

July 17, 1951

A. A. ANDERSEN
DEFROSTING INDICATOR

2,560,537

Filed July 8, 1949

Fig. 1

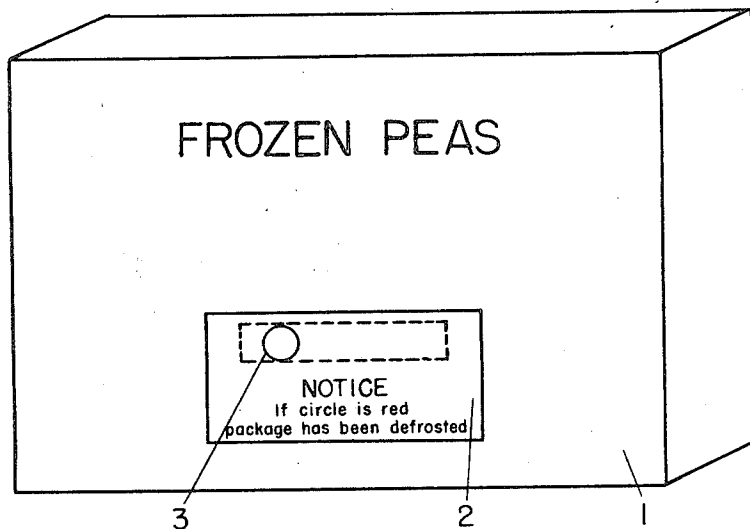


Fig. 2

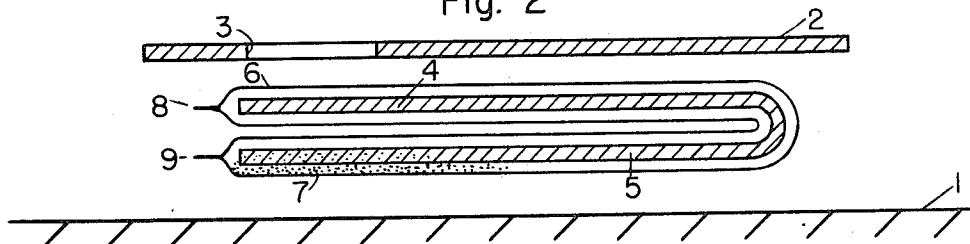
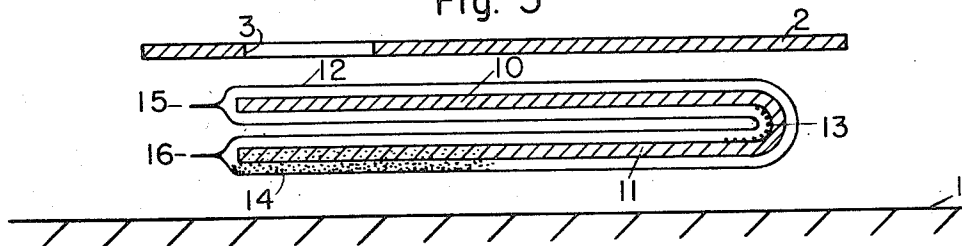


Fig. 3



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2,560,537

DEFROSTING INDICATOR

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United States of America as represented by the
Secretary of Agriculture

Application July 8, 1949, Serial No. 103,661

10 Claims. (Cl. 99—192)

(Granted under the act of March 3, 1883, as
amended April 30, 1928; 370 O. G. 757)

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This application is made under the act of March 3, 1883, as amended by the act of April 30, 1928, and the invention herein described if patented in any country, may be manufactured and used by or for the Government of the United States of America for governmental purposes throughout the world without the payment to me of any royalty thereon.

This invention relates to a novel defrosting indicator, i. e., a device which is to be used in combination with a package of frozen food and which will provide a visible signal if the contents of the package have been subjected to defrosting (thawing).

The indicator of this invention comprises essentially a sheet of porous material, such as paper, on which is deposited a dyestuff and an organic solvent and which is preferably encased in a transparent sleeve. The dyestuff is placed on the sheet in such a position that it is not normally visible. This sheet is then placed on the outside of the package of frozen food and attached thereto, for example, by means of an adhesive or by the use of pressure-sensitive taps. As long as the package is kept at the proper storage temperature, the indicator remains dormant, i. e., the dyestuff is not visible. However, if the package is subjected to an undesirably elevated temperature for sufficient time to induce defrosting, then the dyestuff will be moved to a visible point by the melting and subsequent diffusion of the solvent containing dissolved dyestuff through the sheet, thus providing a signal that the food has been defrosted.

The device of this invention is simple and economical, hence it would be feasible to apply it in commercial use.

The objects of this invention include: the provision of a package equipped with the novel defrosting indicator; the provision of methods for preparing the aforesaid indicator and applying it to a package. Further objects will be evident from the description herein.

The significance of the device of this invention lies in the fact that frozen foods are not sterile, hence if they are subjected to defrosting during transportation or storage, microbial spoilage may develop. The fact that microbial spoilage has occurred is, of course, not easily detectable by the purchaser, as frozen foods are usually sold in cardboard packages and the purchaser is unable to observe the contents of the package. Even if the contents were observable the fact of microbial spoilage would not be readily recognizable, particularly by the retail purchaser who is not

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familiar with such matters. By use of the device of this invention, the ultimate consumer is assured that the foodstuff he is purchasing has been properly handled all along the line from manufacturer to retailer and is hence equal in quality and wholesomeness to the product as originally prepared.

The main advantage of the device of this invention is that it is adapted to be placed on the surface of the frozen food package yet it will not give a visible signal unless substantial thawing of the food has taken place. The point is that in my indicator, the development of the visible signal depends on diffusion of an organic solvent through a porous material whereby a dyestuff in solution in the solvent is moved to a visible section of the device. This diffusion is not an instantaneous process but consumes a definite period of time. Hence if the frozen food package is exposed to temperatures above freezing for only a short period of time whereby no significant damage will be done to the contents, the indicator will not provide the visible signal. However, if the package is maintained at the elevated temperature for such a period of time that substantial thawing has taken place then the indicator will provide a visible signal.

The known indicators do not possess the advantage set forth above. Thus one type of indicator (K. J. Chase, U. S. Patent 2,460,215) responds only to a deep thawing within the package. However, this patented indicator has the disadvantage that it must be located deep within the package whereby there is danger that the contents of the package may become contaminated. Surface indicators are disclosed by MacDonald, U. S. Patent 1,535,536, Midgley, U. S. Patent 1,917,048, and Triplett, U. S. Patent 2,277,278. These devices however respond to even a slight surface thawing of the frozen food.

The drawing appended hereto illustrates two modifications of the device of this invention.

Fig. 1 is an isometric projection of a package on which is positioned the indicator embodying this invention.

Fig. 2 is a cross-sectional view on an enlarged and exploded scale of the preferred modification of the device of this invention.

Fig. 3 is a cross-sectional view on an enlarged and exploded scale of an alternative form of the device of this invention.

Attention is first drawn to Fig. 1 which shows a package of frozen food including the defrosting indicator in accordance with this invention. In this view can be seen package 1, indicator

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cover 2, and opening 3. The shape of the indicator is delineated by the dotted lines.

In Fig. 2 is shown a cross section of the device in greatly enlarged proportions, the various parts being separated from one another so that they may be clearly illustrated. It is of course understood that in practice, indicator cover 2 would be attached to package 1 by an adhesive thus compressing the indicator into a compact body in contact with the surface of package 1.

The device of this invention thus comprises an indicator cover 2 made of stiff paper, cardboard, or the like, which is provided with a suitable legend to indicate the significance of the color change. An opening 3 is provided in the cover 2. This opening may be provided with a window of cellophane or other transparent film, if desired. A strip of filter paper is folded on itself to form upper leg 4 and lower leg 5. A dye-stuff-solvent solution 7 is deposited on lower leg 5. A flat, unitary tube 6 of cellophane or other transparent film completely surrounds legs 4 and 5, the ends of tube 6 being sealed at 8 and 9.

In Fig. 3 is shown a cross section of an alternative form of the indicator. This figure also shows the parts as being separated from one another so that they may be clearly illustrated. It is of course understood that in practice, indicator cover 2 would be attached to package 1 by an adhesive thus compressing the indicator into a compact body in contact with the surface of package 1.

In this modification, cover 2 and window 3 are provided as described before. A strip of filter paper is folded upon itself to form upper leg 10 and lower leg 11. Particles of a suitable dyestuff 13 are deposited on the filter paper near the middle thereof and on leg 11 is placed the solvent, 14. A flat, unitary tube 12 of cellophane or other transparent film completely surrounds legs 10 and 11, the ends of tube 12 being sealed at 15 and 16.

The following examples illustrate particular conditions, steps, and materials within the scope of this invention, it being understood that these examples are given only by way of illustration and not limitation. In Examples I and II, the indicators were constructed as illustrated in Fig. 2. In Examples III and IV the indicators were constructed as illustrated in Fig. 3.

EXAMPLE I

A 1 by 5 cm. strip of filter paper was inserted into a flat cellophane tube which was 6 cm. long. The enclosed strip was then folded midway between its ends and pressed on the fold with a warm iron. This creasing is done to prevent flowing of the dye-solvent solution and restricts its movement to diffusion through the filter paper. A small amount of 2-phenoxyethanol (about 0.05 to 0.07 ml.) containing about 0.25% Phenoform Red B was inserted into the lower leg of the tube. The projecting ends of the tube were then sealed by pressing with a warm iron. The indicator device was then placed on top of a 12 oz. package of frozen peas and secured in place by gluing a paper cover over the indicator strip. This cover was provided with a circular opening $\frac{1}{4}$ " in diameter. The indicator strip was so placed that the leg of the filter paper which was in contact with the 2-phenoxyethanol-dye solution was next to the package. The other leg of the filter strip was thus adjacent the paper cover. The package was stored in a refrigerator for several weeks at 0° F. and during this period

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it was noted that no signal developed. The package was then allowed to stand in a room at 77° F. The appearance of the indicator was noted periodically through the opening in the cover and after standing at this temperature for 6½ hours it was noted that the red color appeared at the visible part of the indicator strip.

EXAMPLE II

A series of indicators were prepared as set forth in Example I using different solvents as set forth hereinafter. The indicators were applied to 12 oz. packages of frozen peas, stored at 0° F., then the packages were removed from storage and allowed to stand in rooms having regulated, elevated temperatures. The following table sets forth the results obtained giving for each sample the solvent used, the temperature of the room in which the package was allowed to defrost, and the time for development of the visible red color.

Table 1

Sample No.	Solvent	Temperature of room in which packages were allowed to defrost, °F.	Time for development of visible color, hours
2.....	2-phenoxyethanol.....	60	10
3.....	do.....	40	48
4.....	do.....	34	109
5.....	2-phenoxyethanol+20% undecanol.	77	3.8
6.....	do.....	60	8.5
7.....	do.....	40	16
8.....	do.....	34	50
9.....	2-phenoxyethanol+33% castor oil.	77	7
10.....	do.....	60	12
11.....	do.....	40	46
12.....	do.....	34	121
13.....	2-phenoxyethanol+5% glycerol.	77	7
14.....	do.....	60	13
15.....	do.....	40	64
16.....	do.....	34	109

EXAMPLE III

Chemical filter paper was cut up into a strip 1 cm. wide and 5 cm. long. A small amount (about 0.1–0.2 mg.) of powdered Phenoform Red B was deposited on the middle of the strip by the use of a circular rubber stamp having a diameter of about 0.7 cm. The strip was then inserted into a flat cellophane tube which was 6 cm. long. The enclosed strip was then folded midway between its ends and pressed on the fold with a warm iron. A small amount of 2-phenoxyethanol (about 0.075 ml.) was placed on one end of the strip within the tube by means of a hypodermic needle. The projecting ends of the cellophane tube were then sealed by pressing with a warm iron. The indicator device was then placed on top of a 12 oz. package of frozen peas and secured in place by gluing a paper cover over the indicator. This cover was provided with a circular opening $\frac{1}{4}$ " in diameter. The indicator was placed so that the leg of the filter strip which was in contact with 2-phenoxyethanol was next to the package. The package was stored in a refrigerator for several weeks at 0° F. and during this period of storage it was noted that no color developed. The package was then allowed to stand in a room at 76–77° F. The appearance of the indicator was noted periodically through the opening in the cover and after standing at this temperature for 7 hrs. and 15 min. it was noted that the red color appeared at the visible part of the indicator. By experiments on similar packages it was noted that under such condi-

tions of refrigerated storage and exposure to a temperature of 76°-77° F., the contents of the package became defrosted, i. e., all the ice therein had melted, in about 6 to 7 hours.

EXAMPLE IV

A series of indicators were prepared as set forth in Example III using different solvents as set forth hereinafter. The indicators were applied to 12 oz. packages of frozen peas, stored at 0° F., then the packages were removed from storage and allowed to stand in rooms having regulated, elevated temperatures. The following table sets forth the results obtained giving for each example the solvent used, the temperature of the room in which the package was allowed to defrost and the time for development of the visible red color.

Table 2

Sample No.	Solvent	Temperature of room in which packages were allowed to defrost, °F.	Time for development of visible color, hours: minutes
18-----	2-phenoxyethanol.....	60	10:00
19-----	2-phenoxyethanol+5% glycerol.....	77	7:05
20-----	do.....	60	12:45
21-----	2-phenoxyethanol+10% butyl stearate.....	77	7:10
22-----	do.....	60	12:20
23-----	glycerol.....	77	11:20
24-----	do.....	60	14:05
25-----	2-phenoxyethanol+5% undecanol.....	77	8:05
26-----	do.....	60	9:35
27-----	2-phenoxyethanol+10% undecanol.....	77	5:15
28-----	2-phenoxyethanol+20% undecanol.....	77	3:47
29-----	2-phenoxyethanol+33% castor oil.....	77	6:55
30-----	do.....	60	13:25
31-----	2-phenoxyethanol+4% lauric acid.....	77	5:22
32-----	do.....	60	9:07
33-----	do.....	40	29:52

It is obvious that many modifications are possible within the spirit of this invention. Thus although Phenoform Red B is the preferred dyestuff when 2-phenoxyethanol is used as the solvent, many other dyestuffs may be used, for example, basic fuchsin, rose Bengal, sudan III, sudan IV, flaming red, and so forth. The particular material to be used is mainly a matter of the color desired for the visible signal. It is obvious that one can use any dyestuff or coloring material which is soluble in the solvent used. When constructing the indicator in accordance with the modification of Fig. 2, the dyestuff is first dissolved in the solvent and this solution is applied to the porous strip. The concentration of dyestuff is not critical as long as sufficient is used to give the desired depth of color in the signal. It is not essential to first prepare this solution. If desired, the dyestuff and solvent may be applied separately to the lower leg of the filter paper. In constructing the indicator as in the modification of Fig. 3, the dyestuff is preferably applied to the indicator sheet in solid form so that it does not move along the sheet but merely remains in place thereon. Powdered dyestuffs can easily be applied by means of a rubber stamp or similar device. The location of the spot of dyestuff is not important except that it should be some distance from the observation point to avoid any premature indication.

Although 2-phenoxyethanol is the preferred solvent, one can use many other organic solvents. In general, the solvent should be substantially

non-volatile and should be one which is normally a liquid but which is solid at proper storage temperature for frozen foods, i. e., 32° F. or below. The time required for development of the visible signal on exposure of the package to an elevated temperature depends on the melting point of the solvent used. Thus solvents which have lower melting points will develop the signal in a shorter time than will solvents having higher melting points. Those solvents which have melting points from about 40° F. to about 65° F. are preferred as they afford a desirable correlation of development of the visible signal with actual rise in temperature within the package. Another point is that odorless solvents are preferred to avoid tainting the food within the package. The time required for development of the visible signal is also dependent on the viscosity of the solvent used, the less viscous solvents giving a faster response. Thus in general, it is preferred that the solvent have a viscosity about the same as that of 2-phenoxyethanol or glycerol so that the diffusion of the solvent will approximately correlate the development of the visible signal with the actual rise in temperature within the package. Thus other solvents which may be used are, for example monoethanolamine, hexadecyl bromide, undecanol, glycerol, didecyl ether, sorbitan mono-oleate, sorbitan monolaurate, butyl stearate, and so forth. The solvents listed above need not be employed individually; one can employ mixtures thereof. By suitable mixing one can adjust the response of the indicator as desired. For example, the addition of undecanol to 2-phenoxyethanol will decrease the time for developing the visible signal as shown in detail in Example II. Other materials can also be added to the activator to alter the rate of development of the signal. For example, one can add lauric acid, methyl palmitate, sorbitan trioleate, or other substances for these purposes. Materials added for such purpose are herein termed modifiers since they modify the physical properties of the solvent. It is obvious that if the particular modifier raises the melting point of the solvent then development of the signal will be slower while a modifier which lowers the melting point of the solvent will have the opposite effect. Further, a modifier which raises the viscosity of the solvent will retard development of the signal while a modifier which lowers the viscosity of the solvent will have the opposite effect. It is thus obvious that any substance which has an effect on the melting point and/or viscosity of the solvent may be added to the solvent to obtain any desired degree of response in development of the signal. In general, the particular substance, or mixture, to be used as the solvent depends on the rate of development desired. Thus this latter factor is governed by the melting point, viscosity and surface tension characteristics of the solvent, the physical dimensions of the indicator and the nature of the porous sheet used and the temperature to which the package is exposed. With regard to the physical dimensions of the indicator, it is obvious that if the sheet of porous material is lengthened, the solvent will have further to diffuse and hence the time for development of the signal will be increased.

In the preferred form of this invention, the fibrous sheet and the transparent sleeve encasing it are folded and the fold tightly creased. This factor prevents flowing of the solvent or solvent-dyestuff solution and restricts movement thereof

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to diffusion through the fibrous material. If desired, other means can be used to compress the transparent sleeve about the sheet without folding. Thus a small metal clamp could be used to crimp the sleeve and sheet together.

The indicator strip is preferably made of chemical filter paper as such material is uniform and highly absorbent. Other porous materials can be used, however, for example, uncoated paper, cloth, asbestos sheet, and so forth.

Having thus described my invention, I claim:

1. A defrosting indicator comprising a strip of paper encased in a transparent tube, said encased strip being folded upon itself whereby to crimp said tube upon said strip thus to divide it into a first portion and a second portion and to substantially prevent movement of liquids from one portion to another except by diffusion through said paper, a cover providing means for attaching said strip to a package, an opening in said cover, said opening giving visibility to a part of said first portion, a dyestuff and an organic solvent being deposited on said second portion.

2. The article of manufacture in accordance with claim 1 wherein the organic solvent is 2-phenoxyethanol.

3. A package having a defrosting indicator attached to the surface thereof, said indicator comprising a strip of paper encased in a transparent tube, said encased strip being folded upon itself whereby to crimp said tube upon said strip thus to divide it into an upper leg and a lower leg and to substantially prevent movement of liquids from one leg to another except by diffusion through said paper, said lower leg being adjacent the surface of the package, a dyestuff and an organic solvent being deposited on said lower leg, a cover providing means for securing said strip to said package and an opening in said cover, said opening giving visibility to a portion of said upper leg.

4. The article of manufacture in accordance with claim 3 wherein the organic solvent is 2-phenoxyethanol.

5. A package having a defrosting indicator attached to the surface thereof, said indicator comprising a strip of paper encased in a transparent tube, said encased strip being folded upon itself

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whereby to crimp said tube upon said strip thus to divide it into an upper leg and a lower leg and to substantially prevent movement of liquids from one leg to another except by diffusion through said strip, said lower leg being adjacent to the surface of the package, a dyestuff being deposited on said strip adjacent to said fold, an organic solvent being deposited on said lower leg, a cover providing means for securing said strip to said package and an opening in said cover, said opening giving visibility to a portion of said upper leg.

6. The article of manufacture in accordance with claim 5 wherein the organic solvent is 2-phenoxyethanol.

7. A defrosting indicator comprising a porous sheet, a first portion of said sheet being visible, a second portion of said sheet comprising the remainder thereof being hidden from view, a transparent casing tightly enclosing said sheet and crimped thereupon whereby to prevent movement of liquids from one of said portions to the other except by diffusion through said sheet, a dyestuff and an organic solvent being deposited on said hidden portion at a substantial distance from said visible portion whereby upon exposure to an excessive temperature for a substantial period of time, the solvent containing dyestuff will enter said visible portion solely by diffusion through an extended length of said sheet.

8. The article of manufacture in accordance with claim 7 wherein the organic solvent has a melting point from about 40° F. to about 65° F.

9. The article of manufacture in accordance with claim 7 wherein the organic solvent is 2-phenoxyethanol.

10. The article of manufacture in accordance with claim 7 wherein the organic solvent is 2-phenoxyethanol and a modifier.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,379,459	Schreiber	July 3, 1945
2,460,215	Chase	Jan. 25, 1949