C. V. BOYS.

EXAMINATION, TREATMENT, OR THE LIKE OF LIQUID FILMS.

APPLICATION FILED OCT. 23, 1911.

1,048,801.

Patented Dec. 31, 1912.

2 SHEETS—SHEET 1.

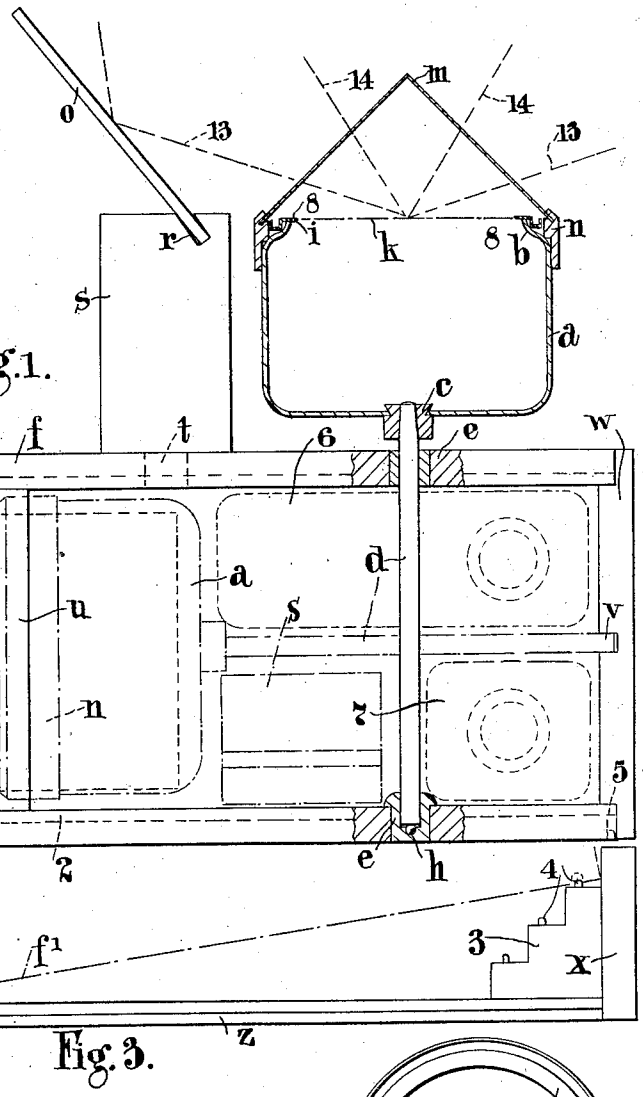

Fig. 1.

Fig. 3.

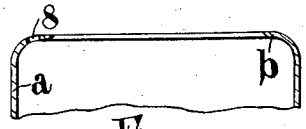

Fig. 6.

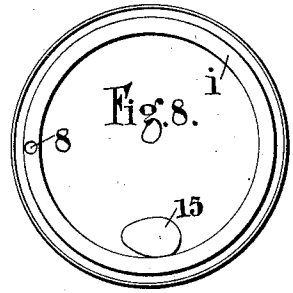

Fig. 8.

Witnesses.
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2 SHEETS—SHEET 2.

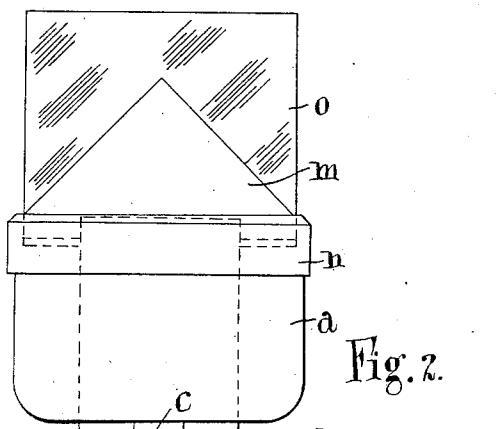

Fig. 2.

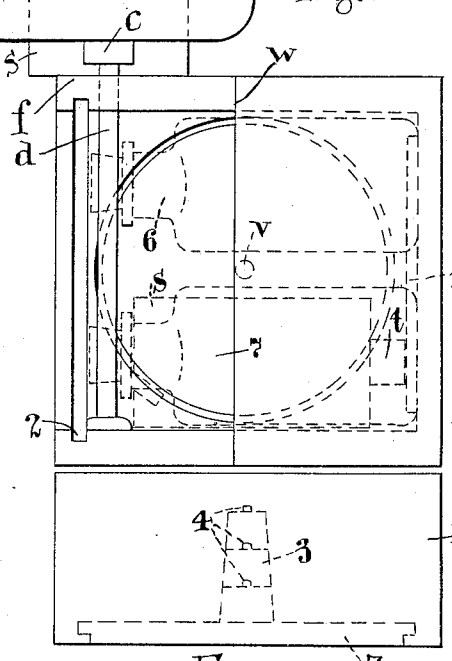

Fig. 4.

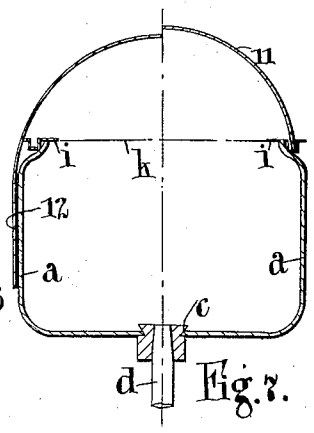

Fig. 7.

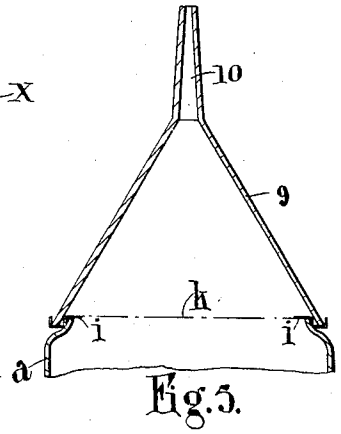

Fig. 5.

Witnesses.
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UNITED STATES PATENT OFFICE.

CHARLES VERNON BOYS, OF LONDON, ENGLAND.

EXAMINATION, TREATMENT, OR THE LIKE OF LIQUID FILMS.

1,048,801. Specification of Letters Patent. Patented Dec. 31, 1912.

Application filed October 23, 1911. Serial No. 656,271.

To all whom it may concern:

Be it known that I, CHARLES VERNON BOYS, F. R. S., a subject of the King of Great Britain and Ireland, and residing at 66 Victoria street, London, S. W., England, have invented certain new and useful Improvements in or Relating to the Examination, Treatment, or the Like of Liquid Films, of which the following is a specification.

This invention relates to methods of and means for demonstrating certain properties of liquid films, such as soap bubbles, which have the property of becoming sufficiently thin without breaking; in particular, according to this invention, such films may be treated for the development of their colors with a certainty, brilliancy, variety and regularity that has not hitherto been possible, and so cheaply that the necessary apparatus may serve either as an attractive toy or as philosophical apparatus for use in the laboratory.

With these objects the invention consists of a method of exhibiting phenomena of the type indicated which consists in supporting peripherally a liquid film and rotating said film partly by rotating air in contact with at least one side thereof and partly by the application of forces to its points of peripheral support.

The invention also consists in the combination of a hollow vessel containing air, said vessel having an annular film-receiving portion and a support in relation to which said vessel together with its contained fluid is rotatable.

The invention further consists in the methods of and means for demonstrating the properties of liquid films to be hereinafter described and particularly pointed out in the claims.

Referring to the accompanying drawings which illustrate different forms of the invention; Figure 1 is a side elevation partly in section of a film cup or box arranged to rotate in bearings provided in its packing case, this figure also showing in dotted lines the film, cup, bottles of solution and other parts packed for transport; Fig. 2 is an end elevation corresponding to Fig. 1; Fig. 3 is a side elevation of the lid of the packing case; Fig. 4 is an end elevation of the same; Fig. 5 is a vertical section of the upper part of the film box showing a removable ring and funnel in position; Fig. 6 is a vertical section of the upper part of the film box showing an alternative construction without the removable ring; Fig. 7 is a similar vertical section of the film box showing on the right and left hand sides respectively half sections of alternative forms of glass shade, while Fig. 8 is a plan view of the removable ring showing also an ovoid body surrounded by the film.

In carrying the invention into effect according to one form by way of example, the film box, *a*, which is open at the top and has an inturned rim, *b*, is supported by means of a boss, *c*, on an axle, *d*; this axle is arranged to rotate in metal bushes, *e*, *e*, provided in the sides of the box or case, *f*, in which the film cup, *a*, and its accessories are packed for transport purposes. The weight of the cup, *a*, may be taken by a steel ball, *h*, forced into a recess in the lower bush, *e*. The spinning cup is provided with a removable annular portion or ring, *i*, with a chamfered inner edge (similar to that shown in Fig. 6 to be hereinafter referred to) which is the actual carrier of the film, the latter being indicated by the chain line, *k*. A transparent cover, *m*, of conical shape having reinforced edges, *n*, fits over the top of the spinning cup.

With the packing box standing on its side as shown and the lid removed, the axle, *d*, is readily accessible and can be turned with sufficient rapidity by hand to rotate the film cup.

Rotation of the cup and cover carries around the air inclosed by these parts so that the film itself is rotated partly by the rotating air in contact with its superficial areas and partly by forces due to adhesion and viscosity arising from the film-carrying portion of the cup. When uniform conditions have been established the whole apparatus, which may be regarded as a vessel divided by a film into two chambers, with the inclosed air, rotates as one body.

The spinning cup, *a*, with its inturned rim is preferably made water-tight so that some soap solution may be placed in it and retained whether the box is spinning or not with the axle vertical or inclined. The cup or box, *a*, mounted on the free upper extremity of the axle serves as a flywheel and maintains the rotation with sufficient uniformity. A mirror, *o*, may also be used in

conjunction with the device described for a purpose to be subsequently indicated. This mirror may conveniently be held in a sawdraft, *r*, cut in the block, *s*, having a cylindrical projection, *t*, which fits into an appropriate hole in the side of the case, *f*.

The cup, *a*, with its cover, *m*, fits into a circular hole of corresponding cross-section in a cross partition, *u*, as shown, for transport purposes, the end of the axle fitting in a corresponding recess, *v*, formed in the half end, *w*, of the box. The other half end, *x*, is formed in one with the lid, *z*, this lid being arranged to slide in grooves, 2, in the side of the box. In the angle between the half end, *x*, and the lid, *z*, and in the center line of the box, a stepped member, 3, is provided, each step of which carries a pin, 4. A corresponding recess, 5, is provided as shown in the case itself, the object being to support the case, *f*, in any of a number of inclined positions, one of which is shown by the dotted line, *f'*, slipping being prevented by the particular pin, 4, concerned entering the recess, 5. Bottles of soap solution, 6 and 7, are shown packed in the box, *f*, together with the mirror block, *s*, and the mirror itself, *o*, the latter being slipped through a recess, 15, at the back of the partition, *u*.

As the beauty of the effects is so much greater when the soap film stretched in the rim is plane, than when it is curved the planeness of the film is insured by providing a hole, 8, in the rim near the inner edge. Then when the cover, *m*, is placed in position and the box is spun, the film whether originally plane or not will become and will remain plane in spite of the changes of pressure which occur in consequence of centrifugal force acting on the air above and below the film.

If it is desired to experiment with a convex or concave film, it is merely necessary to close the hole with a soap film. It is desirable that the interior of the box should be dark in color.

In order to attach a film to the rim, the latter should first be wetted with the liquid being used; a bubble blown by means of a pipe, for example, may then be placed upon the rim and if a single plane film only is required the film on one side should be broken. According to another method, some solution may be poured into the box which is spun so as to wet the sides up to the rim; a bubble is then blown in contact with the liquid so as gradually to rise in the box and attach itself to the rim. Or again, a piece of rubber, card, celluloid or other suitable material may be wetted with the solution and drawn over the edge of the rim. If the film in any case closes the air vent in the rim, this may be broken when desired with a point of blotting paper. If loose rims are employed they need only be dipped in a solution and replaced, the vent hole, if necessary being cleared of film. The transparent cover may next be applied and the box spun by the action of the hand on the axle. Rings of color, being interference colors at first of a high order and gradually of lower orders, are formed which have so great a brilliancy and variety as to make the apparatus serve as an attractive toy. If the rotation be stopped and the axle inclined a little from the vertical the colors arrange themselves ultimately in a series of parallel straight bands but pass through many intermediate forms. If the rotation be started again these bands or patterns are drawn out into spirals of ever changing brilliancy and color which gradually change into a new ring pattern.

If the solution of soap and water be made without glycerin or with very little, the development of the colors as far as the black may be watched in a very short time and even the whole film may become black. A black portion may be drawn out into a spiral of several turns. By the addition of glycerin to the solution the process of thinning and the development of the color rings may be delayed, and the film be made to last longer. By raising and lowering the cover to admit an air draft when the film is thin or by breathing upon the film other color changes may be produced.

According to a modification shown in Fig. 5, an ordinary glass funnel, 9, is inverted and placed on the removable ring, *i*. In such a case there is a leakage escape of air around the rim of the funnel due to centrifugal force, together with a central indraft down the stem, 10. If when the apparatus is spinning the stopper from a bottle of ammonia is held for a moment near the end of the stem, the action of the ammonia vapor immediately causes a new color pattern at the center, which being thicker than the surrounding film, is unstable in that position and very soon makes a kaleidoscopic change in moving toward the periphery of the film. It is not necessary for this purpose to have the complete glass funnel; a celluloid conical shade as shown in Fig. 1 pierced at the vertex, produces a similar result.

Removable rims or rings with holes of various sizes may be employed, but it is desirable when plane films are required to provide an aperture or a scalloped or corrugated edge or other means by which the air pressure on the two sides of the film may be employed.

According to the modification shown in Fig. 6, the film cup, *a*, is provided with an inturned rim, *b*, having an aperture, 8, the removable ring, *i*, being dispensed with. The inner edge of the rim should be chamfered so that the film stretched upon it may

lie accurately in a plane. In this case the amount of liquid which the box will contain when spinning rapidly is approximately equal to that which lies in the annular space inclosed by the wall and bottom of the box and a cylindrical (or more strictly parabolic) surface passing through the exterior edge of the air vent.

The box, *a*, may be made of any convenient material which preferably should not be affected by the water; for instance, pewter, britannia-metal, tin plate, sheet steel with a black finish, and glazed earthenware all answer well.

As regards the cover, alternative forms are shown in Fig. 7, that on the right hand side taking the form of a convex glass, 11, somewhat less than a hemisphere and resting in the loose ring, *i*, while that on the left is similar, with the exception that the hemisphere is provided with a cylindrical prolongation, 12, the whole of such cover resting either on the removable ring, *i*, or the box itself. The advantage of such forms over covers of the clock-glass shape is that when used in front of a window, the light reflected upon the curved glass surface, is not seen superposed upon the film; the conical covers shown also possess the same advantage.

As shown in Fig. 1, a mirror, *o*, may be provided so that a ray of light, 13, may be reflected from the mirror on to the film and so to the eye of the observer, who at the same time can see the film by means of rays, 14. The patterns due to the different rays in such a case are entirely different in color and the contrast is the more striking as both sets of color patterns can be seen at the same time.

The apparatus described above may also be used to demonstrate the centrifugal force of the rotating air. In this case the box, *a*, is spun with a film stretched on the rim but without a cover. If the small hole, 8, is open the internal pressure at that distance from the axis is equal to the pressure of the atmosphere but the internal pressure nearer the axis is less and therefore the film is drawn inward to an extent depending upon the speed of rotation.

If the air hole, 8, is closed and the film is initially plane, the average internal pressure acting on the film is equal to that of the atmosphere acting externally but the internal pressure is less nearer the axis and greater toward the periphery, such distribution of pressure being shown by the depression of the center and the elevation of the outer parts of the film.

Other properties of liquid film may be demonstrated with the same apparatus; thus Fig. 8 shows a removable ring, *i*, across which a film is supposed to be stretched, with an ovoid body, 15*, resting on the rim supposed in a vertical plane. Such ovoid body may be conveniently made by blowing a bird's egg (preferably one somewhat smaller than the egg of a house-sparrow) and then sealing the hole. In such a case the egg is in a position of equilibrium rendered stable by the action of the film. If the film box or ring is turned slowly, the egg will roll end over end, but if quickly, it will jump and roll always keeping its maximum section however in the plane of the film. The ring, if removable, should fit the box so as not to fall off when in a vertical position. Like bodies of other form such as prolate or oblate spheroids, disks, etc., if sufficiently light, may be made to rest or move in a similar manner. The film box, *a*, may also be spun as a free spinning top, but this is not so easily under control.

While any liquid film having the property indicated above of becoming sufficiently thin without breaking may be used, for example, soap solution or melted resin, nevertheless a solution of one part of oleate of soda in forty parts of soft water with glycerin added in any proportion up to two-thirds by volume according to the desired speed of thinning, is eminently suitable. If material such as melted resin is used, the apparatus should be suitably warmed, but rings with smaller apertures are then preferable.

The underlying principle of the invention which consists in rotating a liquid film partly by rotating air in contact with it and partly by peripheral forces due to the action of the film support may clearly be carried into effect in a veriety of ways different from those described.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:—

1. A method of exhibiting phenomena of the type indicated, which consists in supporting peripherally a liquid film and rotating said film partly by rotating air in contact with at least one side thereof and partly by the application of forces to its points of peripheral support.

2. A method of exhibiting phenomena of the type indicated, which consists in closing an open hollow vessel by a liquid film and rotating said vessel about an axis transverse to said film.

3. A method of exhibiting phenomena of the type indicated, which consists in closing an open hollow vessel by a plane liquid film, and rotating said vessel about an axis perpendicular to the plane of said film.

4. A method of exhibiting phenomena of the type indicated, consisting in preparing a liquid film, rotating said film and treating said rotating film to the action of vapors.

5. A method of exhibiting phenomena of the type indicated, consisting in preparing

a liquid film, supporting thereby a light body having a maximum cross-section and rotating said film in a vertical plane.

6. In combination, an open hollow vessel containing elastic fluid, said vessel having an annular portion to receive a liquid film and a support in relation to which said vessel together with its contained fluid is rotatable.

7. In combination, an open hollow vessel having an annular portion closed by a liquid film, said vessel containing elastic fluid to contact with one side of said film and means containing elastic fluid in contact with the other side of said film for inclosing the same.

8. In combination, a hollow vessel having an annular portion closed by a liquid film, said vessel containing elastic fluid in contact with one side of said film, means containing elastic fluid in contact with the other side of said film for inclosing the same and means for equalizing the fluid pressure on the two sides of said film.

9. In combination, a hollow vessel composed of separable contacting parts one of which is transparent and divided by a liquid film into chambers each inclosing elastic fluid together with means for equalizing the fluid pressure on the two sides of the film.

10. In combination, a hollow vessel having an annular portion to receive a liquid film and a transparent cover, said cover having a peripheral fluid outlet and an axial inlet.

11. In combination, a rotatable annular member, to receive a liquid film and a mirror so disposed in proximity to said film that it can be viewed simultaneously by light reflected from said mirror and by light not so reflected.

12. In combination, a rotatable film-carrying annular member and a light rounded body with a maximum cross section, said body being held by the action of the film in a stable position while rolling or jumping.

13. In combination, a rotatable film-carrying annular member and a light prolate body, said body being held by the action of the film in a stable position while rolling or jumping.

14. In combination, a rotatable film-carrying annular member and a light ovoid body, said body being held by the action of the film in a stable position while rolling or jumping.

15. In combination, a hollow vessel composed of separable contacting parts and divisible by a liquid film into chambers each inclosing elastic fluid together with a support in relation to which said vessel is rotatably disposed.

16. In combination, a hollow member and a separable member associated therewith to form a chamber divisible by a liquid film into parts each inclosing elastic fluid, at least one of said members being transparent.

17. In combination, a hollow vessel having an annular portion to receive a liquid film and a detachable transparent cover therefor.

18. In combination, a film-carrying hollow member and a second member separable therefrom and covering the same, one of said members being transparent.

19. In combination, an open hollow vessel closable by a liquid film and a support in respect to which said vessel is rotatable.

20. A hollow vessel having an annular portion with a uni-planar chamfered edge to receive a liquid film.

21. In combination, an open hollow vessel having an inturned rim portion closable by a liquid film, and a support in respect to which said vessel is rotatable.

22. An open hollow vessel having an annular part of a minimum cross-section closable by a liquid film and a support in respect to which said vessel is rotatable.

In testimony whereof, I affix my signature in presence of two witnesses.

CHARLES VERNON BOYS.

Witnesses:
HENRY H. GRUNING,
BERTRAM H. MATTHEWS.