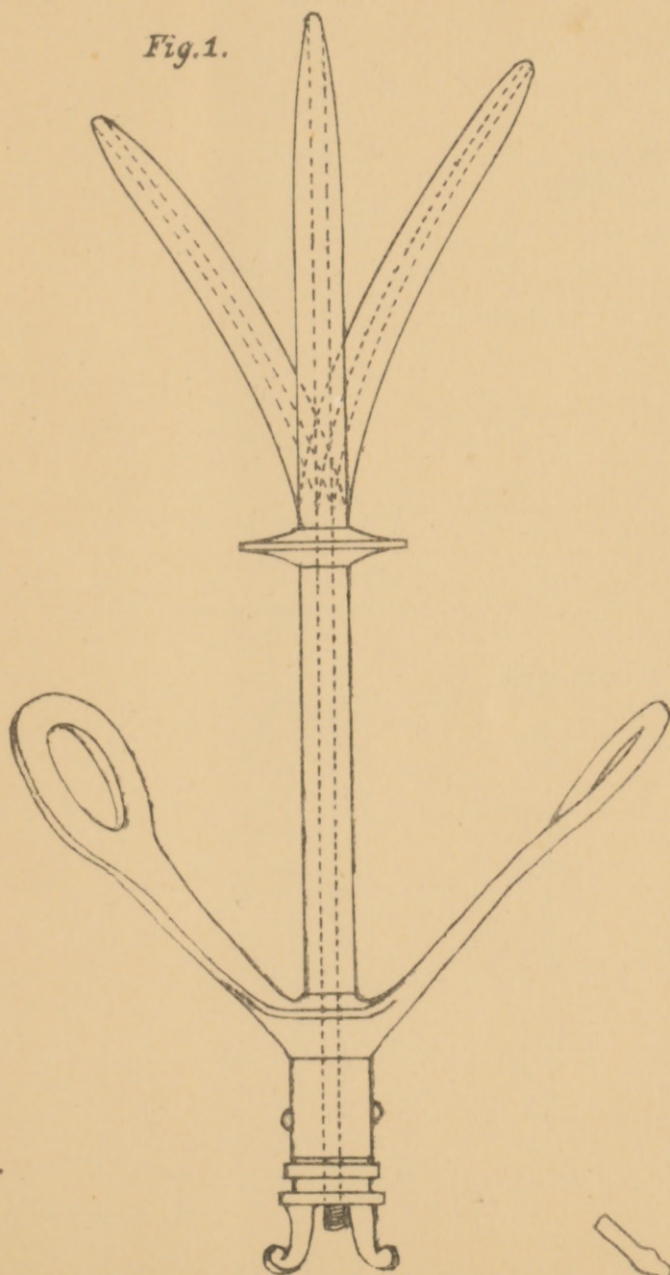
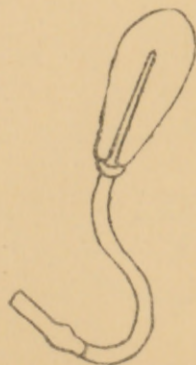
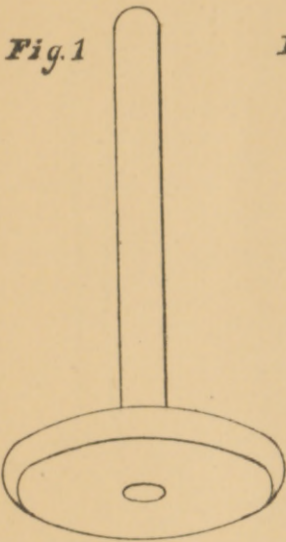


Fig. 2.

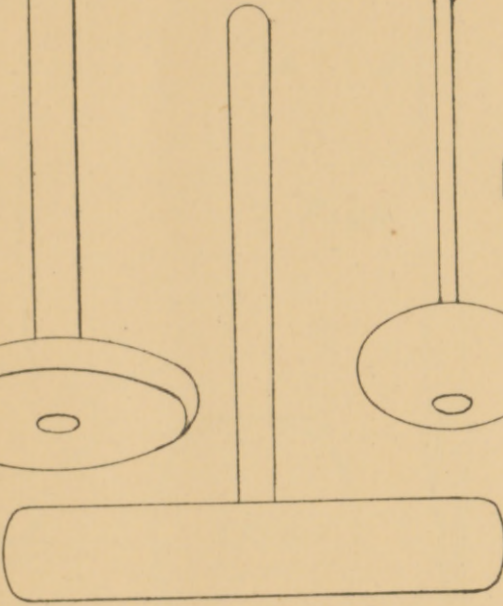




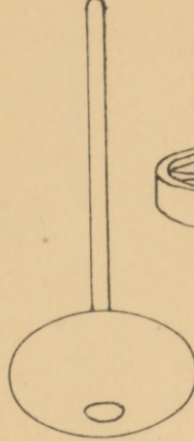




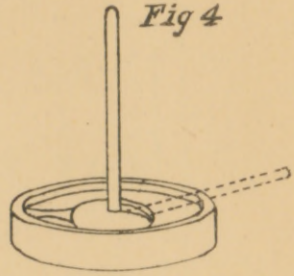
*Fig. 2*



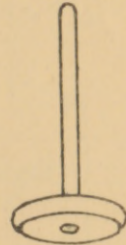
*Fig. 3*



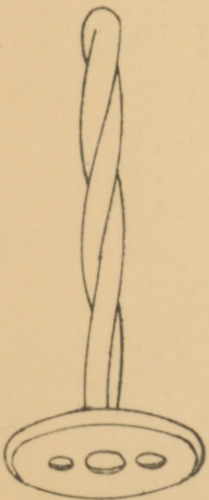
*Fig. 4*



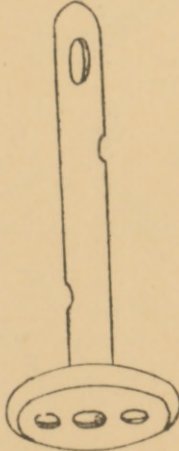
*Fig. 5*



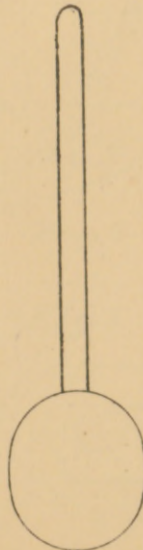
*Fig. 6*



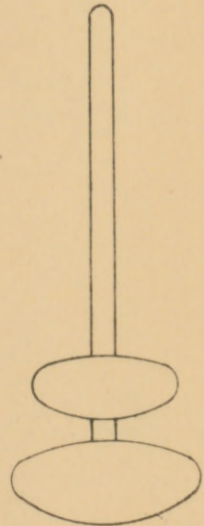
*Fig. 7*



*Fig. 8*



*Fig. 9*







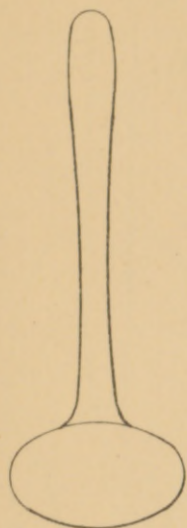


Fig. 1.

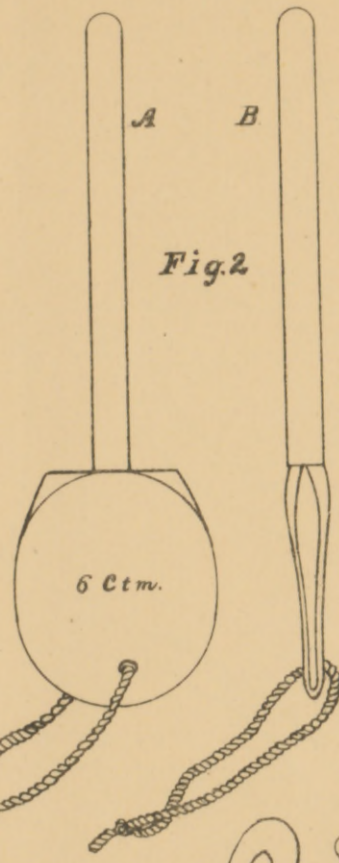


Fig. 2

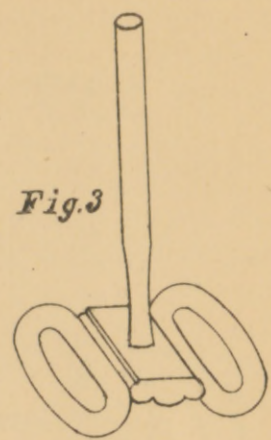


Fig. 3

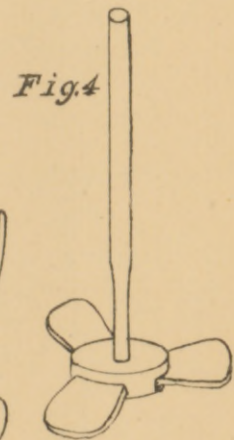


Fig. 4

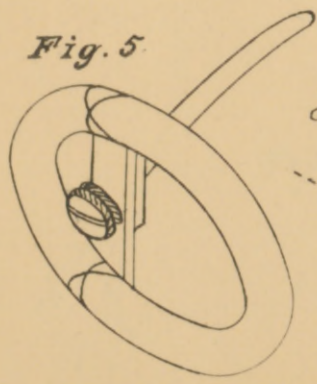


Fig. 5

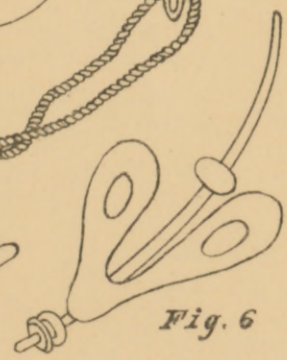


Fig. 6

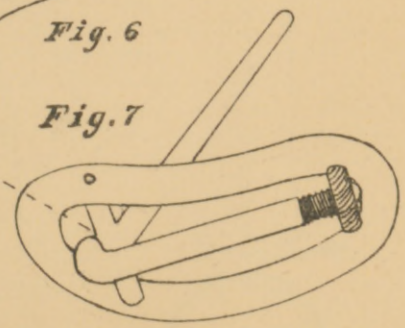
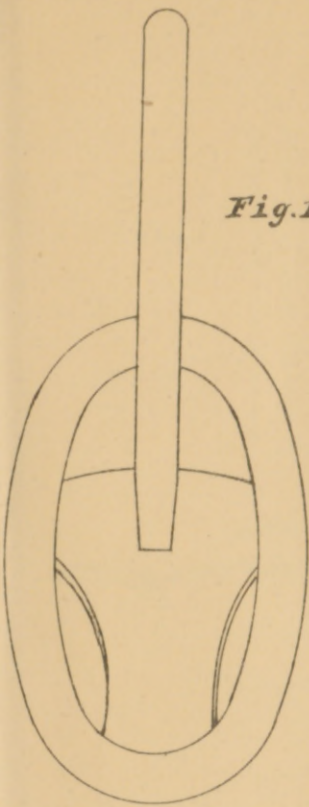


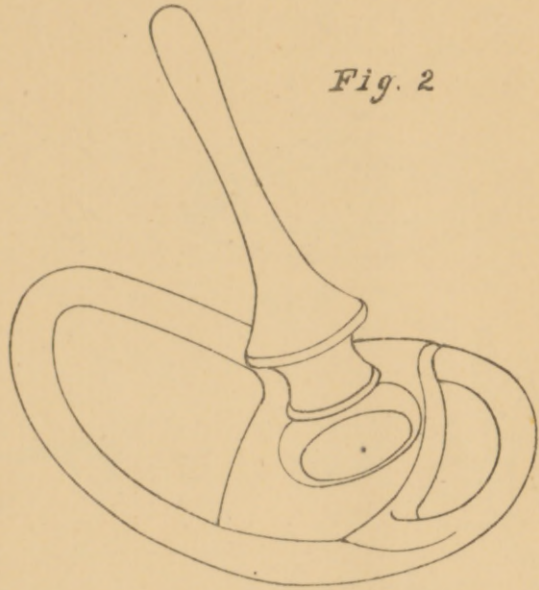
Fig. 7



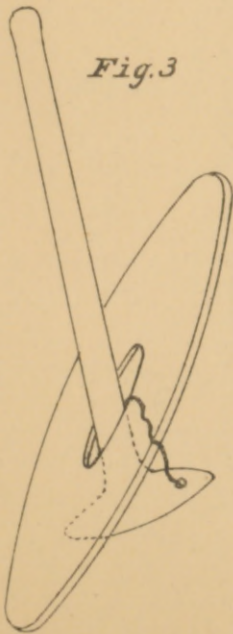
*Fig. 1*



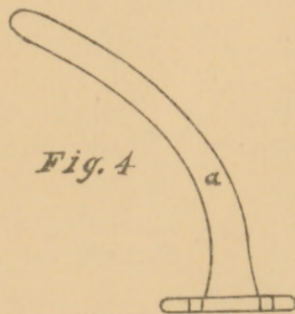
*Fig. 2*



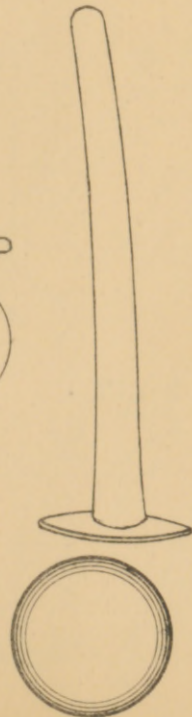
*Fig. 3*



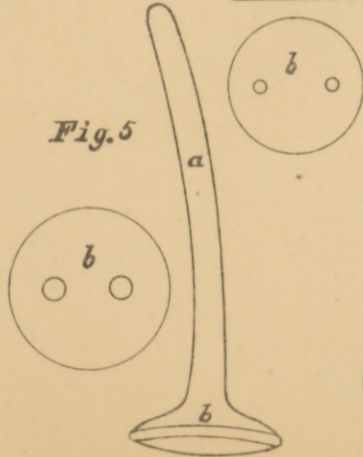
*Fig. 4*



*Fig. 6*



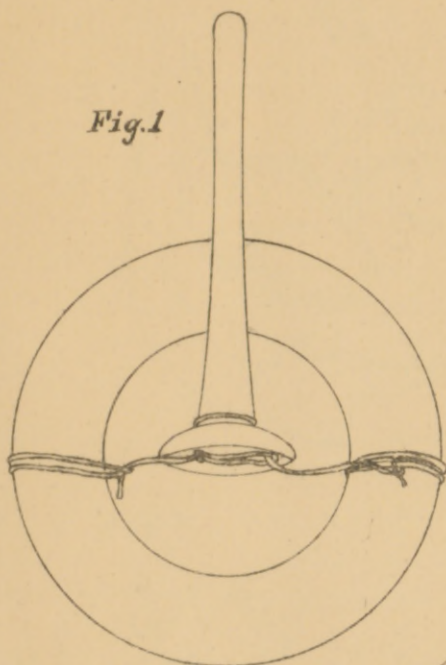
*Fig. 5*



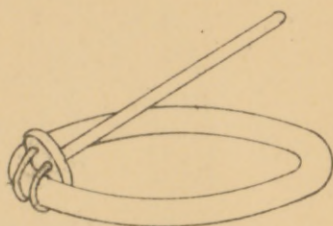




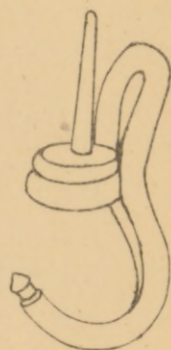
*Fig.1*



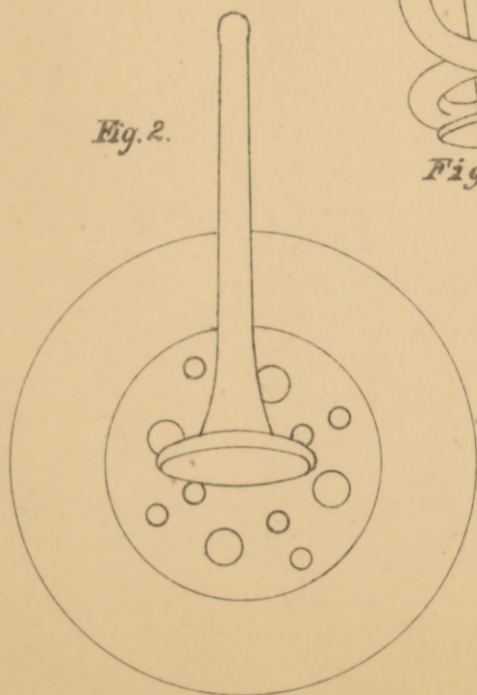
*Fig. 3.*



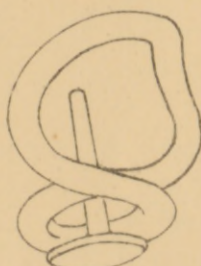
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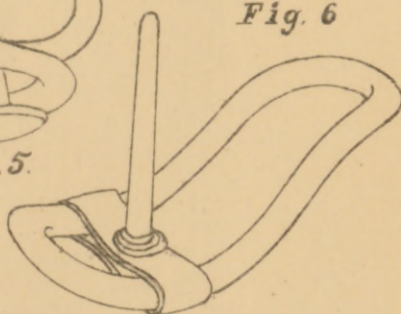
*Fig. 2.*



*Fig. 5.*



*Fig. 6*



*Fig. 7*

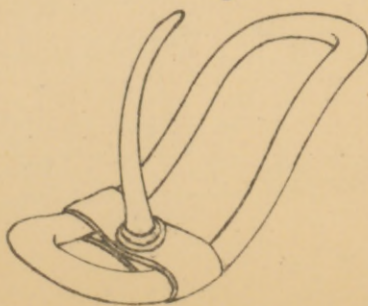






Fig. 1

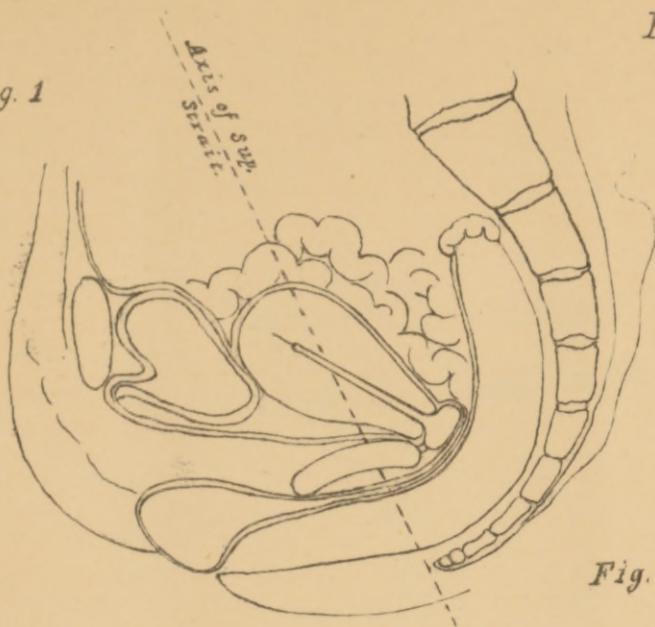


Fig. 2

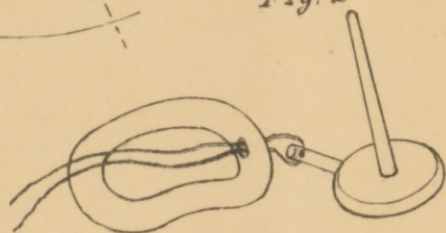


Fig. 3

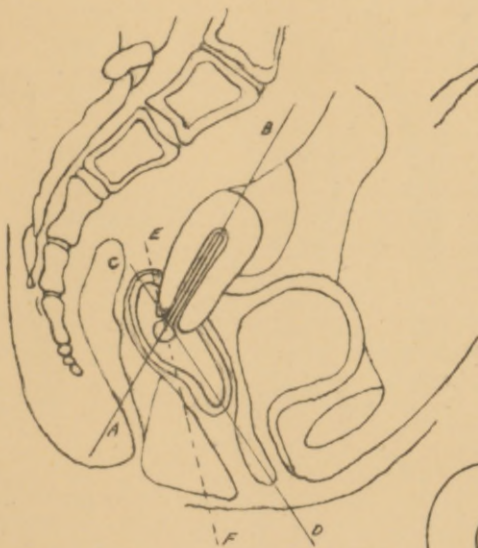


Fig. 4

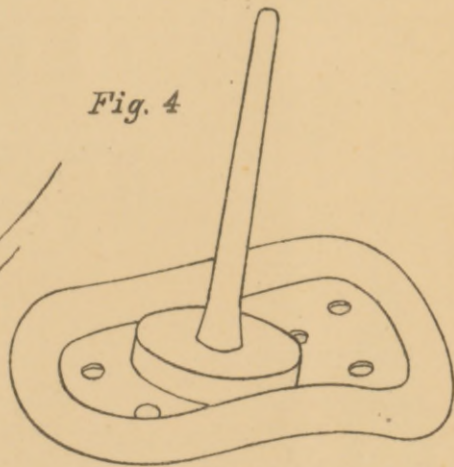


Fig. 5

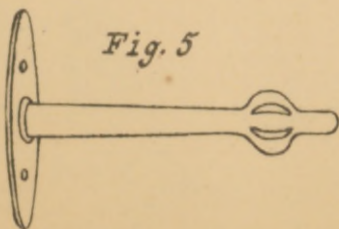
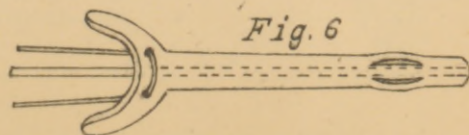


Fig. 6





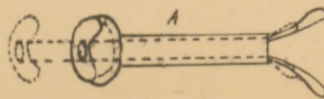
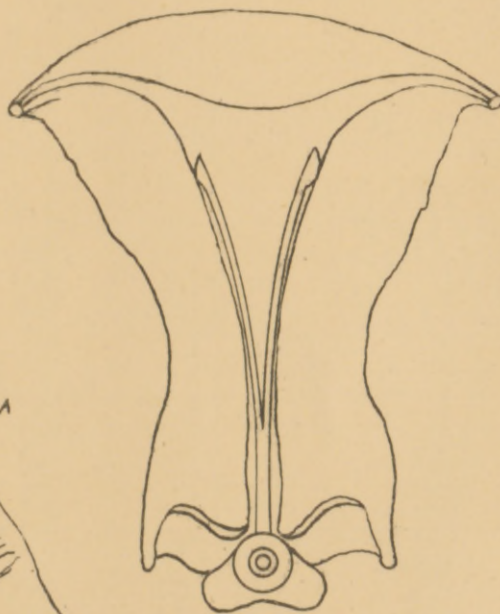
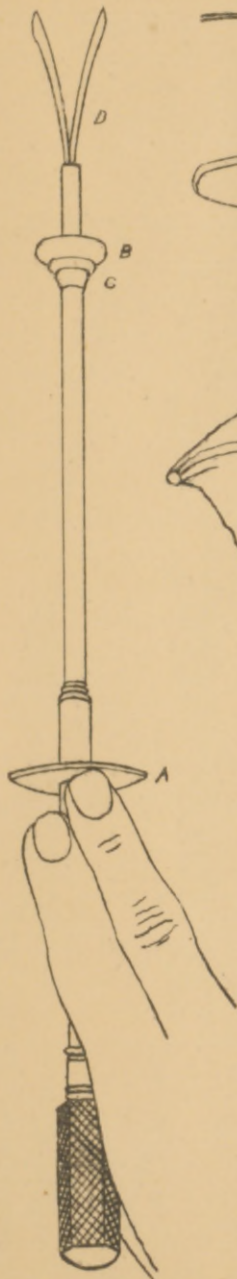
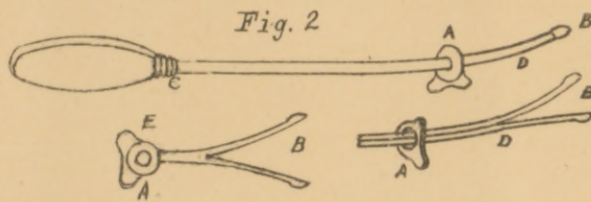
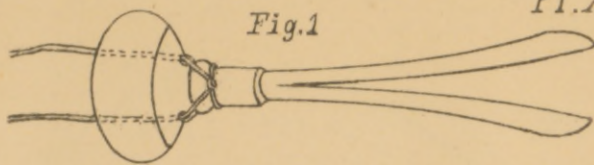


Fig. 6

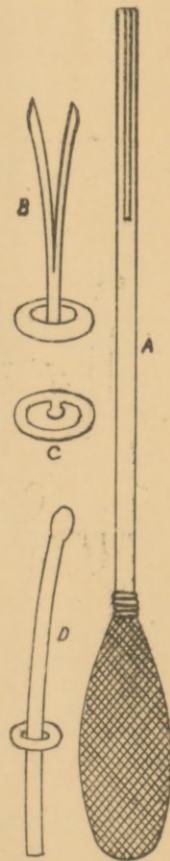
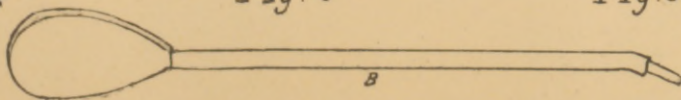


Fig. 9





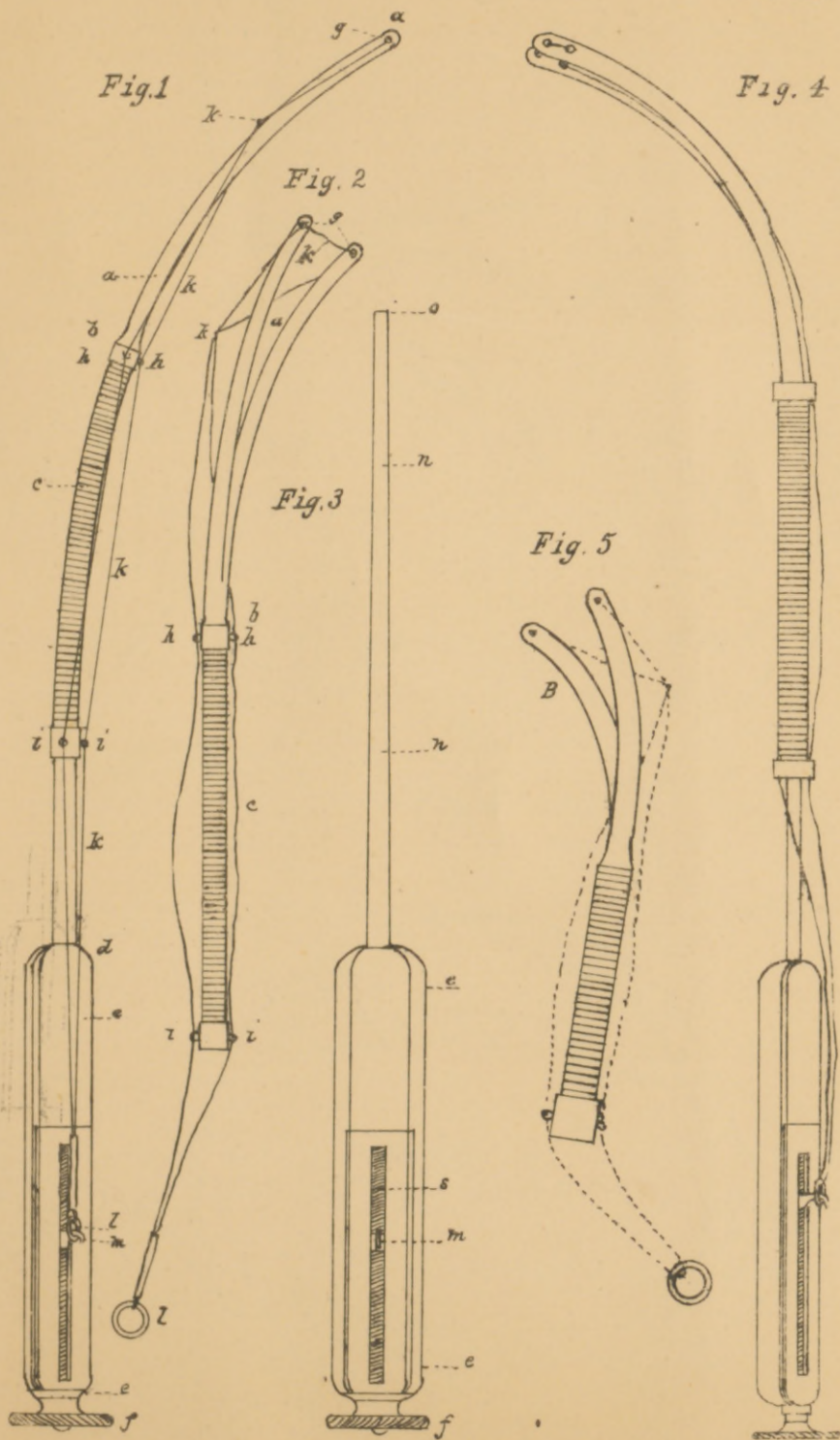
Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5







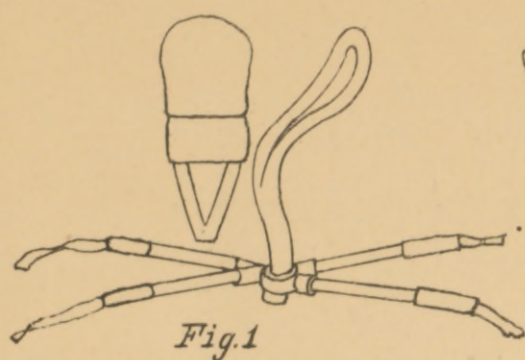


Fig. 1



Fig. 2



Fig. 3

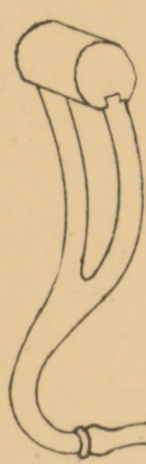


Fig. 4

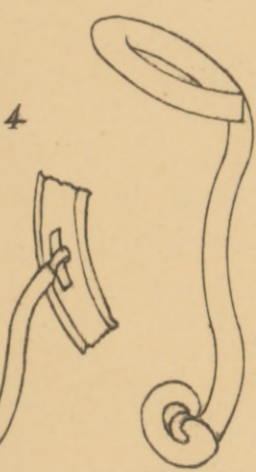


Fig. 5

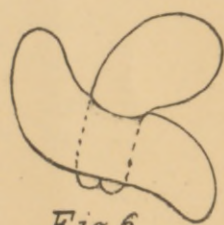


Fig. 6

Fig. 7

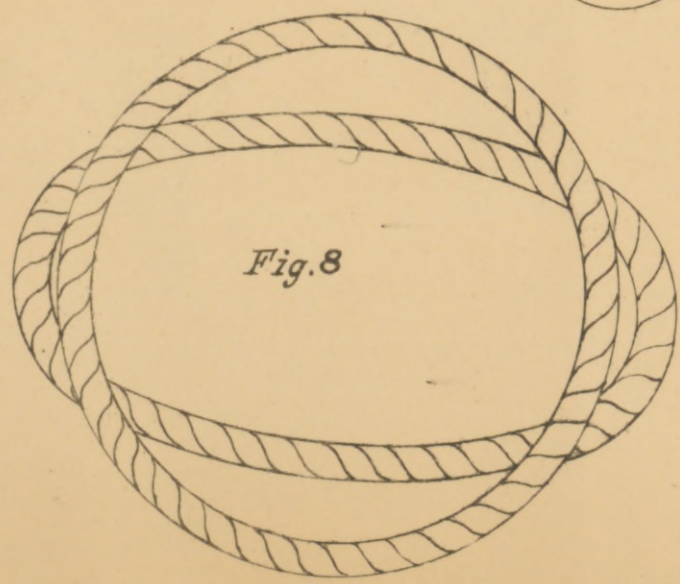
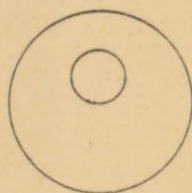


Fig. 8



Fig.1

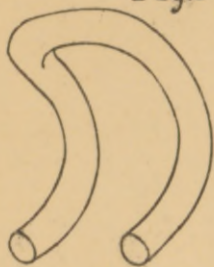


Fig 2

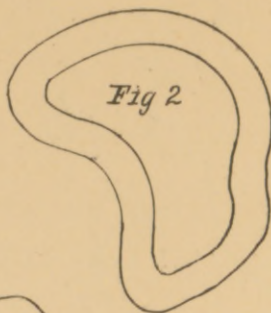


Fig 3

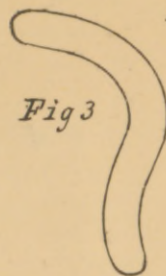


Fig.4

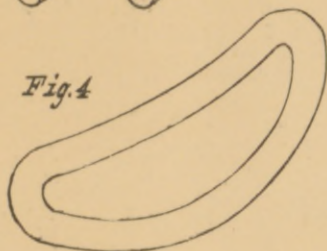


Fig.5

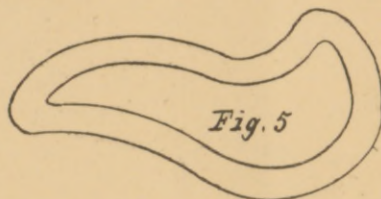
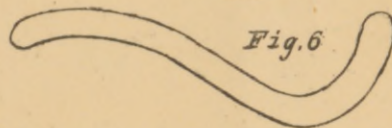


Fig.6



A

B

Fig.7

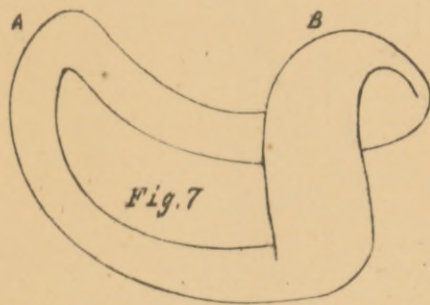


Fig 8

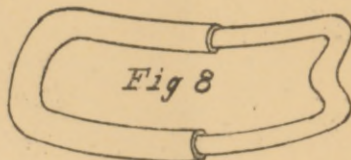


Fig.10

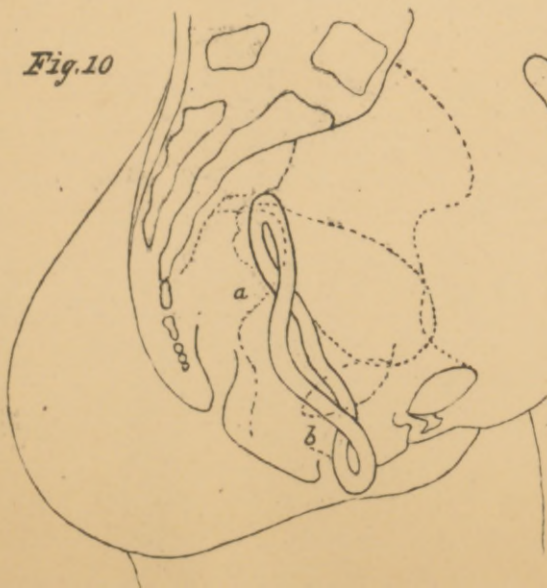


Fig.9

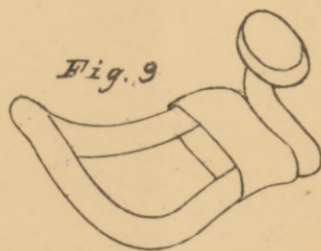
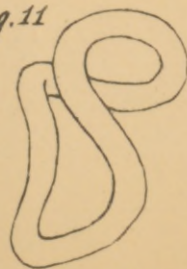


Fig.11







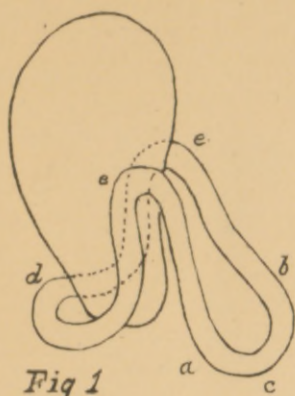


Fig 1

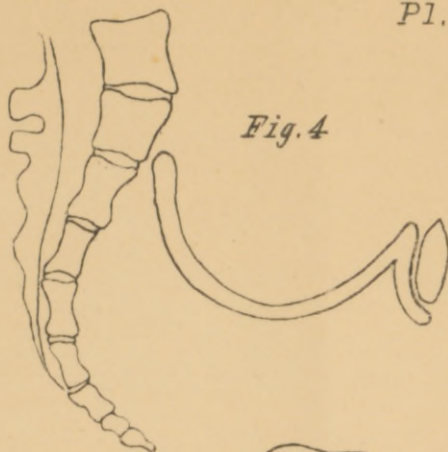


Fig. 4

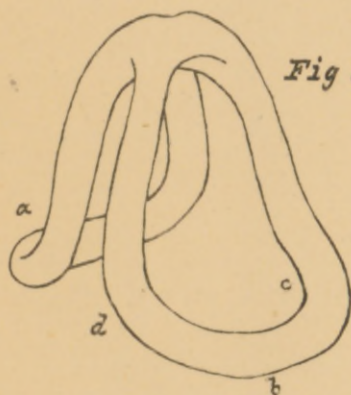


Fig 2

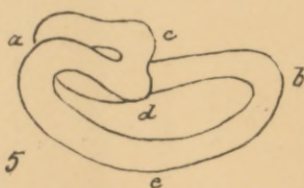


Fig. 5

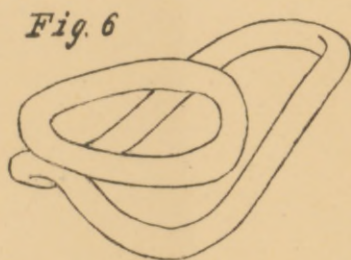


Fig. 6

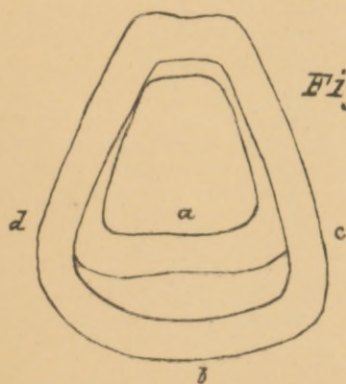


Fig 3

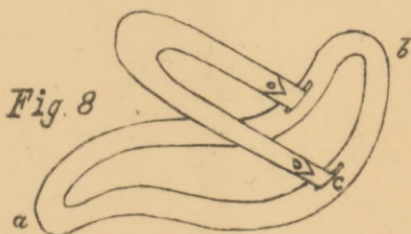


Fig. 8

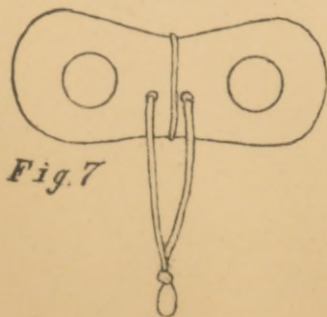


Fig. 7

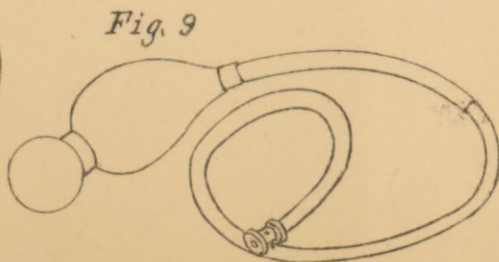


Fig. 9







