THE CURVES OF MIDWIFERY FORCEPS—THEIR ORIGIN AND USES.

By J. H. Aveling, M.D.

No instrument has undergone such multiform changes as the midwifery forceps. Nearly every obstetrician of note has suggested alterations or additions, which have been tested by time and experience. The result has been that many innovations have vanished, whilst others of real value have survived to reach greater perfectibility. Of all the changes which this instrument has undergone, none are of more interest to Englishmen than its curves, for all of them have had their origin in this country.

In the present paper it is not intended to consider the minor curves of midwifery forceps, such as those on the face and at the tips of the blades, intended to facilitate introduction or prehension; nor those of the shanks and handles for affording a more secure grasp. Four only, which may be looked upon as fundamental, will be submitted to your attention; and these will be noticed according to the order of their invention, in their historical, anatomical and mechanical aspects.

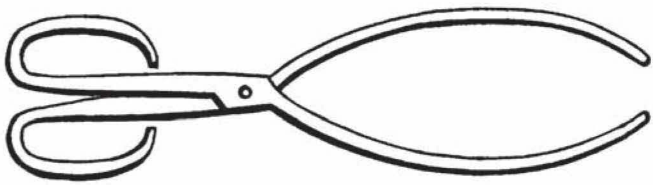
1. *The head-curve.*

(*a.*) *Historical considerations.*—Although the midwifery forceps may be seen looming through the shades of distant ages, history does not present the instrument to us in a substantial and practical form until the time of Dr. Peter Chamberlen. To him all nations now accord the credit of having invented forceps, with fenestrated and separable blades, for extracting a living child. He was the grandson of William Chamberlen (Chambrelein) and Genevieve Vingnon, French Protestant refugees, who fled from Paris and landed at Southampton in 1569. William and Genevieve had two sons of the same Christian name, Peter the elder, and Peter the younger, who both practised in London as Surgeons. Dr. Peter Chamberlen, the inventor of the forceps, was the son of Peter the younger and Sara de Laune.

As is well known, his original instruments are now in the possession of the Royal Medical and Chirurgical Society of London. There does not seem to be much likelihood of the exact date of their invention being ascertained. We have, however, some interesting evidence in a document addressed to the Archbishop of Canterbury by the College of Physicians, concerning a proposal of Dr. Peter Chamberlen to instruct the London midwives. In this paper the College opposes his project, and says :—"But for adding sufficiency to them (the midwives) by the

Doctours instruction, he is not otherwise able to instruct them than any other, the meanest Fellow of our College, *unless he understands it by the use of iron instruments.*" The date of this document is *circa* 1640, and there can be little reason to doubt that the "iron instruments" mentioned referred to his forceps. The most perfect of his instruments is one locked by a pivot. The head curve of this has a diameter of eleven inches. It is seven inches in length with a fenestrum five inches long. Between their apices, when the blades are united, is a space of one inch, and their greatest divergence is three inches. It will be observed, that the head-curve of Chamberlen's forceps and the reciprocal positions of the blades are almost identical with the popular models of the present day (Fig. 1).

FIG. 1.*



(*b.*) *Anatomical conditions.*—The pelvic conditions which affect the head-curve may be reduced to very few. The normal pelvic cavity varies from four to five inches in diameter. When this is reduced below three inches the case is not suitable for forceps. It may be roughly estimated that the obstetrician has ordinarily to deal with an irregularly curved tube, partly rigid and partly elastic, of an average diameter of four and a half inches, and about four inches long.

The fœtal head, according to the way in which it is seized by the blades, varies from three and a half to four and a half inches in diameter. It is elastic in proportion to the amount of its ossification, and may be reduced by

* All instruments and diagrams in this paper are represented one quarter their size.

compression a quarter, or even half an inch, without destroying the life of the child.

(*c.*) *Mechanical requirements.*—The use of midwifery forceps is accompanied by so many variable conditions, that it is impossible to treat with scientific accuracy the application, direction, and intensity of the forces employed. The fœtal head varies so much in its dimensions, shape, and elasticity, the pelvis in its planes, curves, and calibre, and the operator's hand in its size, skill, and strength, that it becomes impractible to have forceps made suitable for every contingency. We must therefore content ourselves with instruments constructed as nearly as possible to meet average conditions and requirements. These requirements may be considered under the headings, Introduction, Prehension, Compression, and Traction.

a. Introduction.—The head-curve must be such as will permit the blades to pass between the fœtal head and the walls of the parturient passage without difficulty or danger. A blade cannot be easily introduced if its curve be too abrupt or open.

In Figs. 2, 3, and 4 the extreme and medium head-curves

FIG. 2.

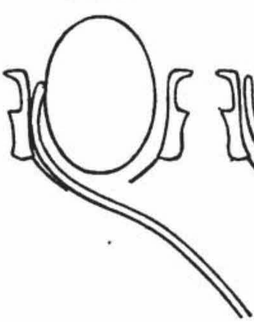


FIG. 3.

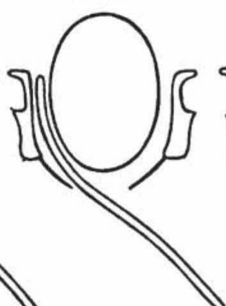
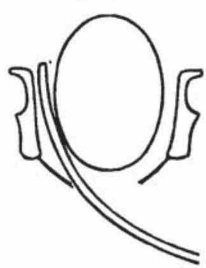


FIG. 4.



of forceps are given in the positions they would occupy during introduction. In Fig. 2 the curve is the arc of a circle of five inches in diameter. In Fig. 3 it is of nine inches and in Fig. 4 of fourteen inches. A glance at these diagrams shows which of the three curves renders introduction most easy. With the five-inch curve the operation must be both difficult and dangerous. With the nine-inch curve introduction may be readily effected in whatever position the head may be; but with the fourteen-inch curve, passing the blade would be almost impossible when the head was pressing on the perineum, although with the head higher it is much better than the five-inch head-curve.

It is fortunate that the nine-inch curve happens to be most suitable for introduction as it also meets other mechanical requirements.

β. Prehension.—After the introduction of the blade the next important requirement is that its curve shall be such as will enable it to grasp the head in the best possible manner. Prehension may be active or passive. The active may be remittent or continuous. The passive may be pelvic or instrumental. Active prehension is when the blades are brought together by manual or mechanical means. Passive prehension is when the blades are held together by the pelvic walls (pelvic), or are maintained parallel at a set distance by mechanical arrangements (instrumental). The principal object of all forms of prehension is to retain the head of the fœtus within the grasp of the blades during traction. This, in fact, is all that passive prehension can accomplish. Active prehension may be carried beyond mere retention, and be employed to effect reduction of the fœtal head. Fortunately the curve suitable for prehension is also equally good for compression. In choosing the best curve for prehension we must select one which presses evenly upon a large surface of the head. The efficiency of its retaining power, and the safety of its employment in compression, depend upon the extent of the areas upon which the blades press. Figs. 5, 6, and 7 show the extent of contact which the three head-curves already mentioned permit during active prehension. The five-inch curve Figs. 5 and 8, has the same effect, in both active and passive prehension. It permits only of slight contact at two points above and below the transverse diameter of the head. The objection to this mode of prehension is obvious, for the tendency must be to indent the fœtal skull and produce dangerous lesions. The black transverse bands represent the extent and direction of the prehensile force resulting from a five-inch head-curve.

Fig. 5.

Fig. 6.

Fig. 7.

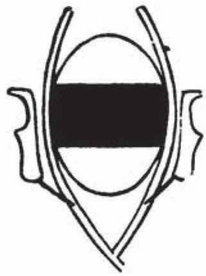


Fig. 6 represents the grasp which a nine-inch curve gives, and the black band shows the area and direction of its prehension. The same are also seen in Fig. 7 in which the head-curve is fourteen inches. It will be observed that the prehensile area presented by the nine-inch curve is the largest and consequently the safest and best.

Fig. 8.

Fig. 9.

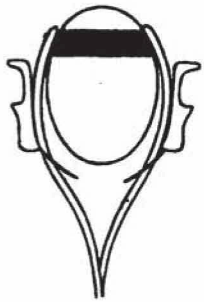
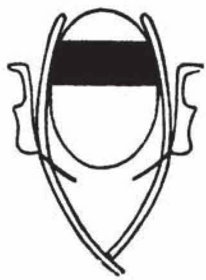


Fig. 10.

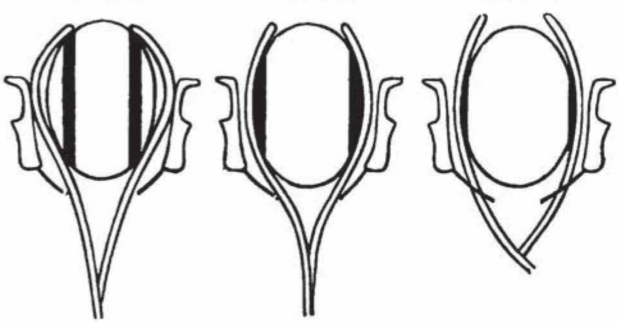


Figs. 8, 9, and 10 represent passive pelvic prehension with the same three head-curves. The five-inch curve is, as has already been stated, the same as in active prehension. With a nine-inch curve, the blades having separated until they are arrested by the pelvis, grasp by their apices a limited area of the head represented in Fig. 9 by the black band. The objections to this form of prehension are that the head is liable to be indented, the parturient canal unnecessarily compressed, and the external parts unduly dilated by the shanks of the instrument.

Fig. 10 shows pelvic prehension with a fourteen-inch head-curve. It is evident that even this curve gives sufficient grasp to enable traction to be used, but the external soft parts of the mother must suffer great distension. In passive instrumental prehension the same objections, although in a minor degree, present themselves.

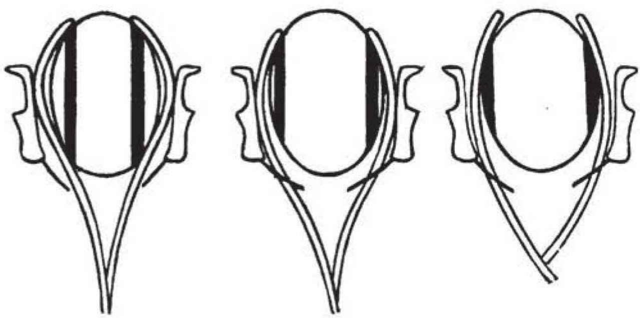
γ. *Traction.*—During active prehension the distal and proximal halves of the blades have the same action upon the head, one antagonizing the other and causing the the greatest diameter of the part seized to remain between the most widely separated portions of the blades. When, however, the head-curve is used in traction these relations cease, the proximal half becoming inactive and the distal active. To insure safe and efficient traction, it is necessary that the head-curve should afford a large retentive

FIG. 11. FIG. 12. FIG. 13.



area. In Figs. 11, 12, and 13 the black bands show the extent and position of the retentive areas and the direction in which forces thus applied act when head-curves of five, nine, and fourteen inches are used. The five-inch curve (Fig. 11) gives an efficient hold, but of a dangerous character, from its liability to indent the skull; the nine-inch (Fig. 12) grants a good retention area with pressure equally distributed. The fourteen-inch (Fig. 13) gives very small retaining power, and the blades can only be prevented slipping by approximating the blades with great force. These diagrams refer to active prehension. The retentive areas in passive pelvic prehension are very different. They are indicated by the black bands in Figs. 14, 15, and 16. The five-inch curve presents the same

FIG. 14. FIG. 15. FIG. 16.



objections as in prehension. The nine-inch assumes the objectionable qualities of the five-inch, and the fourteen-inch, although dangerous for the mother, has the fewest disadvantages as far as the fœtal head is concerned.

The best curve which can be given to the blades to render them safe and effectively retentive is that which coincides most nearly with the curve of the fœtal head. The nine-inch head-curve as far as is practicable fulfils this requirement. It may therefore be advantageously adopted for introduction, prehension and traction.

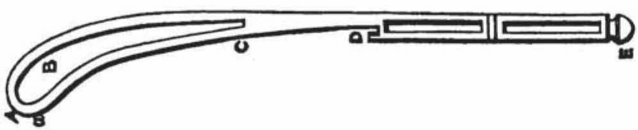
2. *The Pelvic Curve.*

(*a.*) *Historical considerations.*—The invention of the pelvic curve has for many years been attributed to Levret or Smellie, but the merit really belongs to neither. The originator of it was Benjamin Pugh, surgeon at Chelmsford in Essex. In 1754 he published 'A treatise of Midwifery chiefly with regard to the Operation, with several improvements in that Art. To which is added some Cases and Descriptions, with Plates of several new Instruments, both in Midwifery and Surgery.' In his Preface he says, "I shall be as particular as possible in the description and use of all the instruments, both in Midwifery and Surgery (which are my own invention). . . . The curved forceps I invented upwards of fourteen years ago, made me by a man of Mr. Archer's, cutler, now living in Chelmsford. The preference between them and the common straight forceps in every respect is great." Further on, p. 75, he says, " I doubt not but every operator will be sensible of this when he has seen my forceps, which are adapted in such manner to the make of the passage, that they can with ease be introduced into the body of the womb." At p. 77, he adds, "If the head is detained above the brim of the pelvis, or but a small part of it advanced, . . . the curve forceps will answer; for with their help in these cases, and with turning where the strength of the woman would permit, I have never opened one head for upwards of fourteen years."

If Pugh's statements are to be believed he was not only the inventor of the pelvic curve but the first to apply forceps to the fœtal head above the brim of the pelvis. What reasons have we for believing his statements? We have evidence that he possessed considerable mechanical ability. Like Dr. Peter Chamberlen his ingenuity did not show itself only in improving the midwifery forceps. He was the inventor of several new instruments, and evidently had the talent to originate such an improvement as the pelvic curve. But he does more than merely state that he invented his forceps in 1740. He gives the name and address of the man who made his first instrument, giving his contemporaries the power of verifying the fact; and he says, at the end of his book, where his instruments are made and where the originals may be seen. What more could he have done? There were no medical societies nor medical papers at that time and publishing was very expensive. He tells us that four years before his book was printed he attempted to publish it by subscription.[1] We have his own statement that he was the inventor of the pelvic curve. We have evidence that he had the capability of inventing it, and we have testimony that he used all the means for substantiating his claim which could be reasonably expected from a country surgeon at that period.

Is Pugh to be deprived of his merit because he failed to publish his invention before Levret and Smellie? If so, Chamberlen's claim must be relinquished, for he not only did not publish his discovery, but did his best to keep it a secret. It would be unfair to judge the proceedings of inventors of two centuries ago by the rules accepted now. The date of publication is at the present time a fair method of deciding the relative claims of inventors as to priority. In the cases of Chamberlen and Pugh it would not be just. We are, therefore, it would appear, forced to the conclusion that Benjamin Pugh invented, had made, and used forceps with the pelvic curve in 1740, seven years before the date which French writers assign to Levret's invention. Pugh gives a drawing of his forceps (Fig. 17), and thus describes

FIG. 17.



[1] From this statement Dr. McClintock, who ably supports Pugh's claim as inventor of the pelvic curve, suggests that it was invented in 1736, but this is a mistake, for in the preface, where the statement occurs, the author says he invented his curved forceps "upwards of fourteen years ago."

it :—" A, B, C, D, E, my large curve forceps; the length from A to E is fourteen inches, the breadth of the bows from outside to outside in the widest part, which is near the top, is one inch and three quarters. A string being strained from A to C, at B, which is near the middle of the bow, ought to be one inch and a half from the string to the outside edge of the bow (which shows the concave part or proper curve inwards); and a string strained from C to A upon the upward edge of the bow at B, should be three quarters of an inch, which shows the proper side curve, or upwards, which adapts them to the make of the passage, and shows the great preference between them and the common straight forceps both in introducing and extracting." A crotchet forceps and a small forceps are also described and figured. The latter will be noticed again.

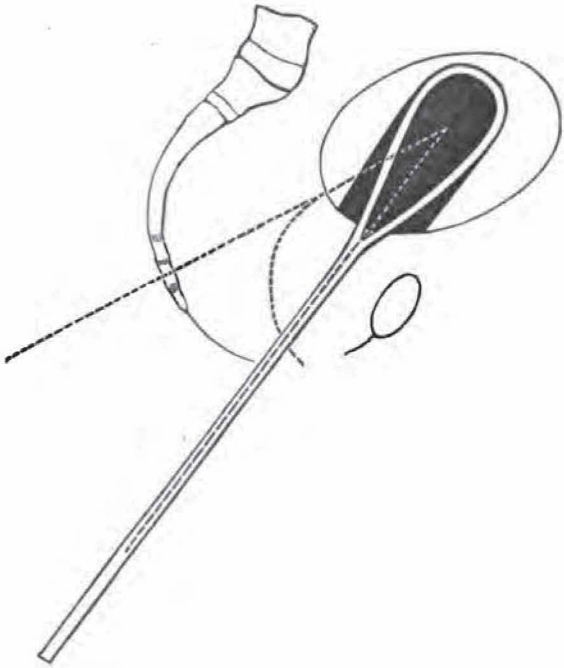
(*b.*) *Anatomical conditions.*—It has already been stated that, in using forceps, we have to deal with a canal about four and a half inches in diameter and about four inches long. In connection with the pelvic curve we have now to remember that it is curved in an antero-posterior direction, which curve varies in accordance with the way in which it is estimated. If we take the mathematical axis of the pelvic cavity, we have a parabolic curve very unsuitable for imitation in constructing the blades of forceps; but if we content ourselves with the classical axis or curve of Carus, we find it to be the arc of a circle of about nine inches in diameter, and a curve most convenient for the pelvic curve.

(*c.*) *Mechanical requirements.*

a. Introduction.—As Pugh first pointed out, this curve facilitates introduction. With the pelvic curve the blades of forceps glide along between the fœtal head and the parturient canal much more readily than when their form does not correspond with the axis of the pelvis. Without this curve the blade passes with its side as well as its point in advance. The result is, that the curved blade progresses in a track of two inches, while the straight blade moves along a path two and a half inches in breadth.

β. *Prehension.*—With straight forceps it is impossible to seize the head in a line corresponding with the axis of the brim. This may be seen in fig. 18, where the straight

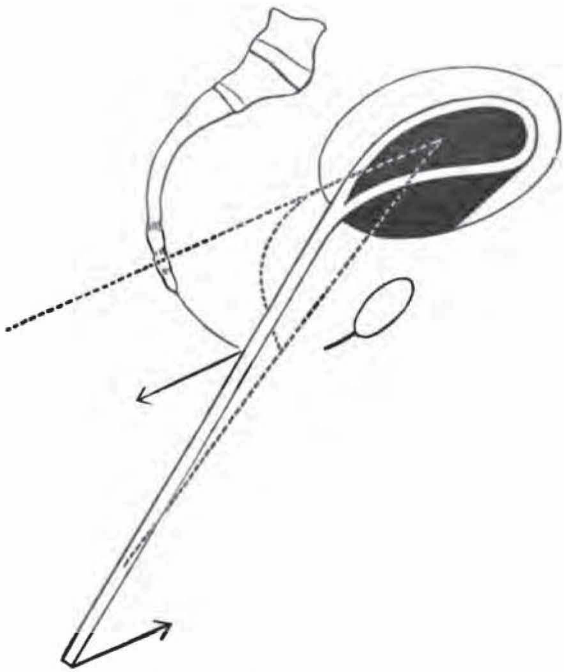
FIG. 18.



blades are represented in the best prehensile position in which it is possible to place them. The disadvantages of this diagonal prehension are removed by the pelvic curve, Fig. 19. By its means the blades may be made to seize the head before it has entered the pelvic cavity, in a line with the axis of the brim, an important advantage, as will presently appear.

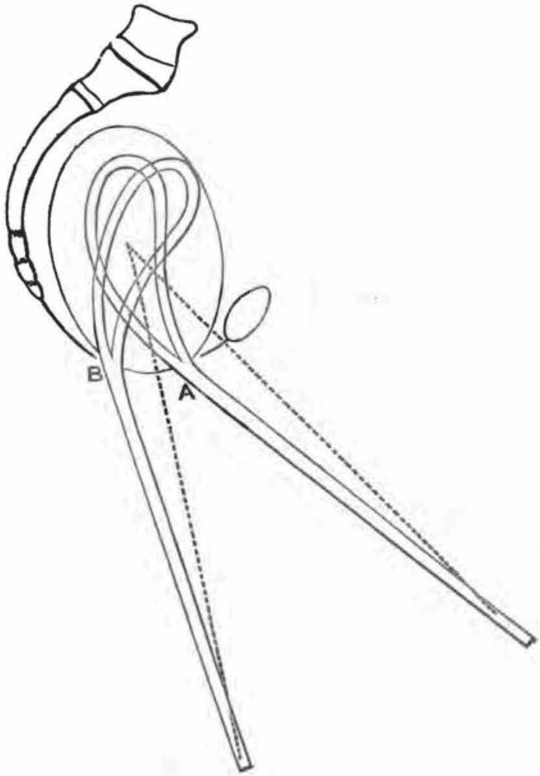
When the prehension is remittent, the prehensile area of blades having the pelvic curve varies as the head advances. The altered relations of the blades and head, early A and late B in labour, are shown in fig. 20. This change does not take place in continuous prehension, nor when force is applied by two hands in the directions indicated by the arrows in fig. 19, nor with forceps having the perineal and handle curves.

Fig. 19.



γ. *Traction.*—The pelvic curve undoubtedly favours introduction and prehension, but it may or may not be advantageous in traction according to the manner in which the force is applied. If the handles of forceps be grasped and traction exerted directly by them, the pelvic curve causes the instrument to have a worse tractile power than the straight forceps possesses; for with the pelvic curve the line of traction and the axis of the brim form an angle of 30°, whereas with the straight forceps this angle is one of 23° (Figures 18, 19). Every degree of divergence of the line of traction from the axis of the pelvis in which the child's head may be situated must necessarily result

Fig. 20.



in loss and misapplication of power. When traction is made by the handles alone the straight forceps draws the head less upon the pubic bones than forceps having the pelvic curve. To overcome this difficulty, pelvic curve forceps must be used with two hands acting in opposite directions, as indicated by arrows in fig. 19.

3. *The Perineal Curve.*

(*a.*) *Historical considerations.*—Obstetricians in their attempts to draw the fœtal head in a line with the axis of the brim, found that the shanks of their forceps pressed unduly upon the perineum. To remedy this inconvenience Dr. Robert Wallace Johnson set himself to work. In 1769 he published 'A new System of Midwifery founded on Practical Observations,' the whole illustrated with copper plates. In this work, after giving a slight historical sketch of the forceps, and saying that he had seen Pugh's forceps at Mr. Cargill's in Lombard Street, and thought them "preferable to any," he writes as follows of his own:—"It appears evident that here, as in every other art and science, one improvement naturally leads to another. That I may not therefore seem to assume too much to myself, I shall now proceed to lay before my readers those hints which suggested to me what I take to be a still greater improvement." Having done this he thus describes his invention, Fig. 21:—"An

FIG. 21.

inverted curve should be made towards the joints whereby the perineum may be saved from injury, the extracting force rightly conducted, and the handles, at the same time, kept from pressing uneasily on the inferior and anterior parts of the pubes." This is the first mention we have of the perineal curve. Some writers have attributed the invention of it to Pugh, but unjustly, for, although his short forceps has a reflex curve, it was clearly the result of accident. The pelvic curve in his instrument is carried along the shanks, and the reflex curve is simply the result of rounding the pelvic curve into the handle. Pugh did not know the value of the perineal curve, or he would have had his long forceps constructed with it, for in the high operation it is more particularly required.

The forceps drawn by Johnson in his work is a short forceps, but he correctly states the advantages of the perineal curve when he says that by it the perineum may be saved from injury and the force rightly conducted.

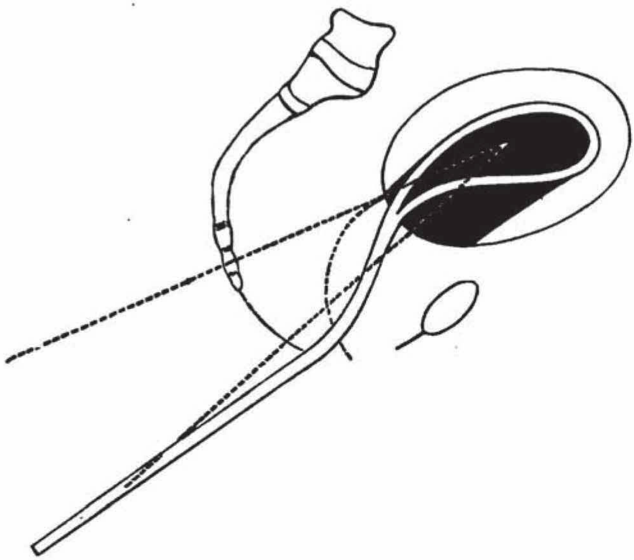
Like Chamberlen and Pugh, Johnson was a man of great inventive genius. He made models in wood of the many instruments he invented, and in some cases gave them the finishing touches.

(*b.*) *Anatomical conditions.*—The great objection to straight forceps has always been, that the perineum would not allow the handles of the instrument to be passed sufficiently back to permit efficient prehension and traction. We have seen that these objections obtain even with the pelvic curve forceps, which, although it generally affords efficient prehension, does not allow traction to be made in a line with the axis of the brim. The perineum stretches across the posterior half of the pelvic outlet, and occludes the space which the shanks of forceps should occupy when traction is exerted upon the distant head. This obstacle, although it will yield to a certain extent, cannot be removed. It therefoie becomes necessary to construct forceps so that bruising and laceration of the perineum may be avoided.

(*c.*) *Mechanical requirements*—The influence of the perineal curve in introduction and prehension is not very great, but what it has, acts in facilitating these operations. In cases where the pelvic curve does not allow the blades to pass sufficiently forward to seize the head, the perineal curve obviates the difficulty.

a. Traction.—It is chiefly in the direction of the force employed during traction that the advantage of the perineal curve is found. In fig. 22 the improved line of traction which this curve permits may be seen. This line it will be observed much more nearly approximates the axis of the brim, than when straight or pelvic curve

FIG. 22.



forceps are used. In fact, it now only diverges from it to the extent of 19°. The advantages of the perineal curve have been only partially appreciated. It has, however, not been entirely neglected, for it has had admirers and patrons in all countries. Many modifications by obstetricians have been published by Van der Laar, Young, Evans, Mulder, Conquest, Hermann, &c. When the perineum is distended by the fœtal head it is very satisfactory to observe how the perineal curve removes the shanks of the forceps from the tense tissues and relieves the operator from the fear of their being lacerated.

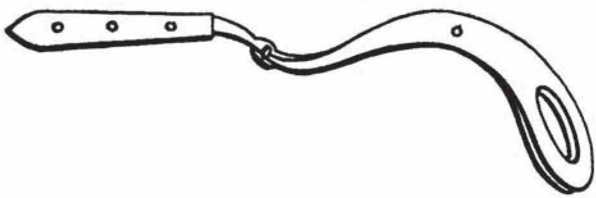
4. *The Handle-curve.*

a. Historical considerations.—Obstetricians soon discovered that the addition of the pelvic and perineal curves did not meet every requirement. No instrument yet invented enabled the operator to exert traction in the required line, when the head was high in the pelvis. Van der Laar in 1777, fig. 23, and T. Hermann in 1844,

FIG. 23.

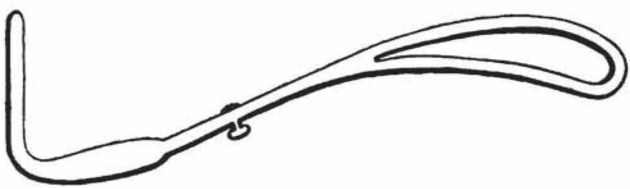
fig. 24, endeavoured to overcome this difficulty by drawing

FIG. 24.



directly from the blades, very much in the same way as is now recommended by Chassagny and Tarnier. Hubert, in 1860, fig. 25, tried another plan. He first bent the

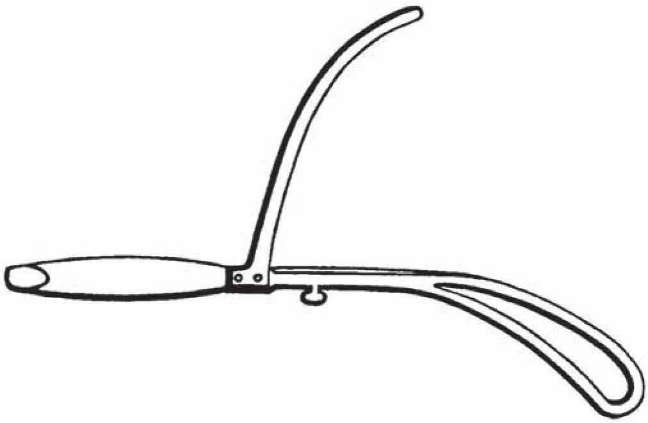
FIG. 25.



handles of his forceps at right angles; and in 1866, fig. 26, fixed a bar at right angles to the shanks.

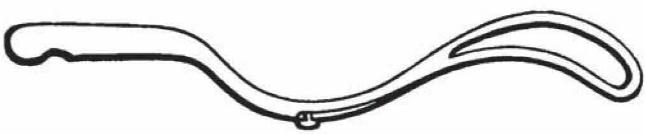
On the 4th of March, 1868, I had the honour of presenting to the Fellows of this Society forceps, the handles

Fig. 26.



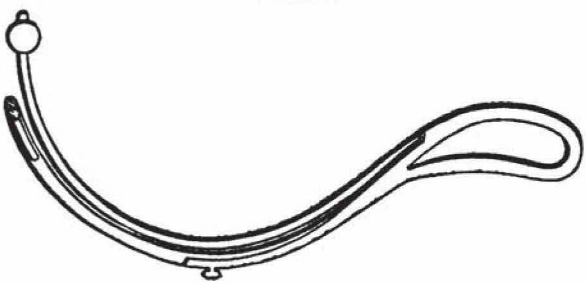
of which were curved backward. This instrument was, I believe, the first in which the handle curve had been adopted. Morales in 1871, fig. 27, carried on the perineal

Fig. 27.



curve, and bent the handles of his forceps in a line with their blades; and Tarnier, in 1877, fig. 28, invented his

Fig. 28.



ingenious forceps, which has the same sigmoid form as my own, and which is undoubtedly theoretically excellent, but practically far too complicated to come into general use.

b. Mechanical requirements.—The pelvic and perineal curves having been invented, curving the handle seems to be an irresistible and logical sequence. It is demanded mechanically and æsthetically, and its accomplishment satisfies both hand and eye.

α. Introduction.—In passing the blades the curved handles are less in the way of the operator than straight ones. The curved handles also do not come in contact with the legs of the patient during the first stage of introduction.

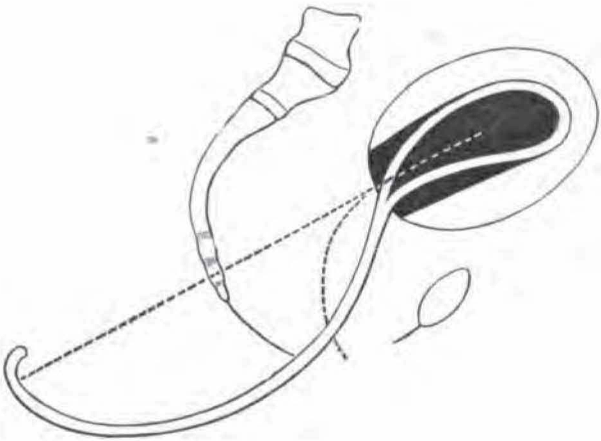
β. Prehension.—The prehensile area first occupied, even when prehension is remittent, is very slightly quitted when forceps having the handles curved is used. This cannot be said of any form of forceps in which provision of some sort is not made to enable the operator to make traction in the axis of the brim.

γ. Compression.—Undue compression is avoided by curving the handles, for when they are used, compression and traction are two separate actions of the hand. Traction is exerted at the hooked ends of the handles, compression at their smooth sides. To effect greater traction with straight handles a larger amount of compression becomes necessary, or the handles slip from the grasp. This remark of course only holds true of straight handled forceps which have no shank rings or handle projections.

δ. Traction—The grasp which curved handles afford the operator is remarkable. He can with one hand, in nearly every case, exercise sufficient force to deliver the child. Should additional force be required, it can be obtained by passing over the hooked ends of the handles a cloth and drawing by it with the other hand. But the great advantage of the curved handles is, that they enable the operator to use traction power in the right direction.

By their aid he can draw the fœtal head in a line with the axis of the brim, and thus reduce the necessary compression and traction to the minimum of intensity. Fig. 29.

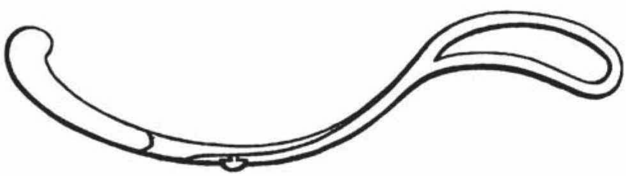
FIG. 29.



During the exit of the child, when its head is sweeping over the perineum, the curved handles come less in the way of the legs of the patient. She is supposed to be lying upon her left side with her knees well drawn up; the position certainly most suitable when the head is high, and one which may be advantageously maintained until the head is delivered.

The forceps, fig. 30, which are now in the hands of the

FIG. 30.



Fellows, are my attempt to carry out the principles of the handle curve. I have used this instrument and short forceps constructed on the same plan frequently; and, although the model is doubtless capable of improvement, I have been much satisfied with its easy application, its efficient prehension, and, above all, with its direct traction power.