

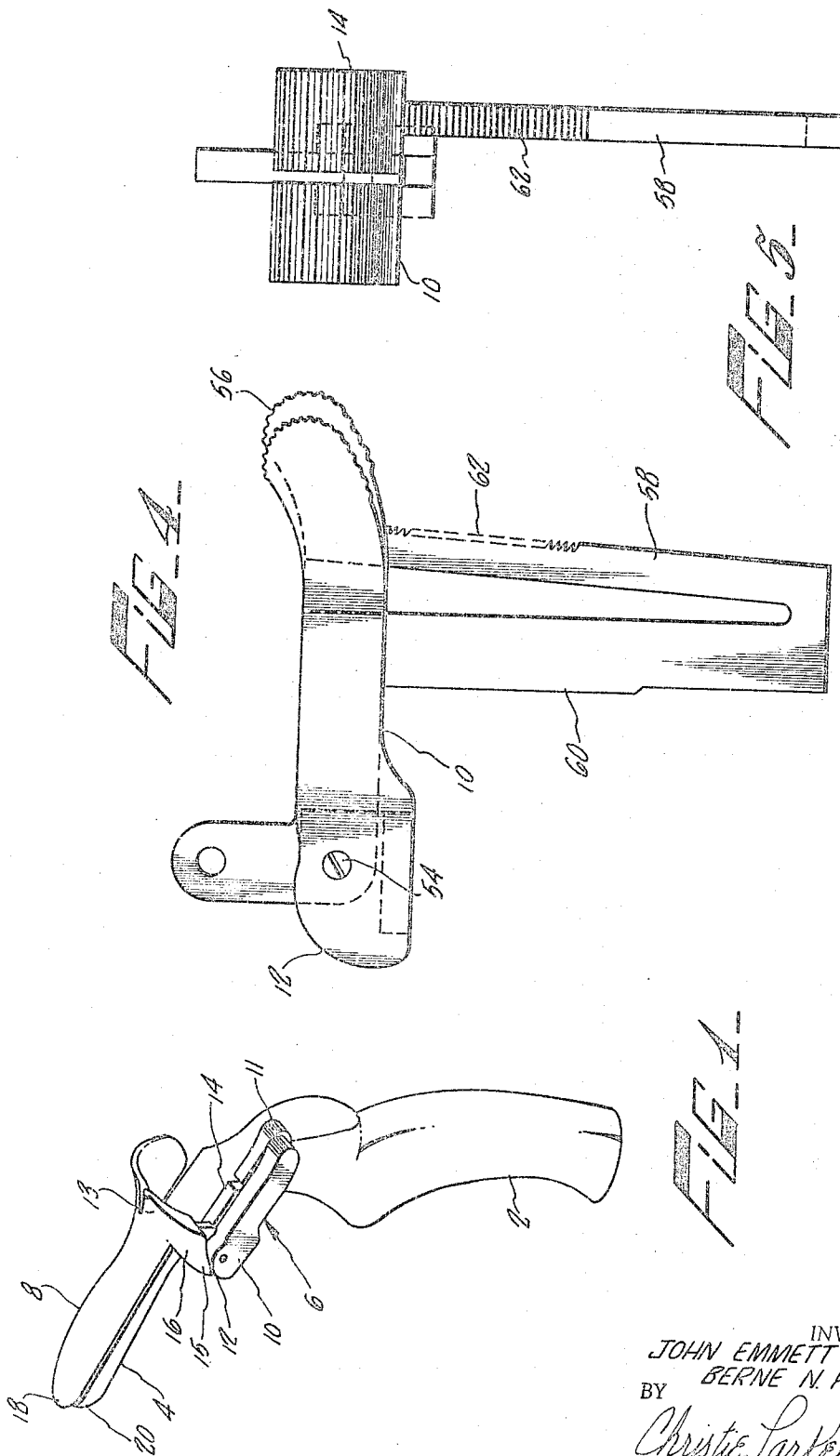
June 13, 1967

J. E. GUNNING ET AL
ILLUMINATED VAGINAL SPECULUM WITH ROTATABLE
CAM PIVOTING AND LOCKING MEANS

3,324,850

Filed April 8, 1964

3 Sheets-Sheet 1



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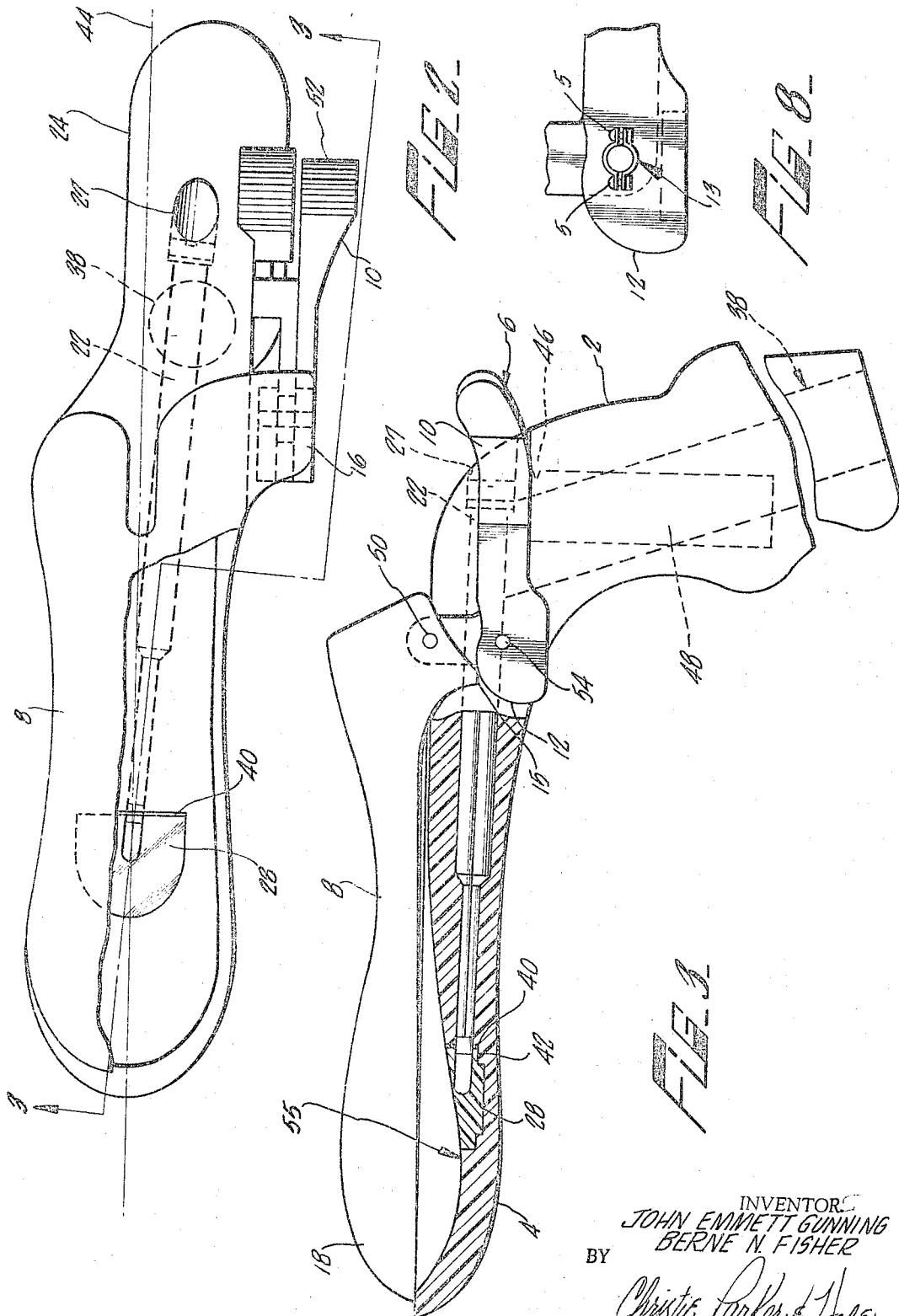
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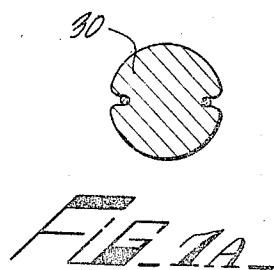
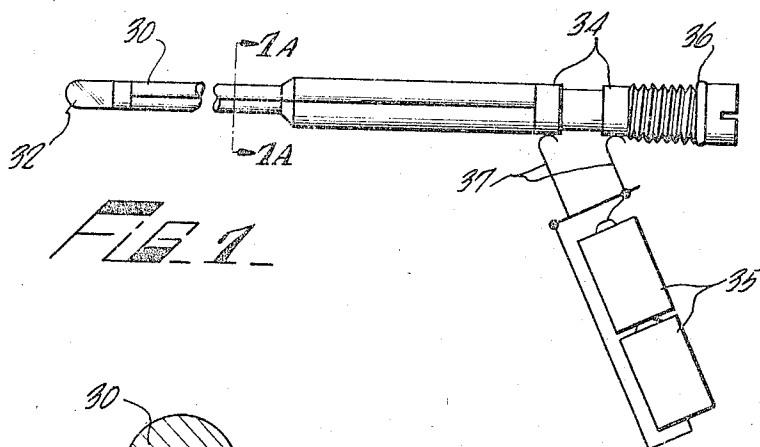
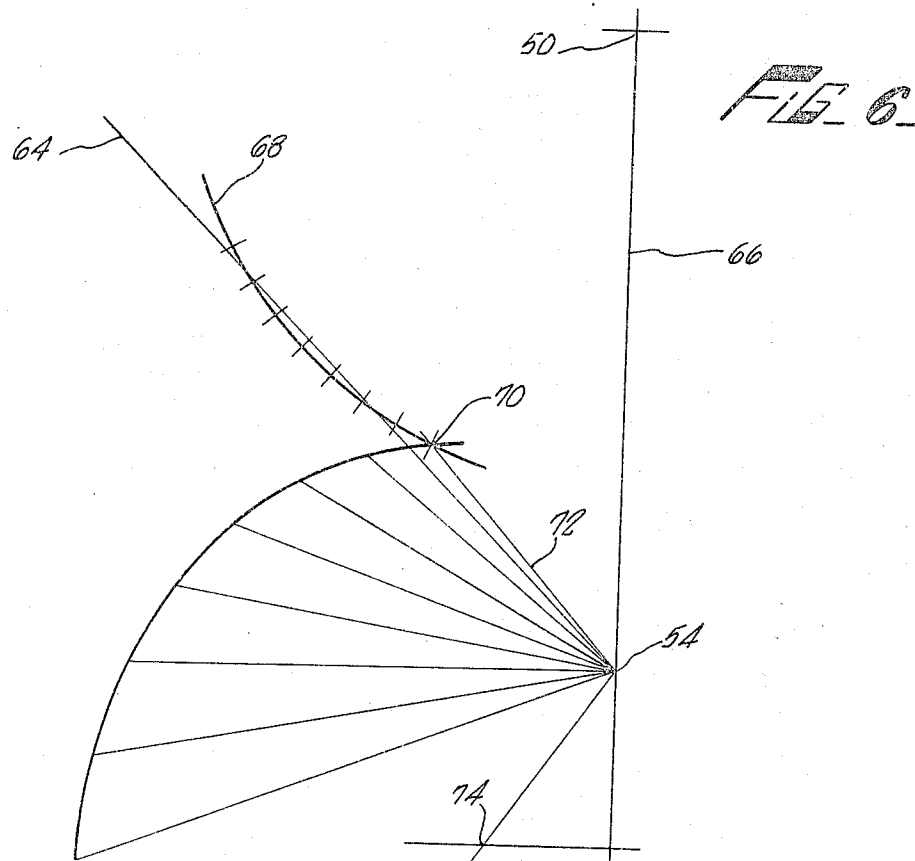
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ILLUMINATED VAGINAL SPECULUM WITH ROTATABLE CAM PIVOTING AND LOCKING MEANS

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This invention relates to internally illuminated medical instruments and more particularly to an internally illuminated Graves vaginal speculum which is capable of providing substantially increased amounts of light on the area to be examined and which is also completely operable with one hand.

In the medical arts specula are instruments used for enlarging the passage into body cavities. Ordinarily such specula are designated by the cavity on which they are designed to be used, for example, nasal, oral, or rectal. This invention relates to a vaginal speculum and in particular to the type which has taken the name of Graves, the physician who first designed it.

A Graves speculum is characterized by a pair of thin blades similar to duck bills approximately three to four inches in length which are attached to a handle to be gripped by a physician. In most instances the handle and the lower blade are integral parts of the same piece of material and the upper blade is attached to this piece of fabrication in one of several ways. In all cases the upper blade is capable of two characteristic motions relative to the lower blade, a pivotal motion with the hinge of the pivot located near the handle end of the blades and a vertical motion wherein the rear end of the upper blade is raised and lowered with respect to the lower blade.

All prior models of such specula were characterized by several problems. The first problem was that in order to use the instrument two hands were required because, when placing the instrument in position, it was necessary to lock the blades in position by tightening locking nuts on sliders and similar devices. Such instruments were further characterized by a lack of illumination within the cavity into which the speculum was inserted. This was due to the fact that lighting was external to the instrument itself. Whether the light was provided by reflection, by an auxiliary source such as a pen light, or by means of a light clipped to the blades, in all cases the source of the light was located at the rear of the blades and was not conveniently adapted to deliver sufficient illumination. In addition, the relation of the handle to the lower blade was such that it was difficult to use auxiliary instruments with the speculum and it could not be used to maximum advantage due to interference of adjacent body structures on the handle of the instrument.

The present invention is an improvement over the basic Graves vaginal speculum and in one aspect contemplates a light source of increased intensity located considerably closer to the area to be examined than heretofore possible. To accomplish this the speculum now has a hollow portion in the handle for insertion of batteries, an internal tube running through the handle and the lower blade into which a source of illumination is insertable, and a lens located in the lower blade. The result is a substantial increase in the amount of illumination provided in the area of examination.

In another aspect the invention contemplates enhanced mechanical operation of the speculum in that the instrument is now completely operable with one hand and utilizes a rotatable cam for providing movement of the distal end of a blade relative to the other, the cam being arranged to engage the upper blade in a self-locking manner, and a riser mechanism for providing movement of

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the proximal end of one blade relative to the other, the riser being slidable in a recess in the handle. The speculum is further improved in that the angle formed by the lower blade and handle is increased from approximately 90° to between 100° and 120° and is offset to one side or the other of the longitudinal axis of the blades to prevent interference of the handle with the use of auxiliary instruments.

These and other features of the invention will become more apparent by reference to the accompanying figures in which:

FIG. 1 is a perspective view of the improved speculum,

FIG. 2 is a plan view of the speculum with a portion of the upper blade cut away,

FIG. 3 is a front elevation partially in section taken along line 3—3 of FIG. 2,

FIG. 4 is a front elevation of the cam and riser mechanism for use with the speculum,

FIG. 5 is a side elevation of the cam and riser mechanism depicted in FIG. 4,

FIG. 6 is a diagram depicting the manner in which the cam surface is designed and the location of other reference points necessary for the manufacture of the cam,

FIG. 7 is a view of the core member and light source for insertion in the speculum,

FIG. 7A is a sectional view of FIG. 7 taken along line 7A—7A, and

FIG. 8 is a side elevation of an alternate embodiment of the cam.

Referring now to FIG. 1, there is depicted in perspective a speculum prepared according to the invention. The instrument comprises a handle 2 connected to a lower blade 4 by means of a mechanical overlap (not shown) and the junction is sealed with a strong cement such as methylene chloride. Mounted adjacent the handle and lower blade and to one side is a cam and riser mechanism 6 to which is attached the upper blade 8. As will be discussed in more detail in connection with FIGS. 4 and 5, the cam and riser mechanism consists of two parts, a lever 10 at one end of which a cam surface 12 has been located, and a riser mechanism 14 which is designed to be seated in a recess in the handle (not shown). The upper blade 8 is then attached pivotally to the riser mechanism and is arranged so that a cam follower 15 on an extension 16 of the upper blade engages with the cam 12 in a predetermined self-locking manner.

Throughout the description of this invention reference will be made to the proximal and distal ends of the blades for purposes of defining the motion of the blades 4 and 8 relative to each other. By proximal is meant the ends of the blades adjacent the handle. Correspondingly the distal ends of the upper and lower blades, 18 and 20, respectively, are those at the end opposite the handle.

The speculum is made of a polycarbonate plastic material such as that designated by the trade name, Lexan. This material recommends itself to this particular use in several respects. First, its temperature distortion point is approximately 270° to 280° F., and this characteristic lends itself readily to use with a source of internal illumination whose maximum temperature is approximately 200° F. Furthermore, such a material has been found to be essentially shatterproof and have exceptional structural strength even when fabricated in thin sheets.

In operation, the speculum is designed to be gripped by the left or right hand of the physician or other technician employing the instrument and is inserted into the body cavity to be inspected with the blades in the closed position as shown in FIG. 1. Once the instrument is in place the operator can, by means of the thumb of either hand, depress the lever 10 causing the distal ends 18 and 20 of the blades to open. It has been found that in the majority of cases that is the only operation of the specu-

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lum needed. However, there are occasions when the proximal ends of the blades must be separated, and this is accomplished by operation of the riser mechanism 14 which supports the upper blade. A pressure by the thumb inward and upward on the knob 11 of the riser mechanism 14 causes pressure to be exerted on a spring by which the mechanism is biased in the recess causing the riser to be freed from this position and capable of being raised or lowered.

Once the blades have been placed in the desired operating position, they lock in place until a change is desired. Locking, in the sense used herein, means that the blades retain their relative position until the operator moves either the cam lever or the riser mechanism lever to change that position. A motion of the thumb is all that is necessary and the need for locking screws or other tighteners to lock the blades in any of their various positions is eliminated. This is particularly advantageous when the instrument is in position and it is desired to change the orientation of the blades.

When using specula and other diagnostic instruments a persistent problem has been the lack of illumination directed toward the area to be examined. In FIGS. 2, 7, and 7A is shown the means whereby illumination is provided with the speculum of this invention. Referring to those figures, an elongated cavity 22 extends from the handle 2 of the speculum through and into the lower blade 4 substantially parallel to the longitudinal axis 44 of this blade and terminates in a D-shaped lens 28. As shown in FIG. 7, a core member 30 with a light bulb 32 mounted at one end and electrically connected to sleeves 34 at the other end is adapted for insertion into the cavity 22. At the end of the core member opposite the bulb 32 an O-ring 36 is provided for sealing the core member within the cavity 22. The sleeves 34 connect with batteries 35 which are located in a second cavity 38 in the handle which intersects the first cavity 22. The batteries connect to the sleeves 34 by means of self-wiping contacts 37.

Prior to this invention structural limitations had made it impossible to bring the source of illumination close to the working end of the speculum because the thinness of the blades prohibited structures such as the elongated cavity 22. Hence, all prior methods for providing illumination were restricted to light sources located at the proximal end of the blades and included locating the light source in the handle and constructing the blades of translucent material, clipping a source of light to the proximal end of the upper or lower blade, or providing light by means of reflection directed down the throat of the blades. However, it was found that with sources of the usual intensity the illumination within the body cavity was unsatisfactory. With the advent of Lexan and other polycarbonate plastics, materials with sufficient structural strengths are now available and readily lend themselves to applications in the thin walls and blades of diagnostic and surgical instruments.

The lens 28 is fabricated of the same material as the speculum but is translucent in order to transmit light from the bulb 32. Depending on the specific illumination requirement, the lens is any one of the several types possible, i.e., concave, convex, Fresnel, etc. With particular types of lenses it is possible to direct substantially all the light emitted by the source toward the area to be illuminated without backlight. In addition the rear edge 40 of the lens is silvered to increase the amount of light directed into the cavity. If needed, a reflector is also mounted in the upper blade 8 to further direct the light toward the working area. As can be described more clearly from FIG. 3, the lens 28 is provided with shoulders 42 for seating within the lower blade 4 and is normally cemented in this aperture in the blade.

As noted, the light source cavity runs down the length of the lower blade 4 at an angle slightly skew to the longitudinal axis 44 of the lower blade. This is due to the fact that the handle 2 is deliberately offset to the left of

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the axis in order to facilitate the use of other diagnostic or surgical instruments once the speculum has been seated in place. In prior instruments the handle was directly in line with the axis of the blade and incumbered instruments being inserted between the blades from the right side of the speculum.

As shown in FIG. 2 the light source cavity 22 terminates in the handle 2 at the opening 27. The core member 30 seats in the cavity 22 and is secured by screw threads cut on the core member adjacent the O-ring 36 on the core member. The sealing plug on the battery cavity is also secured by the same means. This feature, combined with the feature that the contact between the core member and the batteries is a sliding type, means that the electric bulb 32 or the batteries are easily removable from the instrument without the necessity of removing the speculum after it has been placed in operation. This is especially useful if bulb or batteries need to be replaced during an examination or operation. The use of water-tight sealing plugs also makes possible submersion of the instrument for sterilization without the necessity of removing lights or batteries.

FIG. 3 more clearly indicates the spatial orientation of the battery and light source cavities 38 and 22, respectively. A third recess 48 indicated in dotted section in the handle is adapted to receive the vertical support member of the cam and riser assembly 6. A protrusion or tooth 46 located at the top of the rear wall of the recess 48 is adapted to engage notches provided on the rear portion of the vertical support member.

Another feature of the speculum of the invention is that the lower blade 4 is scooped or cup-shaped at the distal end with the bottom of the cup coinciding roughly with the leading edge of the lens 28. The cup 55 is useful in collecting fluids and other organic materials which it may be desired to remove for further analytical purposes. FIG. 3 also depicts the angle of the handle 2 relative to the lower blade 4. In the figure shown this angle is approximately 110°. Previous instruments of this type employed a handle which was approximately at an angle of 90° with respect to the lower blade. The disadvantage there was that body structures surrounding the cavity to be enlarged interfered with the speculum handle and prevented maximum utilization of the instrument.

As shown in FIGS. 2 and 3, the upper blade 8 is pivotally mounted to the cam and riser assembly 6 at the pivot 50 and has an extension 16 which reaches out and over the lever arm 10 of the cam 12 and contacts the cam in its rest position by means of a cam follower 15. The detailed method of operation of this part of the speculum is as follows: Downward pressure of the thumb on the knurled end 52 of the lever 10 causes rotation about pivot 54 and force exerted on the upper blade 8 at the cam follower 15 which acts at approximately a 45° angle to a line connecting the pivot or center of rotation 54 of the lever and the upper blade pivot 50. This produces movement of the distal end 18 of the upper blade 8 with respect to the lower blade 4.

The relation of the cam and lever and the riser mechanism is more graphically depicted in FIGS. 4 and 5. Referring now to those figures, we find that the cam and lever 10 and the riser mechanism 14 are two separate pieces connected by means of a pin concentric with the pivot 54. Pressure on the knurled end 56 of the riser 14 accomplishes two things: the rear portion 58 of the riser mechanism is caused to travel toward the vertical support member 60 against tension built into the riser mechanism. This inward pressure causes notches 62 to disengage from the tooth 46 provided within the riser recess 48 and frees the riser mechanism for vertical motion within the recess. Upward and downward pressure on the knurled end 56 causes the riser mechanism to slide up and down in the recess 48. Release of pressure will cause the rear portion 58 to again seat against the rear wall of the recess 48 and thereby lock the riser mechanism in the desired position.

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Locking of the upper blade and the cam and lever is also an important feature of this invention. In the preferred embodiment such as is shown in FIGS. 2 and 3, this is accomplished by providing a specific relation between the cam 12 and the cam follower 15, such that a locus of points of contact between the cam and follower define a line of contact. This line, together with a point on the cam pivot 54, defines a plane which contains the line of contact and passes through the pivot 54. As will be described more fully below, the cam surface is designed so that the point of contact between it and the cam follower closely approximates this plane for all positions of the upper blade relative to the lower. By proper location of the cam, cam follower, cam pivot and upper blade pivot, this plane is oriented such that it intersects a line connecting the cam pivot 54 and the upper blade pivot 50 at a 45° angle. With the plane oriented at this angle any closing force exerted on the upper blade is translated into a force acting along a line passing through the cam pivot 54 and is absorbed by this structure of the speculum without any rotational force being imparted to the cam. The blades are thereby locked in this position until the lever is moved by the operator. With an orientation of 45°, locking is positive and no force exerted on the upper blade can cause the cam to change position. However, locking can still be achieved even where the plane deviates from the 45° orientation.

Depending on the angle which the cam presents to the cam follower and the amount of friction normal to the particular bearing surface between the pivot 54 and the cam 12, the orientation of the plane may deviate a few degrees above or below the 45° value without adversely affecting the locking feature. As the orientation departs substantially from the 45° figure, forces tending to close the upper blade are no longer directed along the line through the pivot 54 and results in a rotational moment being exerted on the cam. To counteract this moment, means for frictionally coupling the cam 12 to the shaft 54 on which it is mounted are provided. For example, a split ring 13, such as is shown in FIG. 8, is provided as an integral part of the cam 12. By tightening the bolting arrangement 5, friction between the cam and shaft is increased, thus resisting rotational forces exerted on the cam. In this way the blades are again locked in position until the rotational component of an external force exerted on the upper blade is sufficient to overcome the amount of friction provided. The maximum deviation from the 45° angle is dependent on several factors including the friction between the cam and cam shaft, the flatness of the angle which the cam presents to the cam follower, and the contour of the area of contact between the cam and cam follower. Limits felt to be reasonably practicable are 45° plus or minus approximately 15°, that is, the plane can have an orientation such that it forms an angle of approximately 30° to 60° with the line connecting the two pivots and still provide locking if a sufficient amount of friction is built in.

Shown in FIG. 6 is a method by which the preferred embodiment of this self-locking cam is developed. After locating the centers of the two pivots 50 and 54, a line 64 at a 45° angle to the horizontal is drawn through the center 54. The line 64 corresponds to a side view of the plane referred to in the preceding discussion and also represents a close approximation of all points of contact between cam and cam follower. The two centers 50 and 54 lie on the same vertical 66. Using the upper center 50 as the center of a circle, an arc 68 is struck approximating the line 64. Since the blades of the speculum will normally be operated at an angular separation of 5° or more, the zero or unoperated position of the blades is taken as the point of maximum deviation from the 45° line. This point is designated at 70. By striking off points at 5° intervals from the zero position along the arc 68 a number of points on contact of the cam with the cam follower can be located. Seven points are struck corre-

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sponding to the number of five degree increments of separation from zero to 35°. While 35 degrees of separation is the nominal maximum separation contemplated, an over-travel of 7 degrees is provided to compensate for any wear in the bearings and insure that at least 35° of separation is attainable. Once these points have been determined, arcs are struck using the lower pivot point 54 as the center and passing through the point of intersection between the arc 68 and the various five degree increment struck off along the arc 68.

In order to provide a mechanical advantage in opening the blades and to enhance the locking feature, the amount of rotation of the cam is selected such that there is a ratio greater than one to one between the amount of cam rotation and the amount of upper blade rotation. In the illustration of FIG. 6 a two to one ratio is chosen. This means that the lever is rotated through 10° for every 5° of rise of the upper blade. More secure locking is obtained due to the fact that the cam presents a flatter angle to the cam follower. Accordingly, radii drawn through the center 54 are measured at 10° intervals from a line 72 drawn from the center 54 to the zero point 70 when the blades are unoperated. The intersection of these radii with the arcs struck from the center 54 and passing through the various points of contact define points on the cam surface. By trial and error a center 74, .136 inch below the lower pivot 54 and .102 inch to the left of that point, has been found from which a circular arc approximating these points on the cam surface can be struck. Since the cam surface can be closely approximated by a circular arc, the problems of manufacturing such a cam are significantly reduced.

The various features of the invention have been described in conjunction with a particular type of medical instrument, a Graves vaginal speculum. Such a description is intended to be illustrative of the operating principles of each of these features and not limited to this specific instrument. The lighting feature, in particular, is equally well adaptable to other medical instruments requiring illumination of an area to be examined. Any instrument incorporating a thin blade or tube attached to a handle can be provided with a light source in accordance with this invention. Examples of such instruments are retractors and depressors used in surgical or dental applications.

We claim:

1. A vaginal speculum comprising:

an upper blade pivotally mounted relative to a lower blade,

a handle affixed to the lower blade,

a cam follower located on the upper blade, the cam follower having a smooth camming surface, and

a cam rotatably mounted adjacent the handle and disposed in a predetermined position relative to the cam follower, the cam having a smooth camming surface slidably engaged with the cam follower surface, whereby rotation of the cam produces pivoting motion of the upper blade relative to the lower blade and locking of the upper blade in a fixed angular relationship to the lower blade after rotation of the cam.

2. A Graves vaginal speculum comprising:

cooperating upper and lower blades,

a handle affixed to the lower blade,

a first pivot mounted adjacent the handle of the speculum about which the upper blade is adapted to rotate,

a cam follower surface located on the upper blade,

a second pivot including a shaft mounted adjacent the handle below the first pivot,

a lever including a cam surface rotatably mounted on the shaft with the cam surface disposed in contact with the cam follower surface, contact between the two surfaces defining a first line lying in a plane passing through the second pivot at an angle with a second line connecting the first and second pivot, the

- angle between the plane and the second line lying between the limits of about 30° and 60°, and means for frictionally coupling the lever to the shaft whereby rotation of the lever produces motion of the upper blade about the first pivot and the coupling means is adapted to resist rotation of the lever due to forces exerted on the upper blade.
3. A Graves vaginal speculum comprising:
 an upper blade,
 spring means affixed to the upper blade and extending downwardly therefrom,
 a lower blade,
 a handle rigidly affixed to the lower blade, the handle having a cavity provided therein, the spring means being releasably disposed within and vertically movable with respect to said cavity,
 a protrusion from a wall of the cavity for releasably engaging the spring means, and
 means attached to the spring means for disengaging the protrusion and the spring means for repositioning the spring means within the cavity.
4. A vaginal speculum comprising:
 cooperating upper and lower blades,
 a handle to which the lower blade is rigidly affixed,
 a support member for raising the upper blade relative to the lower blade, the upper blade being pivotally mounted on the member,
 a recess in the handle to receive the support member, means for releasably locking the member in a plurality of positions within the recess,
 a lever with a cam pivotally mounted on the support member, and
 a cam follower on the upper blade adapted to engage the cam, engagement of the cam and cam follower defining a line lying in a plane passing through the lever pivot at substantially an angle of 45° with a line between the lever pivot and the upper blade pivot.
5. A vaginal speculum comprising:
 cooperating upper and lower blades,
 a handle affixed to the lower blade,
 a cam follower on the upper blade,
 a rotatable cam mounted adjacent the handle adapted to engage the cam follower for raising and locking in position the distal end of the upper blade relative to the lower blade,
 a cavity in the handle, and
 a member slidably seated in the cavity and pivotally supporting the upper blade for raising and locking in position the proximal end of the upper blade relative to the lower blade, the lower blade being rigidly affixed to the handle at an angle of 100° to 120° and laterally offset from the longitudinal axis of the handle.
6. A vaginal speculum comprising:
 cooperating upper and lower blades,
 a handle affixed to a lower blade at an angle of 100° to 120°, the handle axis being laterally translated from the longitudinal axis of the lower blade to facilitate the insertion of other instruments between the proximal ends of the blades,
 a raising mechanism pivotally supporting the upper blade and seated in a recess in the handle for raising and retaining in position the proximal end of the upper blade with respect to the lower blade,
 a lever pivotally mounted on the raising mechanism on the side opposite the speculum,
 a cam provided at one end of the lever,
 a cam follower on the upper blade adapted to engage the cam,
 the lever being adapted to raise and retain in position the distal end of the upper blade with respect to the lower blade.

7. A Graves vaginal speculum comprising:
 cooperating upper and lower blades for vaginal insertion, each of said plates having a proximal and a distal end,
 a handle affixed to the lower blade,
 an aperture located in the distal end of the lower blade,
 a lens seated in said aperture,
 a first hollow tube extending substantially along the longitudinal axis of the lower blade from the aperture and through the handle to an opening at the rear of the handle,
 a second hollow tube extending through said handle substantially along the axis thereof, said second tube communicating with an opening in the bottom of the handle,
 a core member including a light bulb at one end and sleeves connected to the light bulb at the other end located in the first tube, the core member being replaceable while the instrument is in use,
 a source of electrical power located in the second tube, self-wiping contacts for connecting the source of power to the sleeves on the core member, and
 switch means located at the bottom of the handle for completing the electrical connections between the core member and the power source.
8. A Graves vaginal speculum as defined in claim 7 wherein a cup-shaped depression is provided substantially adjacent the distal end of the lower blade.
9. A vaginal speculum comprising:
 an upper blade pivotally mounted relative to a lower blade,
 a handle affixed to the lower blade,
 a cam follower located on the upper blade, and
 a cam rotatably mounted adjacent the handle and disposed in contact with the cam follower, contact of the cam and cam follower defining a line lying in a plane passing through the center of rotation of the cam at substantially a 45° angle with a line connecting the upper blade pivot and the cam center of rotation.
10. In a Graves vaginal speculum having cooperating upper and lower blades and a handle affixed to the lower blade, the combination comprising:
 a first pivot mounted adjacent the handle of the speculum about which the upper blade is adapted to rotate,
 a cam follower surface located on the upper blade,
 a second pivot mounted adjacent the handle below the first pivot, and
 a lever including a cam surface rotatably mounted on the second pivot with the cam surface disposed in contact with the cam follower surface, contact between the two surfaces defining a line lying in a plane passing through the second pivot at substantially a 45° angle with a line connecting the first and second pivot.

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