This invention relates to flask structures commonly employed by dental technicians for duplicating various dental patterns or models whereby to provide molds to be used subsequently in making castings or the like. An object of this invention is to provide a chilling flask assembly by means of which chilling of duplicating material employed may be regulated so that the duplicating material eventually will yield a perfect mold corresponding exactly with the pattern or model and will be free from bubbles, blow holes, and other imperfections. Another object of the invention is to provide an operating procedure, and means satisfactorily usable in such procedure, whereby a regulated, progressive chilling may be effected that will insure the production of perfect molds. It is also an object of the invention to incorporate into such a procedure, and corresponding apparatus, a provision for application of pressure to compensate for shrinkage which characteristically takes place during chilling of the duplicating material, particularly material of the gel type, whereby further to insure against imperfections and to make certain of the production of a perfect mold and corresponding production of castings eventually to be obtained as final products from such a mold. More particularly, it is an object of the invention to provide for the relatively rapid cooling of the lower portion of a duplicating flask and its content, as by passage of cold water in indirect heat exchange relation with the lower portion of the material, such cooling water being then passed, also in indirect heat exchange relation, upward along the sides of the material so that the upper portions of the material are cooled at a considerably lower rate than the lower and bottom portions. An additional object is to taper the thickness of water-confining walls so that they are thinner adjacent the bottom of the material and thicker adjacent the top of the material whereby further to reduce the cooling rate at the top of the material, and thus further progressively regulate the cooling effects. By the procedure and by the means indicated, the uppermost portion of the duplicating material remains fluid until the last so that, by application of pressure continuously to such upper fluid portion, and also to a fluid core portion, the full volume of the major portion, especially the lower portion, of the material around the pattern is maintained until cooling and setting are complete. Other objects of the invention, and the various features thereof, will become apparent to those skilled in the art upon reference to the following specification and accompanying drawing wherein one embodiment is illustrated.

In the drawing:
Fig. 1 is principally a vertical section of a duplicating flask assembly adapted for the cooling of the duplicating material and the incidental mold thereby formed;
Fig. 2 is a cross section taken on the line 2—2 and looking upward;
Fig. 3 is a fragmentary top plan view as indicated by the line 3—3 of Fig. 1; and
Fig. 4 is a fragmentary vertical sectional view showing a possible modification of one portion of the apparatus. The structure shown in the drawing is representative of one form of duplicating flask by means of which unshrunk gel bodies or other set duplicating materials may be obtained readily and in accordance with the present invention. This apparatus comprises a base member 10 which, as illustrated, is circular and is provided with an integral upstanding annular flange 12. Centrally disposed above the base member 10 is a base portion which is in the form of a platform 14 which conveniently is a sort of false bottom that is spaced upward from the bottom of the base member 10, and is centered within the flange 12, by means of integral supporting feet 14a circumferentially distributed around the edge of the platform 14. This upward spacing of the platform 14 results in the provision of a transversely disposed cooling fluid chamber 15 therebeneath, through which the medium of which cooling water or the like may be brought into contact with the under face of the platform 14. Such a cooling liquid is introduced into the chamber 15 through a peripherally disposed orifice 16 adapted to be supplied by a nipple 17 (Fig. 2) which may be tangentially directed or otherwise as preferred. At the periphery of the platform 14 there is provided an upstanding annular or cylindrical face 18 which includes peripheral faces of upper and lower annular ribs or flanges 19, beyond which the integral supporting feet 14a extend into engagement with the inner wall of the upstanding annular flange 12 of the base member 10.

The base member 10 and its platform 14 receive, when in operating position, an upstanding bell or flask 20 which acts to enclose the platform 14 and in an annular pattern view of it as shown thereupon and representative of any portion of the gums and teeth or other mouth structure of a patient. The bell 20 is conveniently provided with an upper, sloping top wall or cover member 22 which is integrally formed with an annular inner flask wall 24 and an annular outer flask wall 25, these walls 24 and 25 being spaced apart to provide an upwardly tapering annular passage or chamber 26 for receiving the cooling fluid, such as water, which passes upward therethrough from the transverse or horizontal chamber 15 to a discharge nipple 27 on the top 22 of the bell. The top or cover member 22 thus provides a closure for the top of the annular chamber 26 and for the top of the duplicating cavity within the bell 20. As seen in Fig. 1, the inner upstanding wall 24 is formed of tapering construction so that its lower portions are thinner than its upper portions, the tapering being progressive so that the cross-sectional thickness of the wall 24 progressively varies. By this construction heat conduction through the upper portion of the wall 24 is less than heat conduction through the lower portion thereof, as a consequence of which cooling of the upper portion of the duplicating material contained in the bell 20 is slower than cooling of the lower portion thereof, especially in view of the fact that the platform 14 is additionally cooled by cooling fluid delivered in the bottom chamber 15.

For proper assembly of the bell 20 upon the base member 10 and its flange 12, sealing means between the lower portion of the bell and the flange 12 are required. This is accomplished by means of a conventional O-ring 28 carried in a corresponding groove in the upper face of the upstanding flange 12. In the form shown the lower portions of the walls 24 and 25 lie below the upper face of the
flange 12 with the result that the lowermost portion of the outer annular wall 25 is stepped as seen. Since it is desired to seal the inner face of the inner annular wall 24 of the bell 20 along the upstanding annular face 16 of the platform 14 so as to prevent passage of cooling fluid upward into the cavity within the bell 20, it is preferable to employ a conventional O-ring 29 in such upstanding face 18, a corresponding annular groove being provided for that purpose.

In order to anchor the bell 20 snugly upon the base member 10 and its flange 12 during cooling operations, the bell 20 is provided with thumb screws 30 which are received in corresponding bores in outstanding bosses 32 integrally carried by the outer wall of the bell 20. Lower portions of these screws 30 are threaded at 30a and received in threaded holes 33 in corresponding outstanding bosses 34 on the periphery of the annular flange 12. By these means the bell 20 is bound in sealing relationship upon the base member 10 and its flange 12. For the purpose of ready manipulation when attaching the bell 20 to the base member 10 or detaching it therefrom, integral finger pieces 35 are formed on the bosses 32 to extend radially therefrom.

When the pattern P is in place and the bell 20 has been sealed in operative relationship as above indicated, the cavity within the bell 20 may be filled with an appropriate sealing material, such as a liquid gel or a mold-forming plaster composition, by introduction through an integral neck 38 formed on the upper side of the top wall 22 and disposed centrally thereof. When the cavity within the bell 20 has been properly filled with the duplicating material, the neck 38 is closed at its top with a closing and pressurizing structure comprising a cap 40 which is internally threaded to engage upon external threads 41 formed on the upper portion of the neck 38. For the purpose of ready manipulation of the cap 40, fingerlugs 42 are conveniently formed at opposite sides thereof in a radially projecting relationship. In the form of pressurizing structure illustrated, the top wall of the cap 40 is provided with a centrally located, depending, integral sleeve 44 which provides a bore receiving a stem 45 carrying on its lower end below the sleeve 44 a piston 46 having at its periphery an upstanding annular skirt 46a which operates in engagement with the inner wall 38a of the neck 38. In practice the piston 46 and its skirt 46a are sealed within the neck 38 by means of an O-ring 47 or equivalent packing structure. The piston 46 operates under the pressure of an expansion spring 48 which is disposed about the sleeve 44, the lower end of the spring 48 lying within the skirt 46a in bearing relationship against the top of the piston 46, and the upper end of the spring bearing against the under face of the top wall of the cap 40. If desired, a short depending annular flange on the top wall of the cap 40 may be provided further to position the spring 48 as indicated at 48a. The length of the stem 45 is sufficient to accommodate the maximum amount of movement downward that would be required if the piston 46 to compensate for shrinkage of investment material within the neck 38 and the bell 20. To insure against the displacement of the stem 45 from the cap 40 when the latter is removed, a stop ring 49, which may be a split ring, is sprung into a corresponding annular groove in the outer wall of the stem 45 closely adjacent its top, so that such ring 49 will engage with the top wall of the cap 40 when moved into engagement therewith by the spring 48. In order to determine at any time the amount of movement or relative pressure produced by the influence of heat, a portion of the outer wall of the stem 45 may be appropriately calibrated as indicated by the graduations 50 illustrated.

Instead of employing the exact sealing arrangement for the lower end of the bell 20 that is illustrated in Fig. 1, a slightly modified form may be employed which is illustrated in Fig. 4. Here the O-ring packing 25 of Fig. 1 which is disposed at the inner edge of the upper face of the flange 12 of the base member 19 is replaced by an appropriate packing material 28a, which might be another O-ring, that is disposed on the outer side of the flange 12, at a position substantially opposite the packing ring 29 so that it is engaged by the lowermost portion of the outer face of the outer wall 25 of the bell 20. With this construction the thickness of the corresponding lower portion of the outer wall 25 may be appreciably reduced. It will be apparent that other packing materials than the O-rings shown and described may be employed when appropriate or desirable.

In the operation of the duplicating flask of this invention, the false bottom structure providing the platform 14 and its positioning and supporting feet 14a is fitted into the circular space within the upstanding flange 12 of the base member 10 as seen in Figs. 1 and 4. The pattern P, of which a corresponding mold is to be produced, is then placed upon the platform 14. Thereupon the bell member 20 is lowered into the illustrated position and the thumb screws 30 turned down into their threaded seats 33 to secure the parts together in contact with the sealing rings 23 and 29 or other packing material employed. The pressurizing structure comprising the cap 40 and its plunger 46 are removed from the neck 38 of the bell 20, the cavity within the bell 29 is then filled through the wide neck 38 with the duplicating gel or other composition to be employed for duplicating the pattern P. This duplicating material, which is of such liquid or fluid consistency as to flow readily through the wide neck 38 into the bell 20 and about all surfaces and into all pockets and crevices of the pattern P, is commonly one which may be readily set by external cooling, as by means of cool or cold water. Also, commonly, such a composition shrinks upon cooling. Unless such shrinkage is controlled, so that there is, in fact, no shrinkage at all where the duplicating material directly engages the pattern, the mold cavity eventually remaining when the pattern material is subsequently melted out or otherwise removed, is not an exact replica of the pattern. As a consequence a casting produced in such a mold is not true.

Therefore, operations are conducted in accordance with this invention to insure positive contact of the duplicating material with the pattern at all times during cooling and setting and to regulate the amount of shrinkage therefrom so that total and accurate contact will be assured. To accomplish these results, duplicating material is introduced so that it rises in the neck 38 approximately to the point where the bottom face of the piston 46 will come into contact therewith when the spring 48 is compressed and the top 49 is screwed down into operative position upon being installed. Air readily escapes around the piston 46 as the latter is being positioned, whereas the escape of the duplicating material past the sealing ring 47 is effectively prevented.

The operative assembly having been completed as above indicated, cold water, or other cooling fluid, is introduced through the nipple 17 and through its supply port 16 into the cooling liquid chamber 15 below the platform 14. Cooling of the platform 14 initiates cooling of the pattern P and those portions of the duplicating material in contact with the platform 14 and with the pattern P. Cooling liquid passes then from the flat, transverse cooling chamber 15 radially outward between the supporting feet 14a and ring, and into the annular cooling chamber 26 of the inner annular wall 24 and the outer annular wall 25, such liquid rising and gradually passing out of the annular chamber 26 by way of the discharge nipple 27 on the top wall 22 of the bell 20. Cooling imparted to the parts of the platform 14 and thence to the contents in the lower portion of the bell 20 is enhanced by concurrent absorption of heat through the adjacent lower portion of the
inner tapered wall 24. Thus, cooling is initially imparted to the lower portion of the contents of the cavity within the bell 20. Inasmuch as the thickness of the inner wall 24 gradually increases, the cooling effect through such wall gradually decreases from bottom to top as the cooling liquid moves upward, and such decrease may be further produced by slow travel of the cooling liquid so that the latter is somewhat warmer in the upper part of the cavity 26 than in the lower portion thereof.

By the procedure just described, the duplicating material in the central and upper portions of the cavity within the bell 20 and in the neck 38 remains liquid or fluent while the material in the lower portion of the bell and around the pattern P begins to set. As a consequence, the pressure of the piston 46, effected both by gravity and by the influence of the spring 48, causes such liquid or fluent portions to move downward toward the pattern P as the duplicating material begins to contract, with the result that no condition ever develops which could cause or permit the setting duplicating material to shrink away from the pattern P. Thus, when the piston 46 reaches the lower limit of its downward movement, cooling and setting of the duplicating material will have become complete and there will never have been any opportunity for the duplicating material to shrink away from or lose contact with any part of the pattern P, and the duplicating material will therefore set as an absolutely accurate mold. Upon subsequent removal of the pattern P, as by melting if it is a wax pattern, the mold cavity within the set duplicating material will be representative of a perfect replica of the pattern P. No bubbles will have developed, no shrinkage will have developed, and certain contact at all points will have occurred.

Cooling and setting having been completed, upon cutting off of cooling fluid to the nipple 17 into the cooling chamber 15, the thumb screws 30 will be loosened, the parts separated, and the solidified duplicating material with the contained pattern P removed for further handling to obtain the desired final cast replica.

Also, by these means and procedure, quick chilling and setting is accomplished without waiting for normal cooling to room temperature, as is commonly done.

It is intended to cover all such variations of the generic invention herein disclosed as fall within the scope of the patent claims.

I claim as my invention:

1. A compensating duplicating flask comprising in combination: a base member; a cover member removably located above said base member; platform means carried by said base member and providing a cooling fluid chamber in said base member and below said platform means; spaced inner and outer upstanding walls means disposed between said members and providing between them a cooling fluid chamber; means providing communication between said chambers, said members and walls enclosing a working cavity, said inner wall being tapered to be thicker at its top than at its bottom, whereby to absorb heat more rapidly at its bottom and provide for more rapid cooling of material in the lower portion of said cavity and for retarded cooling in the upper portion thereof; pressure compensating means carried by one of said members to compensate for volume change of a duplicating material in said cavity during cooling; and means for passing a cooling fluid into one of said chambers and from the other of said chambers.

2. A combination as in claim 1 wherein said walls are attached to said cover member and are removablely received and sealed on said base member.

3. A duplicating flask comprising in combination: a base member having a bottom; platform means carried by said base member above said bottom and providing a first cooling fluid chamber therebetween; spaced inner and outer upstanding walls means disposed upon said base member and having between them a cooling fluid chamber in communication with said first cooling fluid chamber, said inner wall means being carried in sealed relation with respect to said platform means to exclude cooling fluid from the space above said platform means and within said wall means, the heat-conductive capacity of the upper portion of said inner wall means being less than that of its lower portion; cover means overlying and enclosing said space above said platform means and within said wall means, said cover means being free from cooling fluid passages lying above such space, thereby to avoid corresponding cooling of the top portions of such space under said cover means; means for conducting cooling fluid into one of said chambers; and means for conducting cooling fluid from the other of said chambers.

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