Oct. 15, 1940. J. ASSMUTH ET AL 2,218,078

MITOSIS MODEL

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Fig. 1.

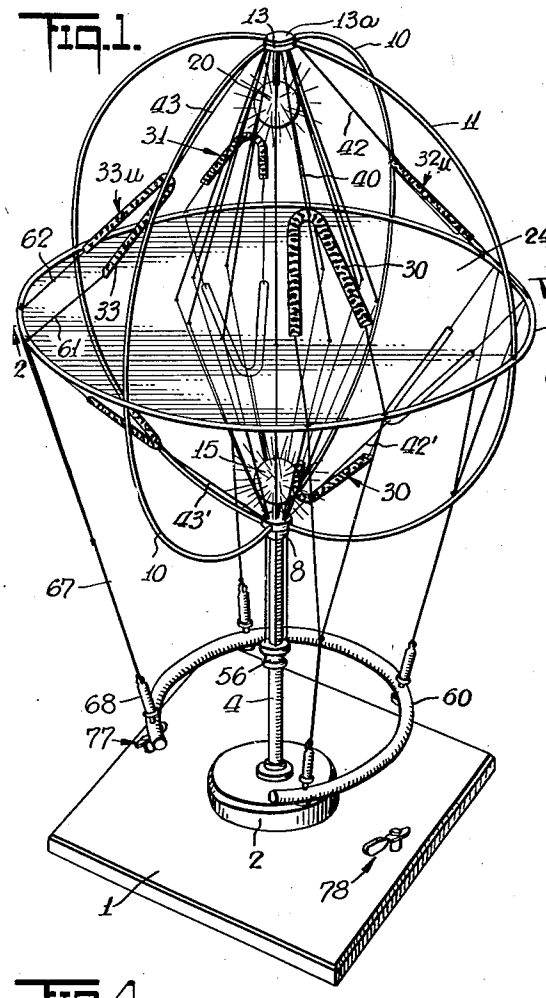

Fig. 2.

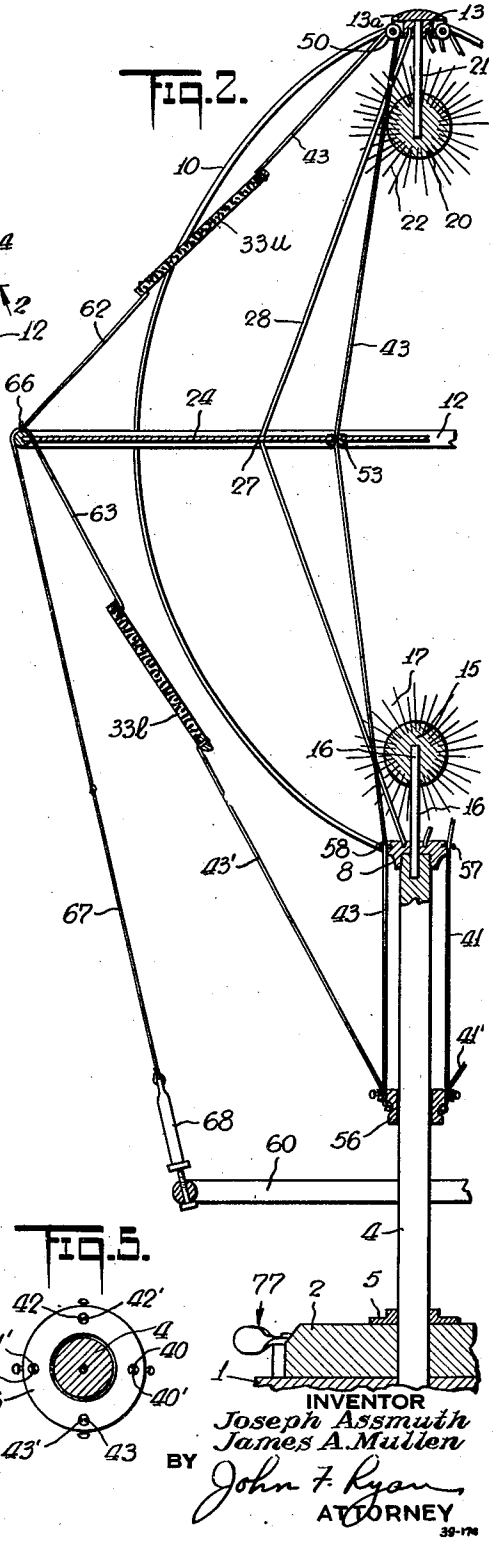

Fig. 4.

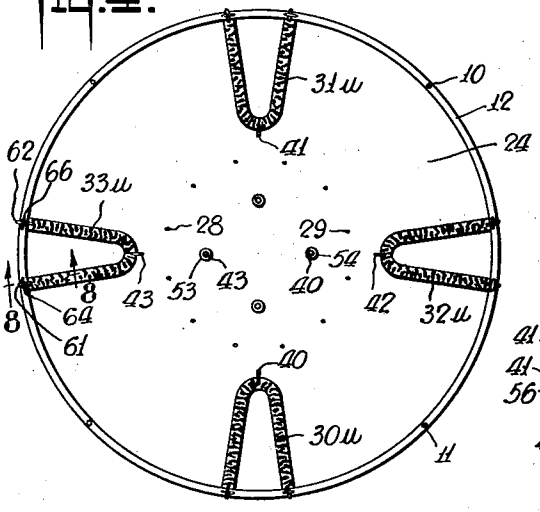

Fig. 5.

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FIG. 3.

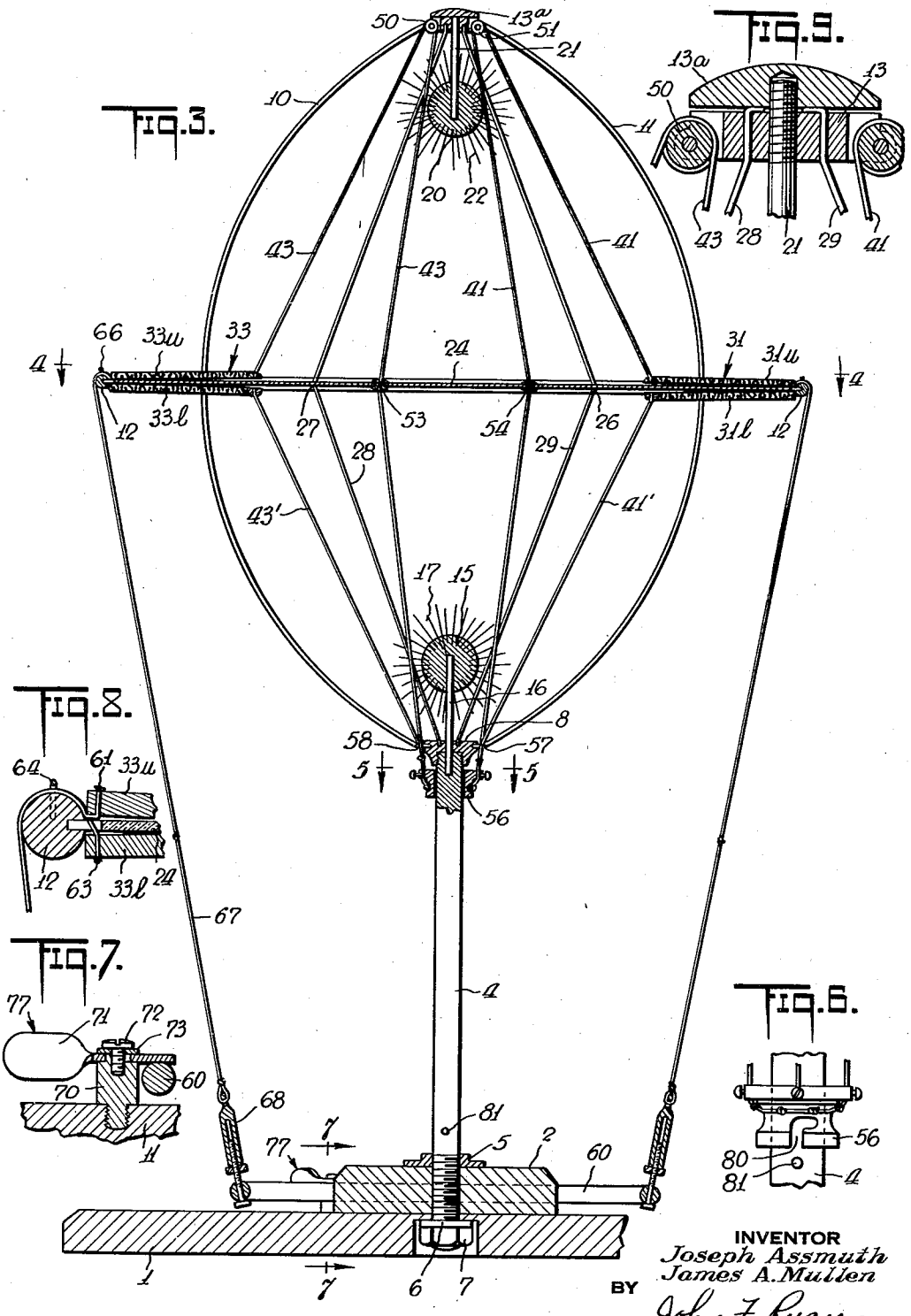

FIG. 9.

FIG. 8.

FIG. 7.

FIG. 6.

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MITOSIS MODEL

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Application January 26, 1940, Serial No. 315,658

8 Claims. (Cl. 35—20)

This invention relates to a mechanical operating model for illustrating cell structure and division.

It is an object of the invention to produce a device representing the general physical structure of a cell with certain parts thereof mechanically operable to visually illustrate cell division.

It is a further object to produce such a device which is simple and rugged in construction, easily operable by an instructor or student and so designed that cell structure and division can be readily visualized by the student.

Looking at the drawings:

Fig. 1 is a perspective view of the model,

Fig. 2 is a longitudinal vertical section through 2—2 of Fig. 1,

Fig. 3 is a vertical section through 2—2 of Fig. 1 wherein the counter-balance ring is shown in its lowermost position and the various connected parts shown in their relative positions.

Fig. 4 is a section through 4—4 of Fig. 3 showing a plan view of the equatorial plate of the device,

Fig. 5 is a plan view along 5—5 of Fig. 3,

Fig. 6 is a side elevation of the ring shown in Fig. 5,

Fig. 7 is a detail through 7—7 of Fig. 3, partly in section, showing one of the latches designed to hold the counter-balance ring in its lowermost position,

Fig. 8 is a detail through 8—8 of Fig. 4, partly in section, showing how the connecting and operating cords are secured to the chromosomes, and the relationship of the ends of the chromosomes to the horizontally disposed ring forming part of the framework of the device.

Fig. 9 is an enlarged view more clearly showing the construction and details of the top of the mitosis model.

Looking at the figures, 1 is a base or stand which can be made of wood or similar material of such size and weight as to readily support the model without danger of permitting it to tip over or fall sideways. Secured to the top thereof, is a circular block of wood or other suitable material, shown at 2 as centrally disposed on the platform 1. Block 2 and platform 1 are axially drilled to produce a hole for receiving the supporting stanchion 4. The stanchion 4 is secured to the base and block of wood, and the members are locked together by means of a nut 5 threaded on stanchion 4 and normally positioned on the upper side of block 2. On the underside of the base is a washer 6 and a nut 7, designed to draw the base and block of wood together between washers 5 and 6.

Stanchion 4 is in the form of a vertically disposed rod to the upper end of which is screwed a nut with a circular head as shown at 8. This circular nut 8 in turn supports two rings 10 and 11 both of which are arranged in a vertical plane at right angles to each other. These rings support and are tied together by an equatorial ring 12 which is horizontally disposed midway between the upper and lower poles formed by the rings 10 and 11. Rings 10 and 11 are supported and joined together in their upper pole by means of a circular nut 13. On top of nut 13 is a cap 13a with a slightly convex outer surface, screwed on the upper end of rod 21. The cap serves to cover the colored strings, hereinafter described, which pass through holes in nut 13. The three rings 10, 11 and 12, form the outline of a sphere.

Spherical balls of cork or similar material are mounted on the inside of the rings near the ends of the vertical axes thereof to represent centrosomes. The lower centrosome shown at 15 is mounted on a short rod 16 inserted through nut 8 and into stanchion 4. A large number of metal pins or the like shown at 17 are inserted into the surface of the ball 15 to represent the astral rays emanating from the centrosome. A cork ball 20 is mounted on the rod 21 supported in the nut 13 to represent the upper centrosome. The astral rays of this representation of the upper centrosome are likewise illustrated with pins or thin pieces of metal as shown at 22.

The equatorial plate is made of a circular piece of transparent material such as heavy Cellophane, Celluloid, a resinous condensation product, or the like. It is illustrated at 24 and supported on the ring 12. This circular transparent member representing the equatorial plate, has a number of holes therethrough disposed in the form of a circle around the center point of said plate. Two of these are shown at 26 and 27. Through each hole is passed a piece of colored string, the ends of which are secured to the nuts 8 and 13. Two of these are shown at 28 and 29. These colored pieces of string represent the spindle rays which extend from one centrosome to the other. In the embodiment of the invention illustrated in the drawings, the perforations through the equatorial plate for the spindle rays, are about one inch apart and form a circle, six inches in diameter.

Near the periphery of the equatorial plate represented by the transparent circular sheet, are disposed a number of V-shaped elements adapt-

ed to represent chromosomes. Each element is made up of an upper and lower portion which are designed to separate to illustrate a split chromosome, and each element is preferably stippled with various odd designs to show the genes. In the drawings, four split chromosomes are illustrated at **30**, **31**, **32**, and **33**. The upper portion of each will be designated by the addition of the letter *u* to the numeral, and the lower portion by the addition of the letter *l*. These V-shaped representations of split chromosomes are designed so that both halves thereof are normally disposed together in the equatorial plate, but may be split apart with the upper portions moving upwardly toward the upper centrosome, and the lower portions moving downwardly toward the lower centrosome.

Cord or strong thread is connected to the apex of each portion of each chromosome. Some of these cords are shown at **40**, **41**, **42** and **43**. The cords attached to the upper portions of the V-shaped members representing chromosomes, pass upwardly as shown, and through suitable small pulleys inserted in nut **13**. Pulleys **50** and **51** serve cords **40** and **43** as shown in Fig. 3. Then these cords pass downwardly through holes **53** and **54** in the equatorial plate, and are attached to ring **56** which is slideable up and down on the stanchion **4**. The length of these cords is such that when the V-shaped members representing the split chromosomes are disposed together on the equatorial plate as shown in Fig. 3, the ring is in its uppermost position. The corresponding cords **40'**, **41'**, **42'** and **43'** for the lower V-shaped members are connected directly from the apices thereof through suitable small eyelets **57** and **58** to the ring **56**.

In the embodiment illustrated, there are furnished four cords for the upper halves of the four V-shaped members. These pass through pulleys in nut **13**. Four cords for the lower halves pass through eyelets in ring **8**. All are connected to movable ring **56**. When the ring **56** is moved downwardly along the stanchion **4**, it tends to pull the lower portion of the V-shaped elements, that is **31***l* and **33***l* as shown in Fig. 3, downwardly toward the lower centrosome, and simultaneously draw the upper V-shaped elements **31***u* and **33***u* upwardly toward the upper centrosome.

The outer ends of the V-shaped elements are connected by suitable cords to a counter-balance ring shown at **60**. Each leg of each V-shaped element has a cord connected thereto. Taking element **33** as illustrative of the four elements representing the split chromosomes, we find cord **61** (Fig. 8) attached to the end of one leg of the upper portion of the element which has been designated as **33***u* and cord **62** attached to the end of the other leg. Each of these pass through a small eyelet mounted on the ring **12**. Cord **61** passes through eyelet **64** and cord **62** through eyelet **66** (Fig. 4). Similarly, there are two cords attached to the legs of the lower portion of element **33** which has been designated as **33***l* (one of these is shown at **63** in Fig. 8), and in like manner, these cords pass through the eyelets **64** and **66**, and all four cords are joined together to a single cord **67** which is connected through an adjustable turn-buckle **68** to the ring **60**. In like manner, each of the legs of the split chromosomes has a cord passing through an eyelet on the ring **12** and joined to the counter-balance ring **60**, through the medium of an adjustable turn-buckle.

The result is that the weight of the ring **60** is always tending to move the V-shaped members representing the split chromosomes toward the equatorial plate, and because of the manner in which the ends of the cords are attached to each V-shaped member, the downward tug of the ring **60** tends to cause the V-shaped member, to come together in the equatorial plate as illustrated in Fig. 3. The ends of the cords are joined to the V-shaped members as illustrated in Fig. 8.

In order to maintain sufficient tension on the cords connected to the ring **60**, such as the cord **67**, to position the elements **30**, **31**, **32** and **33**, closely adjacent to the equatorial plate as illustrated in Fig. 3, a pair of latches **77** and **78** one of which is illustrated in detail in Fig. 7, are designed to hold the ring **60** down. These latches consist of a pivot **70** screwed into the base **1**, and mounted thereon is a pivoted latch **71**, which is held in place by a screw **72** and a washer **73**, in such manner that it can be moved around the pivot **70**. One arm of the latch, that is the left end as viewed in Fig. 7, is intended to be engaged by the operator of the device and so is disposed in a vertical plane. The other is intended to engage the top of the ring **60** to hold that ring down. This end is disposed in a horizontal plane. Two of these latches are illustrated and it will be seen in Fig. 1 that these are diametrically spaced from each other.

Fig. 6 illustrates a detail of the ring **56** and shows a bayonet latch including a right angular recess **80** designed to engage pin **81** which projects from the side of stanchion **4** near the lower end thereof. The purpose of pin **81** is to engage in the recess **80** of the ring **56** to hold the ring in its lowermost position, at which time the elements representing the chromosomes will be positioned near the centrosomes.

The model is shown in its first position in Fig. 3 with the counter-balance ring **60** in its lowermost position, held there by latches **77** and **78**. It will be seen that the ring **56** is in its uppermost position and that corresponding V-shaped elements representing the chromosomes are drawn together on the equatorial plate. When it is desired to operate the model to illustrate cell division, latches **77** and **78** are operated to release the ring **60** and the ring **56** is drawn downwardly on the stanchion **4**. As this is done, the ends of the V-shaped members disposed in the direction of the interior of the sphere formed by the rings **10**, **11** and **12**, are drawn away from each other. The upper portions are drawn upwardly toward the upper centrosome **20** and the lower portions downwardly toward the lower centrosome **15**, and at the same time the counter-balance ring **60** is raised.

When the ring **56** is drawn down to its lowermost position, the bayonet slot **80** may be engaged by the pin **81** to hold the various parts stationary with the representation of the chromosomes adjacent to the balls **15** and **20** which illustrate the centrosome. The upper V-shaped elements will arrange themselves around the upper centrosome and the lower V-shaped elements around the lower centrosome.

To return the V-shaped elements to their original position, it is only necessary to disengage the ring **56** from the pin **81** and then the weight of the ring **60** will move the V-shaped elements downwardly toward the equatorial plates. The adjustable turn-buckles such as the one shown at **68**, are so adjusted that when the ring **60** is

pressed downwardly to be caught under the latches 77 and 78, sufficient tension will be produced in the cords connecting it to the V-shaped elements to cause the elements to assume the positions shown in Fig. 3. That is, with upper and lower portions together in the equatorial plate.

We wish it to be understood that we do not limit ourselves to the exact details of construction shown and described, as our invention is obviously capable of various modifications.

Having thus described our invention what we claim as new and desire to secure by Letters Patent is:

1. In a mitosis model, elements representing upper and lower centrosomes, elements representing split chromosomes, and mechanical means for separating each of said latter elements and moving the separated portions thereof in the direction of the centrosomes.

2. In a device of the character described, elements representing a pair of centrosomes, an equatorial plate located therebetween, members comprising upper and lower portions representing split chromosomes, and means for positioning said portions into upper and lower positions and moving them respectively toward upper and lower centrosomes and for returning said portions to the equatorial plate and positioning them together to represent chromosomes before they have split into two parts.

3. In a device of the character described, a plurality of rings disposed to define the outlines of a sphere, an equatorial plate arranged at right angles to the vertical axis of said sphere, elements representing split chromosomes each consisting of an upper and lower portion, means for positioning said upper and lower portions together on the equatorial plate and means for operating said portions and moving the upper portions toward the upper part of said sphere, and the lower portions toward the lower part of said sphere, and means for returning said portions to their original position in the equatorial plate.

4. In a device of the character described, a pair of vertically disposed rings arranged in planes at right angles to each other, an equatorial ring arranged in a horizontal plane between the upper and lower poles of the first mentioned rings, a stanchion for supporting said rings on a base, an upper and lower centrosome arranged near the upper and lower poles of the sphere outlined by the rings, elements representing split chromosomes and comprising upper and lower V-shaped members, means for positioning these members adjacent to each other in the equatorial plate to represent unitary chromosomes, and means for operating said upper and lower portions and moving them away from each other, the upper portions toward the upper centrosome and the lower portions toward the lower centrosome, and means for returning these movable portions to their original position in the equatorial plate.

5. In a device of the character described, a plurality of vertically disposed rings forming the outline of a sphere, an equatorial plate disposed at right angles to the vertical axis of said sphere, a vertical stanchion for supporting this structure on a suitable base, elements representing split chromosomes and consisting of upper and lower V-shaped members, a counter-weight connected to said members by flexible connectors and designed to urge them into a position adjacent to the equatorial plate and with upper and lower portions thereof adjacent to each other to represent unitary chromosomes, a vertically movable ring attached to the apices of said members by flexible connectors so that upon downward movement of said ring, said upper and lower members are separated, the lower ones move downwardly toward the lower pole of said sphere, and the upper ones moves upwardly toward the upper pole against the weight of the aforesaid counter-weight ring.

6. In a device of the character described, a plurality of vertically disposed rings forming the outline of a sphere, an equatorial plate disposed at right angles to the vertical axis of said sphere, a vertical stanchion for supporting this structure on a suitable base, elements representing split chromosomes and consisting of upper and lower V-shaped members, a counter-weight connected to said members by flexible connectors and designed to urge them into a position adjacent to the equatorial plate and with the upper and lower portions thereof adjacent to each other to represent unitary chromosomes, a vertically movable ring attached to the apices of said members by flexible connectors so that upon downward movement of said ring, said upper and lower members are separated, the lower ones move downwardly toward the lower portions of said sphere, and the upper ones move upwardly toward the upper portions thereof against the weight of the aforesaid counter-weight ring, and means for holding the aforesaid ring in its lowermost position.

7. In a device of the character described, a plurality of vertically disposed rings forming the outline of a sphere, an equatorial plate disposed at right angles to the vertical axis of said sphere, a vertical stanchion for supporting this structure on a suitable base, elements representing split chromosomes and consisting of upper and lower V-shaped members, a counter-weight connected to said members by flexible connectors and designed to urge them into a position adjacent to the equatorial plate, and with the upper and lower portions thereof adjacent to each other to represent unitary chromosomes, a vertically movable ring attached to the apices of said members by flexible connectors so that upon downward movement of said ring said upper and lower members are separated, the lower ones move downwardly toward the lower portions of said sphere, and the upper ones upwardly toward the upper portions thereof against the weight of the aforesaid counter-weight ring, and means for holding the counter-weight ring down in its lowermost position.

8. In a mitosis model, a substantially spherical framework, a pair of elements representing centrosomes one positioned in the upper portion of the framework and one diametrically opposite in the lower portion, members comprising upper and lower portions representing split chromosomes, means for positioning corresponding portions of said chromosomes together in a plane about half-way between said centrosomes or for moving the portions into position adjacent to said centrosomes.

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