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DIAGNOSTIC AND MEDICATING CAPSULE AND THE METHOD OF USE

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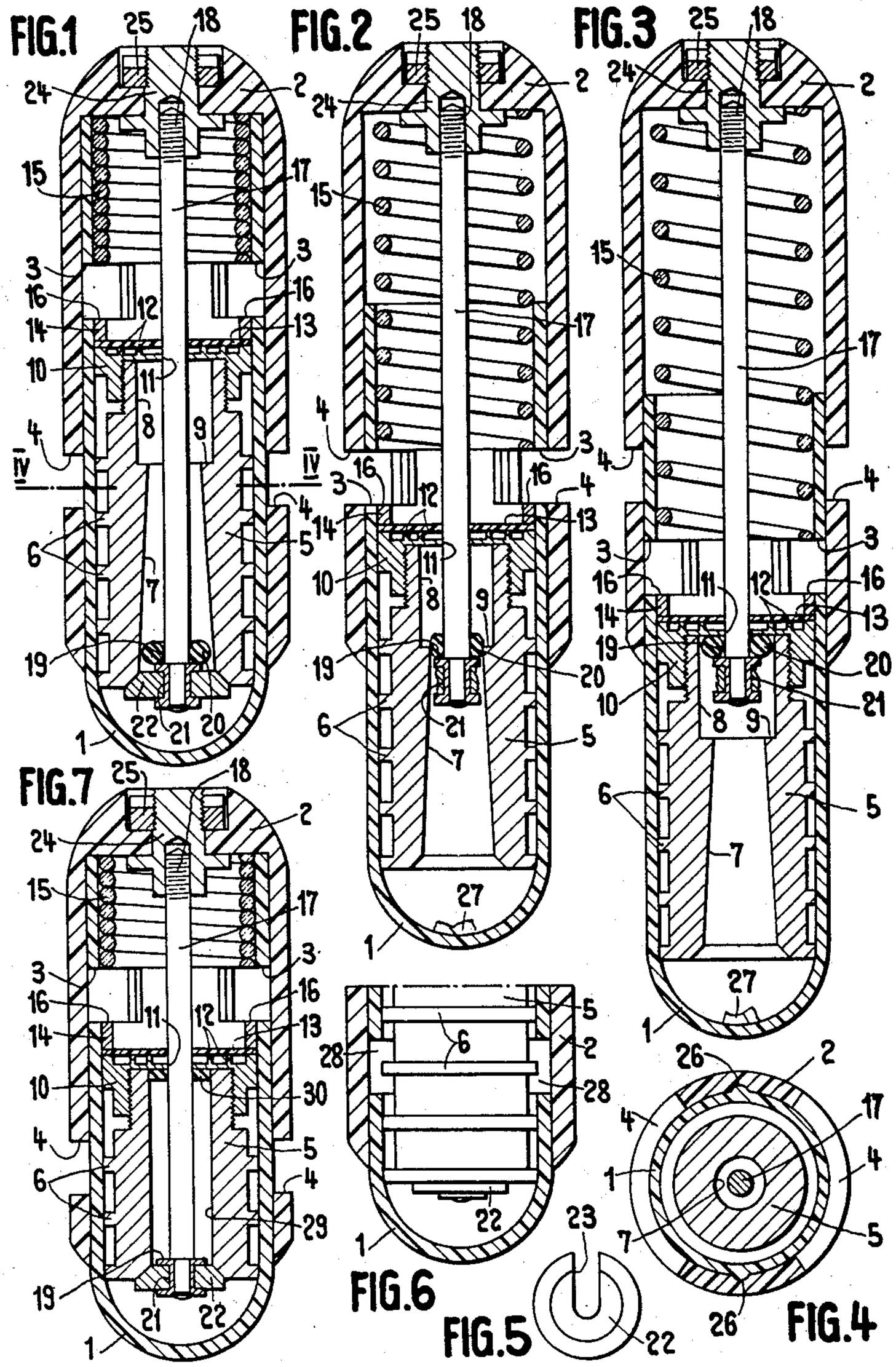

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DIAGNOSTIC AND MEDICATING CAPSULE AND THE METHOD OF USE

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The present invention aims to facilitate the work of the physicians specially dealing with the digestive system of man. There are, indeed, two main problems which have not been solved up to now or at least not in a satisfactory manner.

The first problem consists in taking at a predetermined place of the alimentary canal a sample of liquid for purpose of analysis. Such an operation is useful, either for diagnosing a disease or, more generally, for better knowing the digestive process. Moreover, taking of samples may promote the scientific researches in parasitology, bacteriology and enzymology.

The second problem consists in introducing a substance into a predetermined place of the alimentary canal. This substance may be a medicament adapted to cure a given disease or any other substance the action of which at a predetermined level of the alimentary canal should be known.

For solving the first problem, it has been proposed up to now to use sounds. Gastric sounds are known, by means of which liquid can be taken from the stomach. There also exist other sounds, called sounds of Miller-Abbott, by means of which the small intestine can be reached more or less completely, but these sound are very unpleasant to swallow for the patient and provoke reflexes which are themselves susceptible of producing modifications of the intestinal contents. On the other hand, the sounds introduced through the rectum only allow exploration of the colon. It is, therefore, impossible, with the known means, to take correct samples of liquid at any place of the small intestine, unless a surgical operation is made. Now, it would just be interesting to have the possibility of taking such samples and evacuating the samples from the body without alteration.

The second problem has not been solved either up to now. It would be possible, in case of need, to use the already mentioned sounds for introducing a substance into the stomach, for instance, but here again a whole portion of the alimentary canal is inaccessible. It is true that the patient can merely swallow the substance referred to, but this substance is considerably altered while it travels through the alimentary canal, and it would be interesting to cause the intact substance to act at a predetermined level of the alimentary canal.

Thanks to the present invention both above-mentioned problems can be solved in a particularly simple manner. The invention relates to a capsule consisting of two hollow parts provided with openings and susceptible of being moved with respect to each other, these openings being initially not in register, a block of metal, a spring means tending to move the parts with respect to each other and a retaining means including a metallic element with a low melting point, neutralizing the action of the spring means, the whole being arranged in such a manner that when the capsule is placed into a high frequency electromagnetic field, the metallic block is heated and causes the said element with a low melting point to melt, so that the spring means is free to act for moving one of the parts of the capsule with respect to the other in order to bring, at least temporarily, the openings of both parts in register and thus to put in communication the interior of the capsule with the environment.

The invention also relates to the use of the said capsule,

in which the capsule is swallowed by a human being, the position of the capsule is ascertained in the alimentary canal by radioscopy, and a high frequency electromagnetic field is generated in the vicinity of the capsule when the latter is in the desired position, so as to cause the capsule to open and thus to put in communication, at least temporarily, the interior of the capsule with the environment.

The accompanying drawing shows, by way of example, some embodiments of the invention.

FIG. 1 is an axial section of the first embodiment.

FIGS. 2 and 3 are similar sections of the same capsule, but in two different working positions.

FIG. 4 is a section taken along the line IV—IV of FIG. 1.

FIG. 5 illustrates a detail of the pastille.

FIG. 6 is an elevation view, partially in section, of a fragment of a modified embodiment.

FIG. 7 is an axial section of another embodiment.

The capsule illustrated in FIGS. 1 to 5 consists of two hollow parts 1 and 2 capable of sliding on each other and enclosing the several members of the capsule. For the sake of clarity, the part 1 will be called hereinafter the lower part and the part 2 the cap. Both parts 1 and 2 are made of a material resisting the action of chemicals, for instance of a plastic material such as "Teflon" (registered trademark). The lower part 1 has two lateral windows 3 of rectangular shape, and the cap 2 is provided with two windows 4, which are also of rectangular shape.

In the lower part 1 is fitted a block 5 made of such a metal (for instance steel) that it is easily heated when it is placed in a high frequency electromagnetic field. The block 5 has on its outer face ribs 6. It has in addition a conical bore 7 followed by a cylindrical bore 8, connected with the bore 7 by means of a shoulder 9. On the upper end of the block 5 is screwed a stop member 10 provided with a central hole 11 and having on its upper face a plurality of ribs 12 on which rests a washer 13 of plastic material (for instance of "Teflon"). On the washer 13 rests a metal sleeve 14 on the upper face of which bears one end of a coil spring 15 the other end of which bears against the bottom of the cap 2. Cut-out portions 16 are provided in the sleeve 14, facing the windows 3 of the lower part 1.

In the longitudinal axis of the capsule is arranged a rod 17 made of stainless steel, threaded as at 18 at its upper end, whereas its other end is provided with a shoulder 19 against which bears a packing 20. The packing 20 is of the type commonly called "O-ring" and is intended to serve as a brake when it moves in the conical bore 7 of the block 5, as described later. It is made for instance of rubber or of plastic material. Below the shoulder 19 the rod 17 has an annular groove 21 in which is accommodated a pastille 22 made of a metal or alloy with a low melting point. The pastille 22 may be made, for instance, of so-called Wood's metal, melting at about 70° C., or of another alloy. There is presently known an alloy sold under the trade name "Cerslow 117" the melting point of which is about 47° C. and which, therefore, is suitable for making the pastille 22. The pastille 22 is also shown in FIG. 5. It has a lateral notch 23, so that it can easily be placed on the rod 17. The pastille 22 bears against the lower edge of the block 5, at the large end of the conical bore 7 (FIG. 1).

On the threaded end 18 of the rod 17 is screwed a fixing member 24 which secures the cap 2 to the rod 17 by means of a lock nut 25.

For avoiding that the parts 1 and 2 of the capsule can rotate with respect to each other, there are provided on the lower part 1 two longitudinal ribs 26 (FIG. 4) which engage corresponding grooves of the cap 2.

The capsule illustrated and described is used in the following manner:

When the capsule is assembled as shown in FIG. 1, it is swallowed by the patient, for instance during a meal. Its position in the alimentary canal is ascertained by radioscopy and thus the moment at which the capsule should be released can be chosen at will.

Releasing of the capsule is effected as follows: The patient is isolated from earth by the fact that he is placed on a glass stool or the like, and is then surrounded by a copper cable with an insulating sheath. The ends of this cable and a point situated at about one third of its length are connected to a high frequency generator (about 2 megacycles) having a power of 1 kw. The copper cable acts as a coil in which flows a very strong high frequency current, which results in heating the block 5 of the capsule by induction. When the temperature of the block 5 reaches the melting point of the pastille 22, the later melts, which releases the longitudinal movement of the capsule parts. Indeed, as long as the pastille 22 is intact (FIG. 1), it retains the rod 17 and the cap 2 in the position shown in FIG. 1, thus neutralizing the elastic force of the spring 15. When the pastille 22 melts, its fragments 27 fall onto the bottom of the lower part 1 and the spring 15 causes the cap 2 to move upwards. During this movement, the packing 20 is displaced upwards, but the conical bore 7 compresses it, as shown in FIG. 2, so that the expanding movement of the capsule is slowed down. The packing 20 finally leaves the conical bore 7 and reaches the cylindrical bore 8 where there is no longer any braking action. The expansion becomes again faster, until the packing 20 strikes against the stop member 10 (FIG. 3). The dimensions of the different parts of the capsule are chosen in such a manner that the windows 3 and 4 of the lower part 1 and the cap 2 respectively are in register with one another at the moment when the expanding movement of the capsule is braked by the passage of the packing 20 in the upper portion of the conical bore 7 (FIG. 2). Due to this fact, the chamber of the capsule, situated above the washer 13, is put in communication with the environment during a time sufficient to allow the liquid situated in this environment (for instance the small intestine) to enter the said chamber. Upon expansion of the capsule, a vacuum takes place inside the capsule chamber, owing to the increase of volume. This vacuum can be increased by reducing the volume of the initial cavity of the cap 2, for instance by extending downwards the fixing member 24. The said vacuum promotes the suction of the liquid to be taken. It is worth noting that when the expanding movement has come to an end (FIG. 3), the windows 3 and 4 are again out of register, so that the capsule is again closed and the liquid taken cannot flow out of the capsule. In the position of FIG. 3, the spring 15 is still under a certain tension in order to avoid that for any reason the cap 2 moves downwards and the liquid taken can flow out of the capsule.

The capsule then acts as a means for transporting the liquid taken which is isolated from the environment by tight closing means. The capsule is found again in the stools and is then opened for extracting therefrom the contents to be analysed.

For guaranteeing on the one hand that the parts 1 and 2 smoothly slide on each other and on the other hand that a tight joint be obtained between these parts, the outer cylindrical surface of the lower part 1 may be smeared with a silicone-containing pomade.

For facilitating swallowing of the capsule by the patient, the capsule may be entirely coated with a thin layer of a material easily soluble in the saliva or the gastric juice, such as for instance gum-arabic.

It will be noted that, at the moment of being swallowed by the patient, the capsule has a very small volume (FIG. 1). It has for instance a length of 24 mm. and a diameter of 8 mm. When the capsule is in the stomach or the intestine, it can somewhat expand without incommoding the patient. The quantity of liquid taken by means of this capsule is about 0.25–0.030 cm.^{3}, which is absolutely sufficient for analysis purposes. Moreover, the test can be repeated at near intervals without any difficulty.

The method described for taking liquids in the digestive system causes no traumatism. Its use is very easy. It only necessitates the possession of a suitable high frequency generator.

As concerns the ribs 12 of the stop member 10, they prevent, in connection with the washer 13 of plastic material, the heat transmission from the block 5 to the liquid contained in the capsule chamber. The washer 13 also has the function of sealing the joint between the said chamber and the portion of the lower part 1 which contains the block 5.

In the modified embodiment partially illustrated in FIG. 6, additional windows 23 are provided in the wall of the lower part 1, in order to accelerate cooling of the block 5 after releasing of the capsule.

In the above-described embodiment of the capsule, a certain quantity of liquid had to be taken from the alimentary canal of the patient. To this end the capsule, initially closed, is temporarily opened for putting its interior in communication with the environment, and is then again closed hermetically. On the contrary, in the embodiment illustrated in FIG. 7, the capsule, initially closed, is then opened and remains in this condition, in order to allow a substance contained in the capsule to flow out of the capsule and to act at the desired place of the alimentary canal. The substance referred to may be a medicament or any other substance the specific action of which at a predetermined place of the alimentary canal should be known.

The capsule shown in FIG. 7 is similar to that of the first embodiment, except that the body 5 has a single cylindrical bore 29 in which is arranged a packing 30 of rectangular section. Therefore, when the pastille 22 melts, the rod 17 is no longer retained and the spring 15 moves upwards the cap 2 with respect to the lower part 1. This movement now takes place freely, without braking action, and is merely damped at its end when the shoulder 19 of the rod 17 strikes against the packing 30. At this moment, the windows 4 of the cap 2 are in register with the windows 3 of the lower part 1, and the substance contained in the capsule chamber can flow out of the capsule. This evacuation is facilitated by the stirring movement which normally takes place in the ambient liquid.

Instead of being formed of two parts telescopically arranged on each other, the capsule might also include two parts susceptible of rotating with respect to each other. In this case, no variation of volume of the capsule would occur at the moment of releasing of the capsule.

While certain representative embodiments and details have been shown for the purpose of illustrating the invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

What I claim is:

1. A method of taking a sample of liquid from the alimentary canal, comprising the steps of swallowing a capsule provided with closing means which open temporarily when heated by a high frequency electromagnetic field, locating the desired position of the capsule in the alimentary canal by radioscopy, generating a high frequency electromagnetic field in the vicinity of the capsule when said capsule has reached the desired position, and using the high frequency field to produce heat to open said closing means and to put the interior of the capsule temporarily in communication with the environ-

ment so that liquid may be entrapped within the capsule thereafter the closing means being automatically actuated to retain said liquid within the capsule.

2. A method of introducing substance into the alimentary canal, comprising the steps of swallowing a capsule containing a substance therein, the capsule provided with closing means which open when heated by a high frequency electromagnetic field, locating the desired position of the capsule in the alimentary canal by radioscopy, generating a high frequency electromagnetic field in the vicinity of the capsule when said capsule has reached the desired position, and using the high frequency field to produce heat to open said closing means and to put the interior of the capsule in communication with the environment, so that said substance can flow out of the capsule into the alimentary canal.

3. A swallowable capsule comprising a pair of hollow parts complementing each other to define a chamber, one of the parts slideable over the other part to vary the size of the chamber, at least one of the parts having an opening on the sidewall thereof so positioned that as the parts are separated the opening provides fluid communication means between the interior and the exterior of the chamber, spring means tending to separate the parts, heat responsive means normally effective to render the spring means ineffective, and means adapted to be heated under the action of a high frequency field, said last-mentioned means positioned in juxtaposition to the heat responsive means so as to transfer heat thereto, whereby under the action of the high frequency field the spring means is released to move the hollow parts so that the openings therein are in registration.

4. A capsule adapted to be swallowed comprising a pair of generally cup-shaped members adapted to be nested together with their closed ends defining a chamber which is expanded as the cup-shaped members are separated, both of the members having at least one opening on their sidewalls, the openings of the two members not in registration when the chamber is contracted, the openings in registration as the chamber is expanded and thereby providing an opening into the chamber, the openings again not in registration as the chamber is further expanded, spring means tending to separate the members and thereby expand the chamber, delay means effective to restrict the action of the spring means, heat responsive means operative normally to render the spring means ineffective, and means adapted to be heated responsive to the action of a high frequency field and positioned in heat exchange relationship with the heat responsive means whereby under the action of the high frequency field the spring means is operative to expand the members thereby at least temporarily providing an opening into the chamber, further movement of the members again closing the opening into the chamber, the expansion of the members tending to produce a suction into the chamber so that fluids within the body of the swallower may be collected.

5. A capsule adapted to be swallowed comprising a pair of generally cup-shaped members adapted to be nested together with their closed end defining a chamber which is expanded as the cup-shaped members are separated, both of the members having at least one opening on their sidewalls, the openings of the two members not in registration when the chamber is contracted, the openings in registration as the chambers is expanded and thereby providing an opening into the chamber, spring means tending to separate the members and thereby expand the chamber, heat responsive means operative normally to render the spring means ineffective, and means adapted to be heated responsive to the action of a high frequency field and positioned in heat exchange relationship with the heat responsive means whereby under the action of the high frequency field the spring means is operative to expand the members thereby providing an opening into the chamber, so that substances within the chamber may be dispensed within the body of the swallower.

6. A swallowable hollow capsule, means forming an opening into the capsule, closing means releasably closing the opening into the capsule, yieldable means tending at least temporarily to render ineffective said closing means, means adapted to be heated under the action of a high frequency field and thereby render ineffective the closing means and allowing the yieldable means to at least temporarily open the chamber, and delay means allowing the capsule to be opened for a predetermined time and thereafter closed.

7. A swallowable capsule comprising a pair of hollow parts complementing each other to define a chamber, one of the parts slideable over the other part to vary the size of the chamber, both of the hollow parts having openings therein so positioned that in a contracted position of the hollow parts the openings are not in registration but become in registration as the parts are expanded thereby providing fluid communication means between the interior and the exterior of the chamber, spring means tending to separate the parts, heat responsive means normally effective to render the spring means ineffective, and means adapted to be heated under the action of a high frequency field, said last mentioned means positioned in juxtaposition to the heat responsive means so as to transfer heat thereto, whereby under the action of the high frequency field the spring means is released to move the hollow parts so that the openings therein are in registration.

8. A capsule according to claim 7 in which the openings are so positioned that upon further expansion of the parts after the openings are in registration the openings are again not in registration.

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