Jan. 18, 1966 W. M. BRIGHT 3,230,174

SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE

Filed Aug. 2, 1960 20 Sheets-Sheet 1

CYLINDER FOAM VOLUMES OF SODIUM DECANESULFONATE (SULFATE BUILT) AND LHES (SULFATE BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

30 SECONDS AFTER FOAM FORMATION

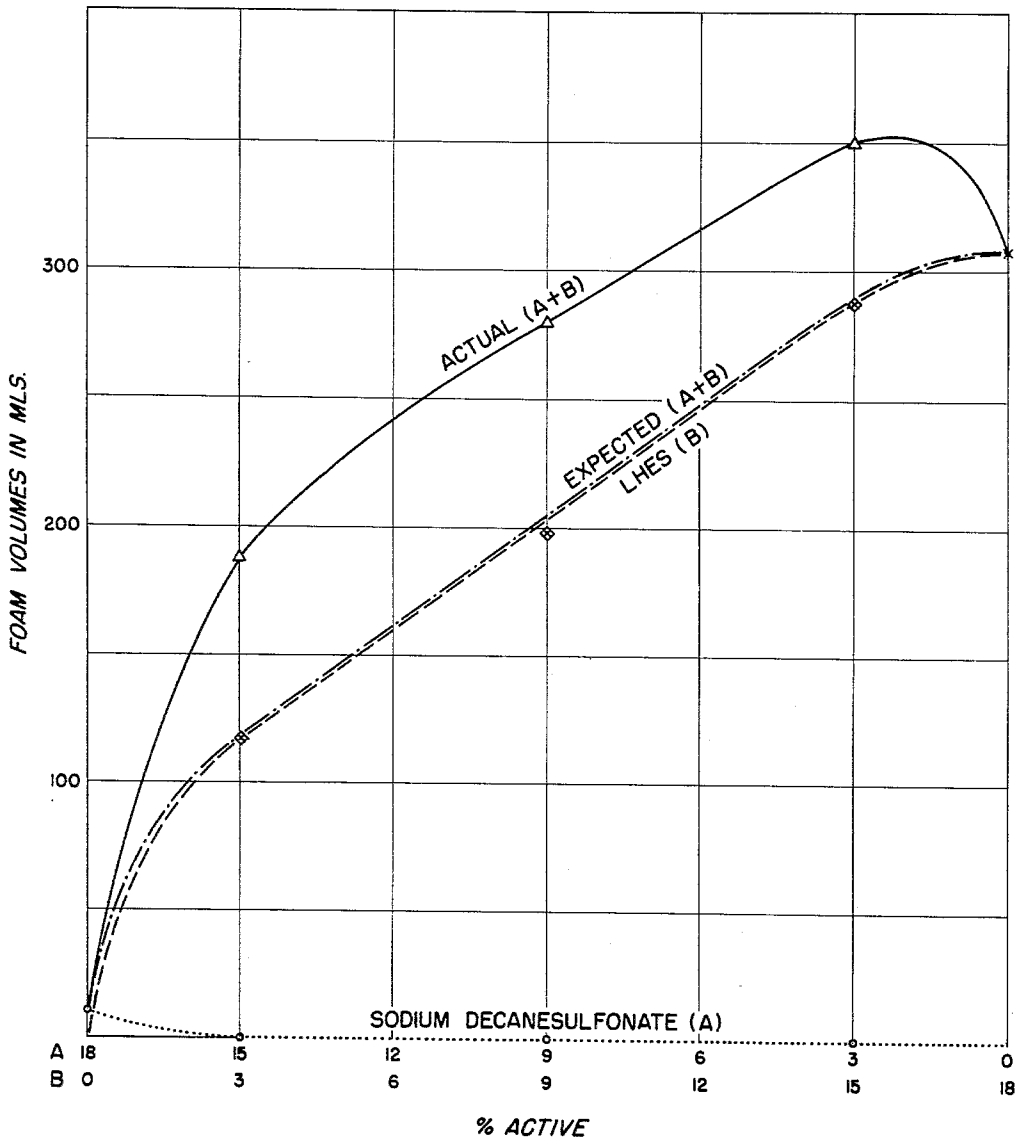

FIG. 1A

INVENTOR.
WILLARD M. BRIGHT
BY Brumbaugh, Free, Graves & Donohue
his *ATTORNEYS*

CYLINDER FOAM VOLUMES OF SODIUM DECANESULFONATE (SULFATE BUILT), AND LHES (SULFATE BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

15 MINUTES AFTER FOAM FORMATION

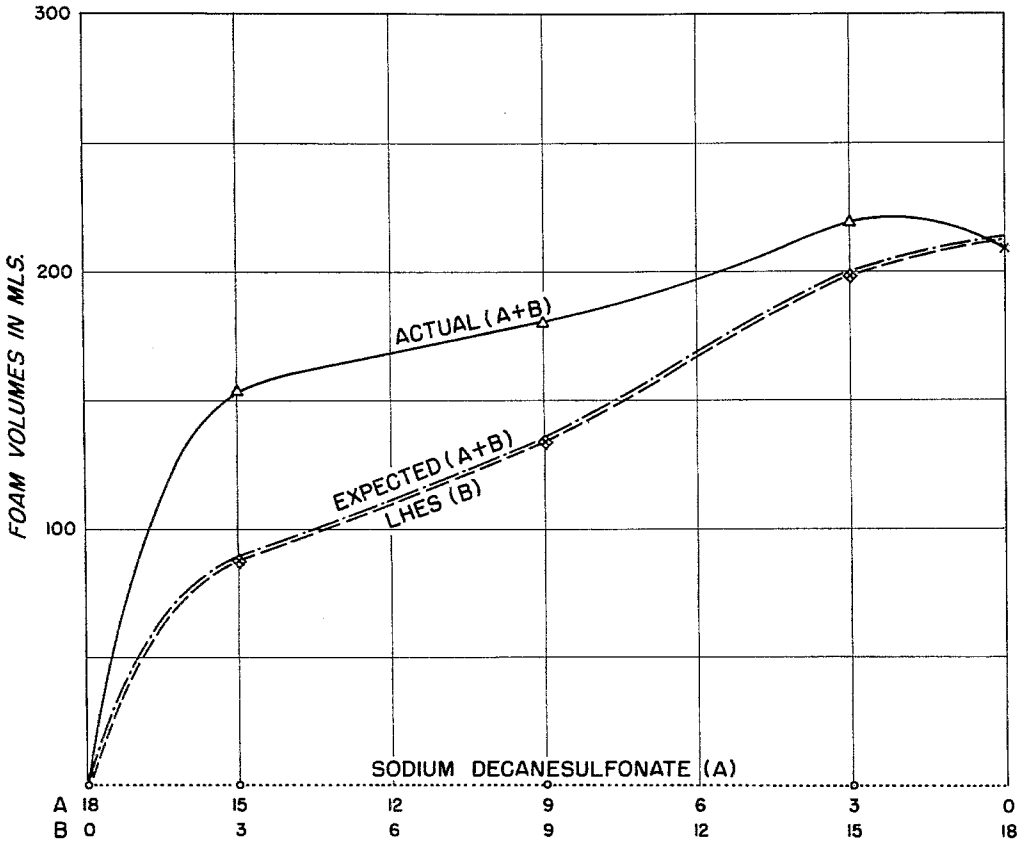

FIG. 1B

INVENTOR.
WILLARD M. BRIGHT
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Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2. 1960 20 Sheets-Sheet 3

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (SULFATE BUILT) AND THES (SULFATE BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

30 SECONDS AFTER FOAM FORMATION

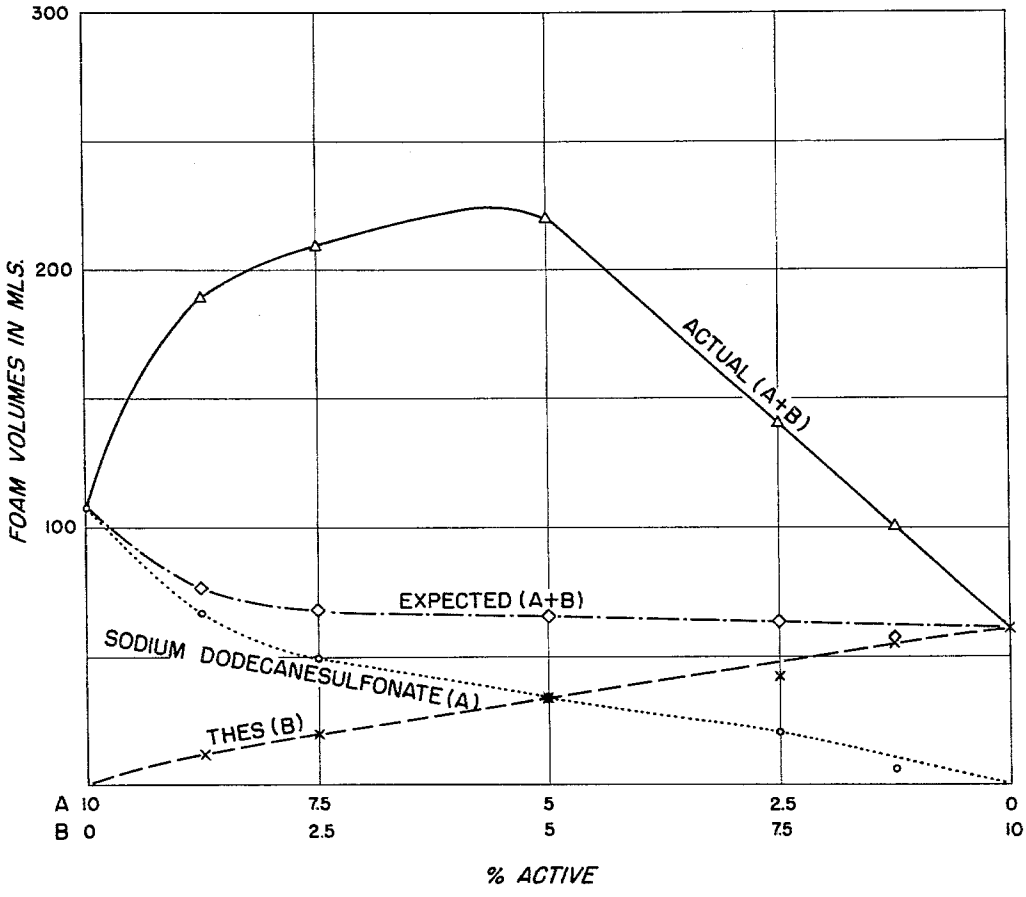

FIG. 2A

INVENTOR.
WILLARD M. BRIGHT
BY Brumbaugh, Free, Graves & Donohue
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CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (SULFATE BUILT) AND THES (SULFATE BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

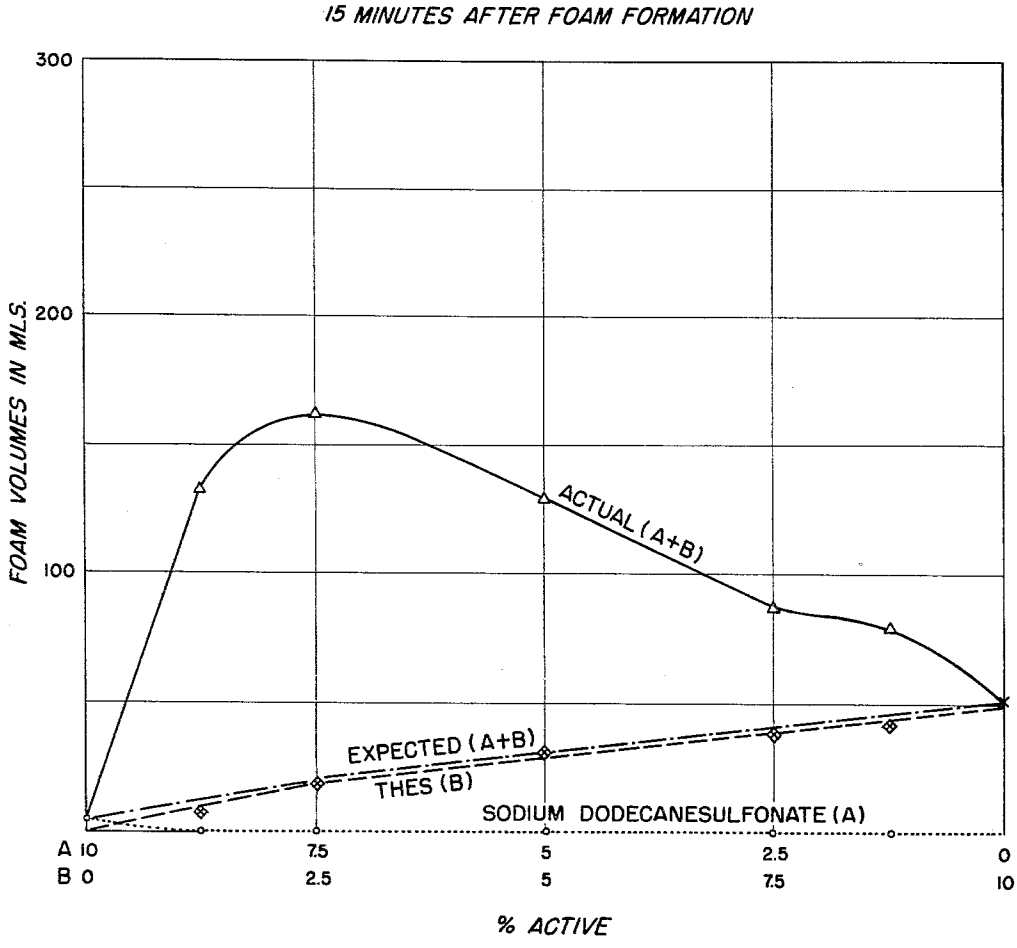

FIG. 2B

INVENTOR.
WILLARD M. BRIGHT
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Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2, 1960 20 Sheets-Sheet 5

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (PHOSPHATE BUILT) AND THES (PHOSPHATE BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

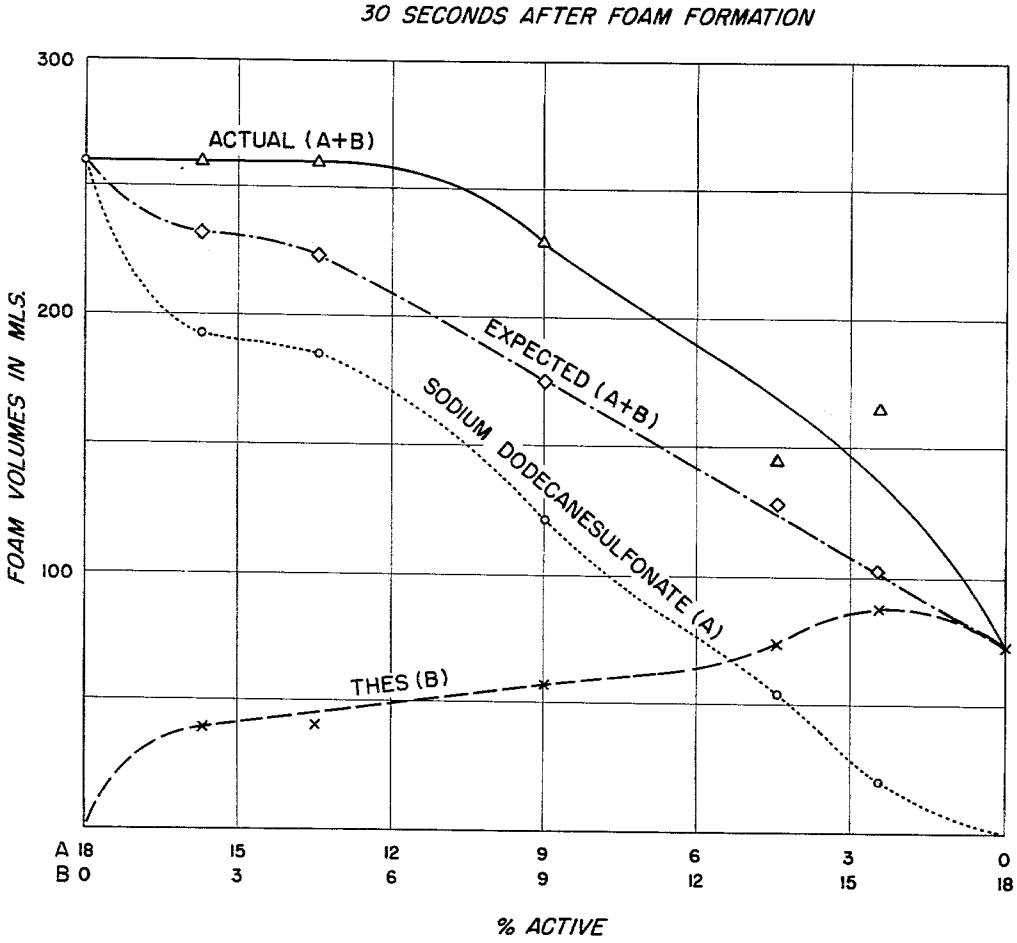

FIG. 3A

INVENTOR.
WILLARD M. BRIGHT
BY Brumbaugh, Free, Graves & Donohue
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Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2, 1960 20 Sheets-Sheet 6

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (PHOSPHATE BUILT) AND THES (PHOSPHATE BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

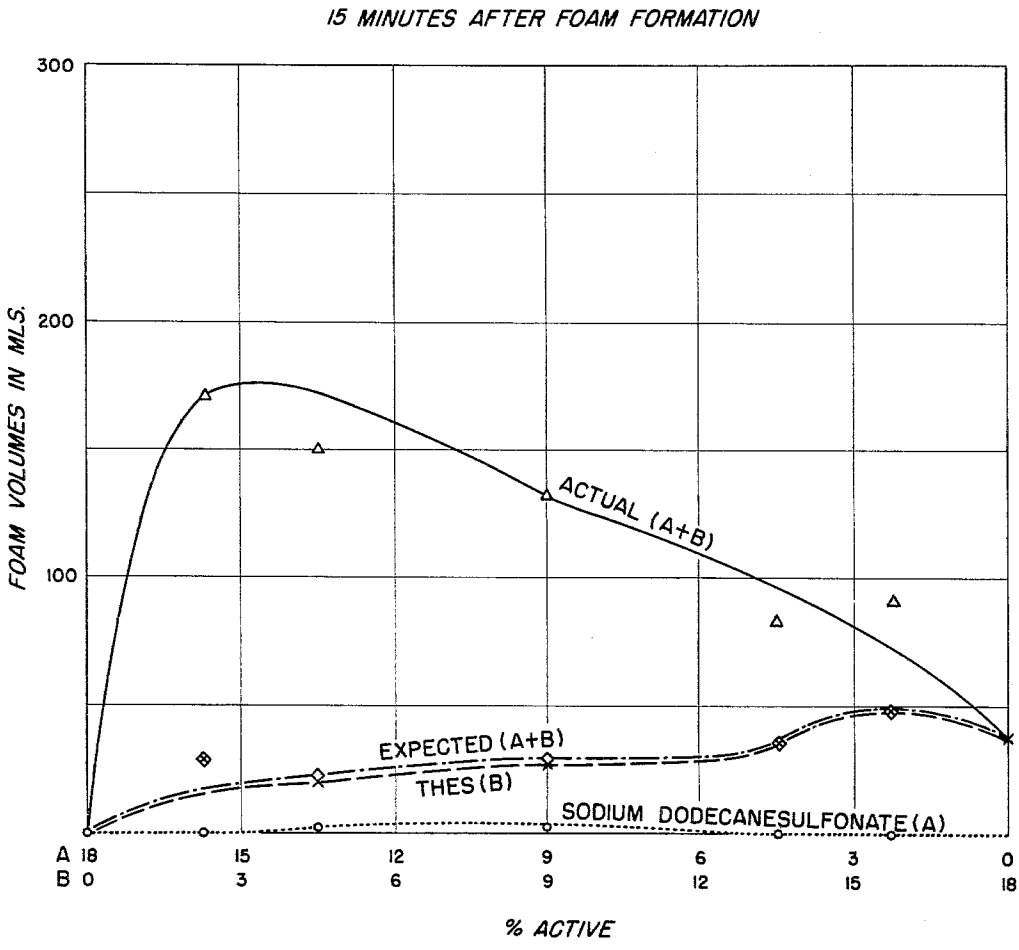

FIG. 3B

INVENTOR.
WILLARD M. BRIGHT
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Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2. 1960 20 Sheets-Sheet 7

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (NON-BUILT) AND THES (NON-BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

30 SECONDS AFTER FOAM FORMATION

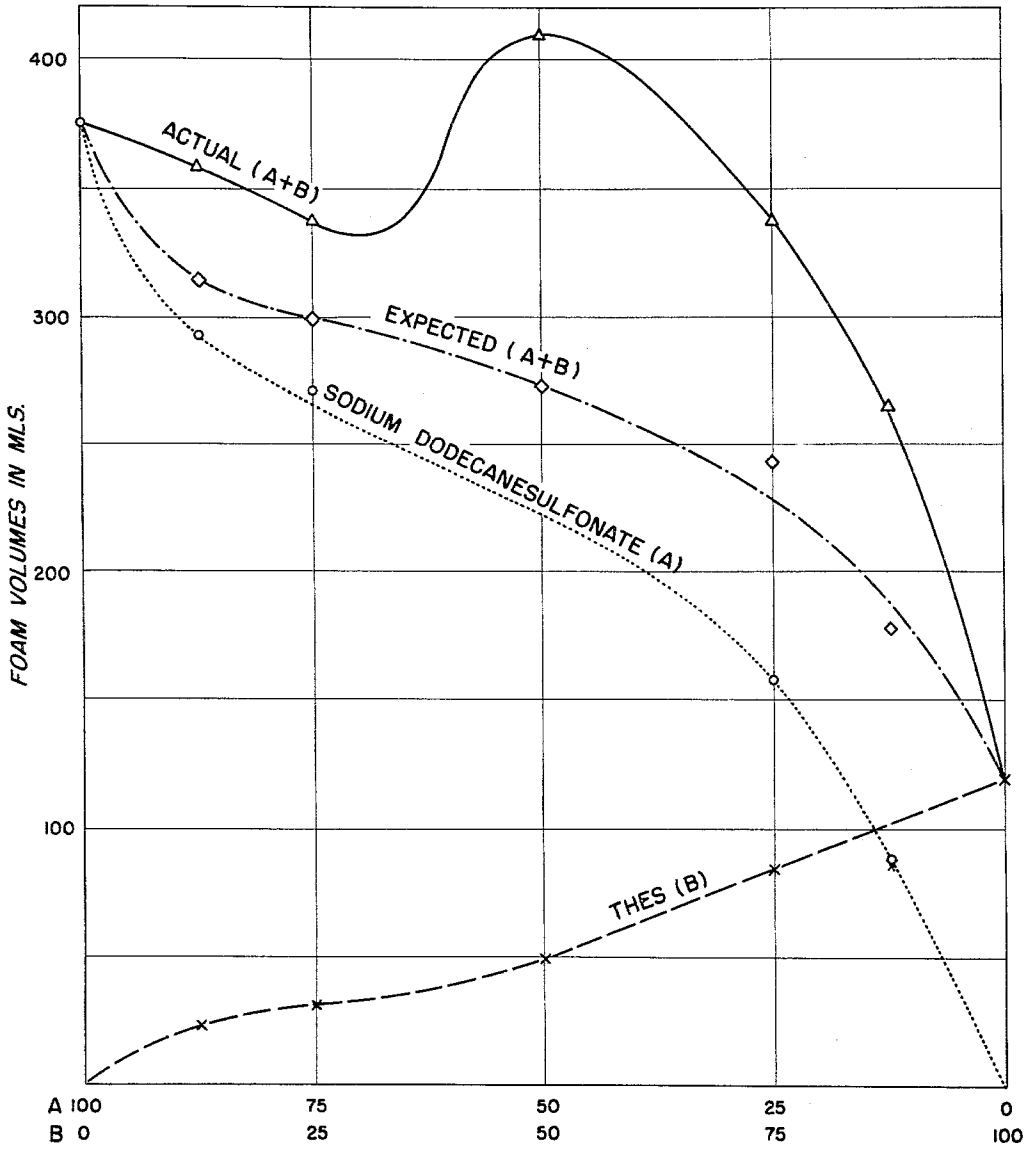

FIG. 4A

INVENTOR.
WILLARD M. BRIGHT
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Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2. 1960 20 Sheets-Sheet 8

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (NON-BUILT) AND THES (NON-BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

15 MINUTES AFTER FOAM FORMATION

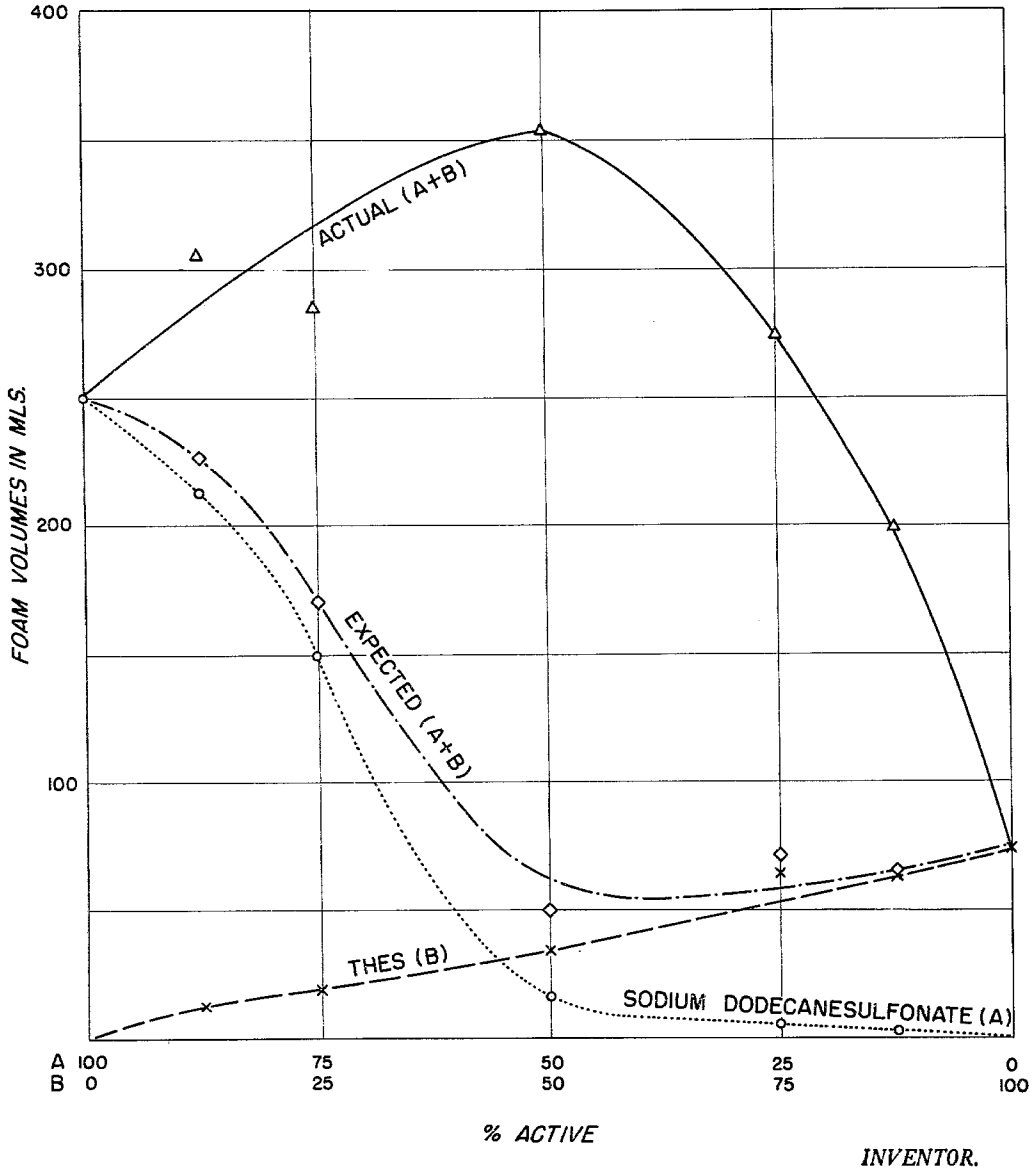

FIG. 4B

INVENTOR.
WILLARD M. BRIGHT
BY Brumbaugh, Free, Graves & Donohue
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Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2, 1960 20 Sheets-Sheet 9

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (SULFATE BUILT) AND LHES (SULFATE BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

30 SECONDS AFTER FOAM FORMATION

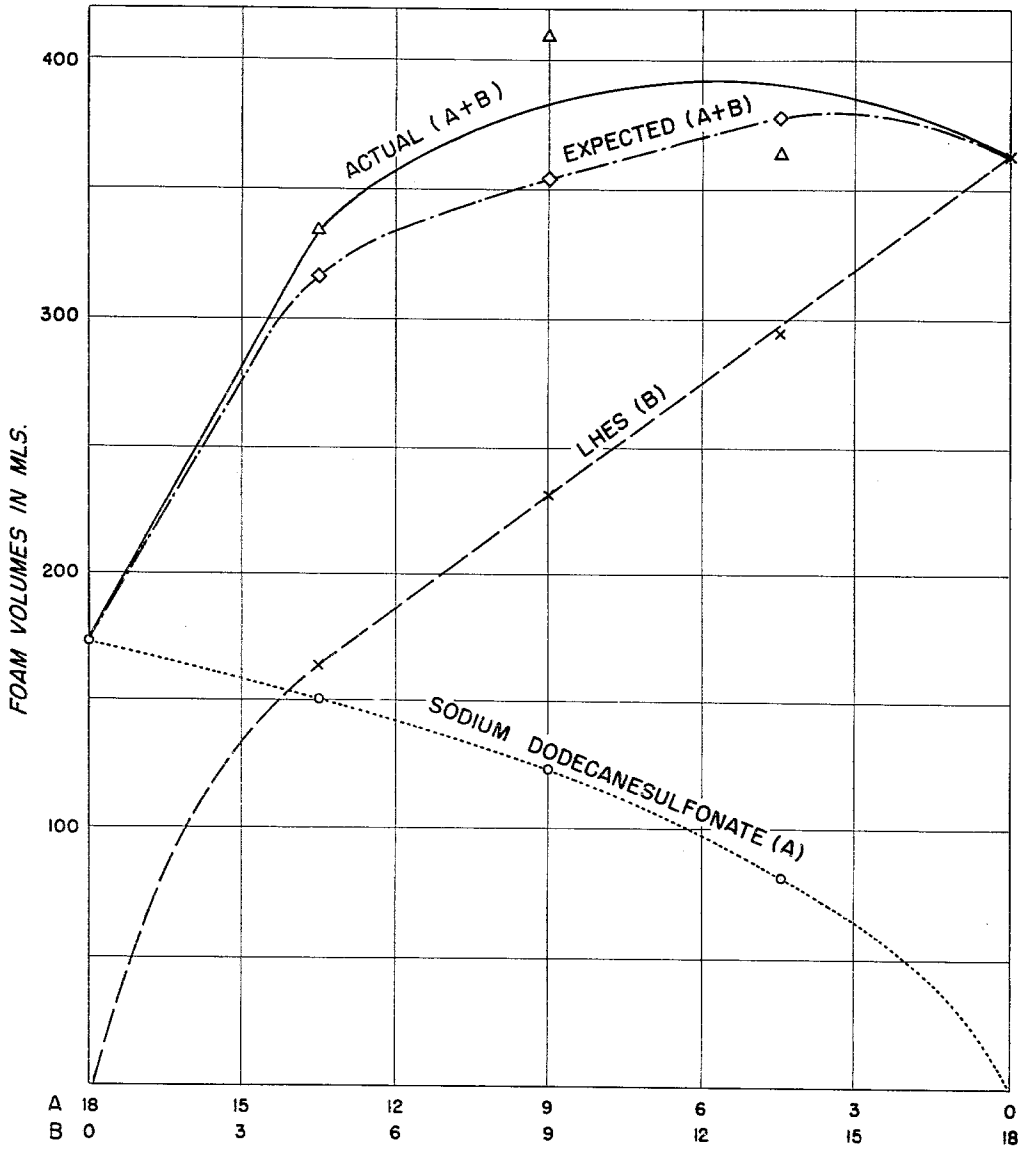

FIG. 5A

INVENTOR.
WILLARD M. BRIGHT
BY Brumbaugh, Free, Graves & Donohue
his ATTORNEYS

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (SULFATE BUILT) AND LHES (SULFATE BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

15 MINUTES AFTER FOAM FORMATION

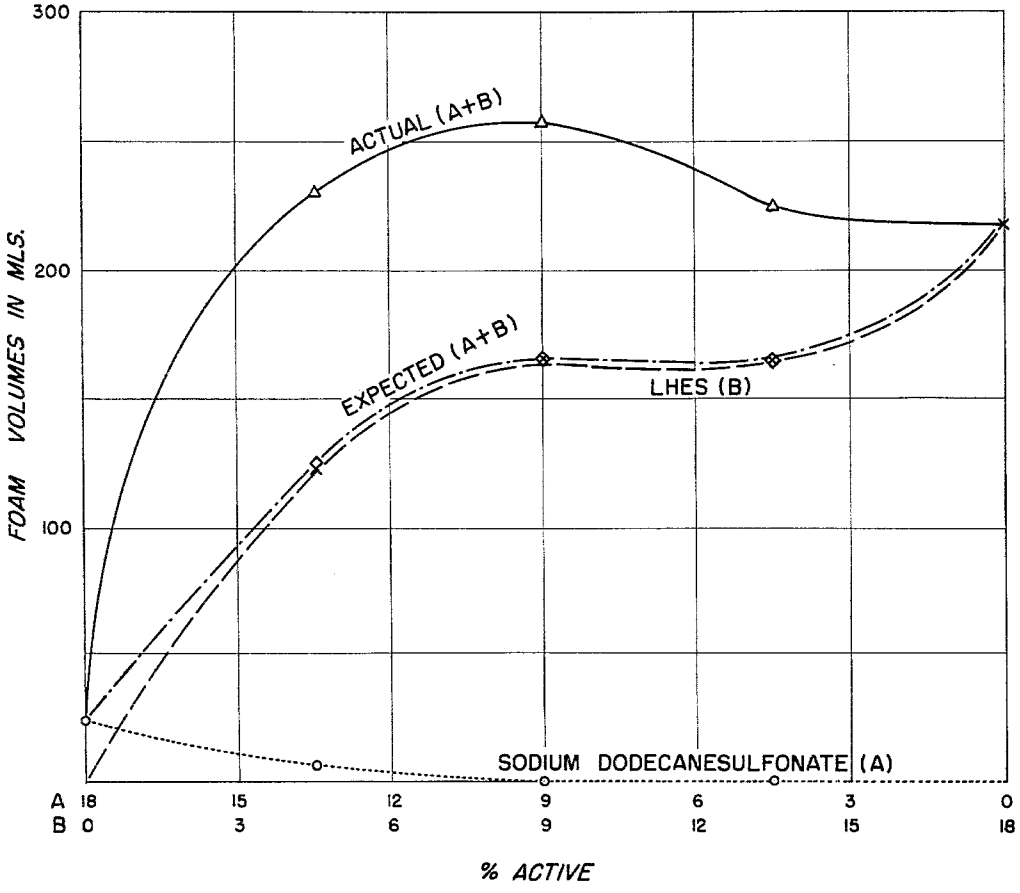

FIG. 5B

INVENTOR.
WILLARD M. BRIGHT
BY Brumbaugh, Free, Graves & Donohue
his ATTORNEYS

Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2. 1960 20 Sheets-Sheet 11

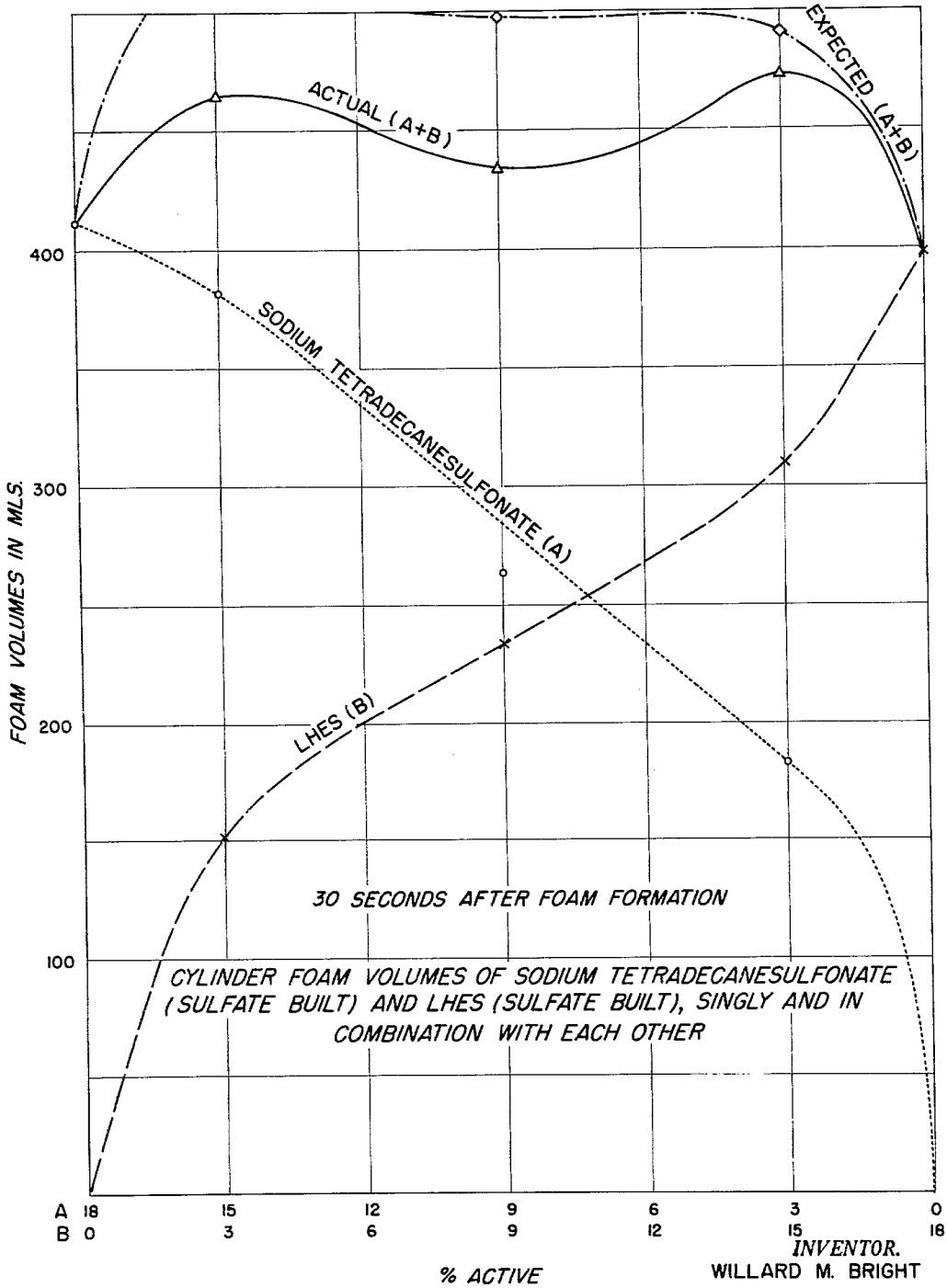

FIG. 6A

INVENTOR.
WILLARD M. BRIGHT

BY Brumbaugh, Free, Graves & Donohue
his ATTORNEYS

Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2, 1960 20 Sheets-Sheet 12

CYLINDER FOAM VOLUMES OF SODIUM TETRADECANESULFONATE (SULFATE BUILT) AND LHES (SULFATE BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

15 MINUTES AFTER FOAM FORMATION

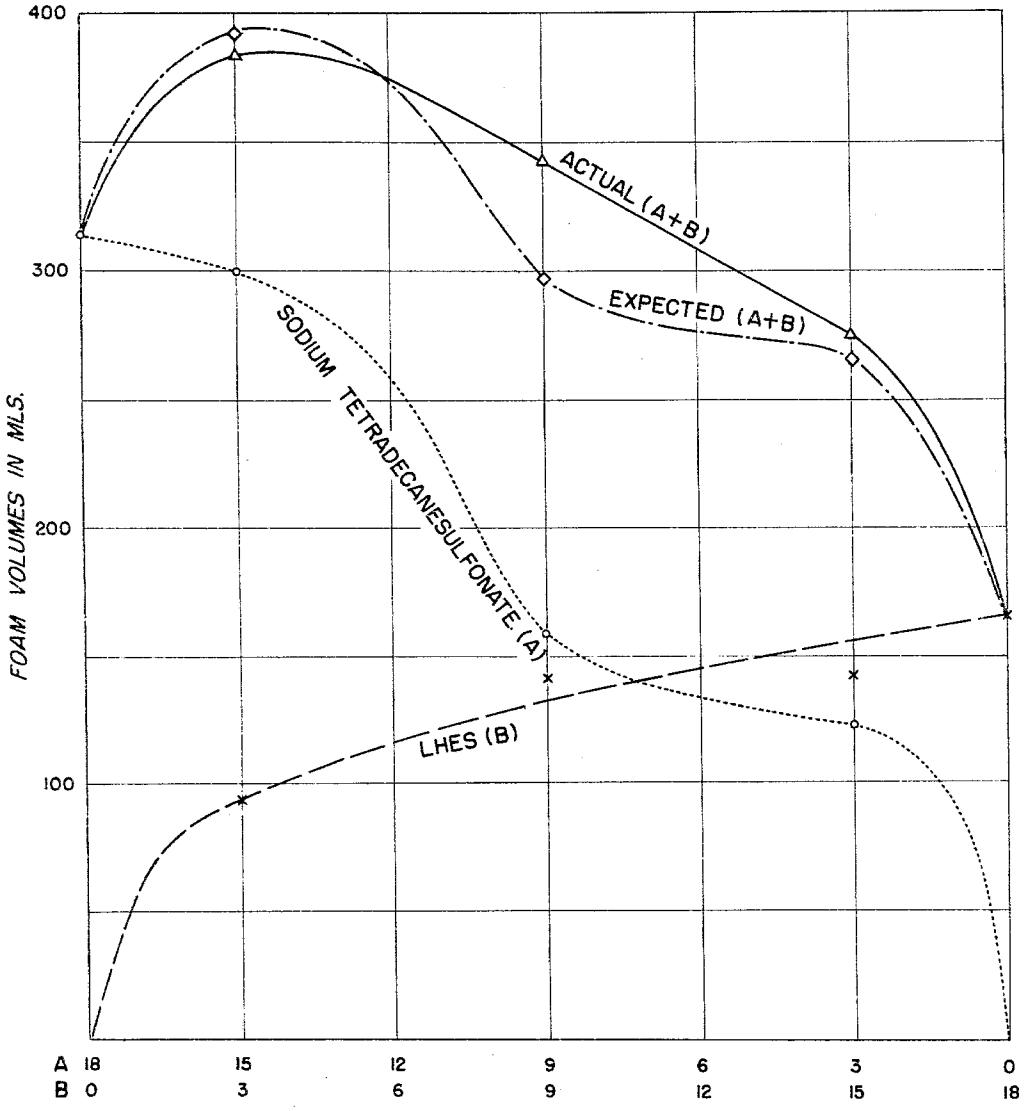

FIG. 6B

INVENTOR.
WILLARD M. BRIGHT

BY Brumbaugh Free Graves & Donohue
his ATTORNEYS

Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2, 1960 20 Sheets-Sheet 13

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (NON-BUILT) AND STEPANOL WAT (NON-BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

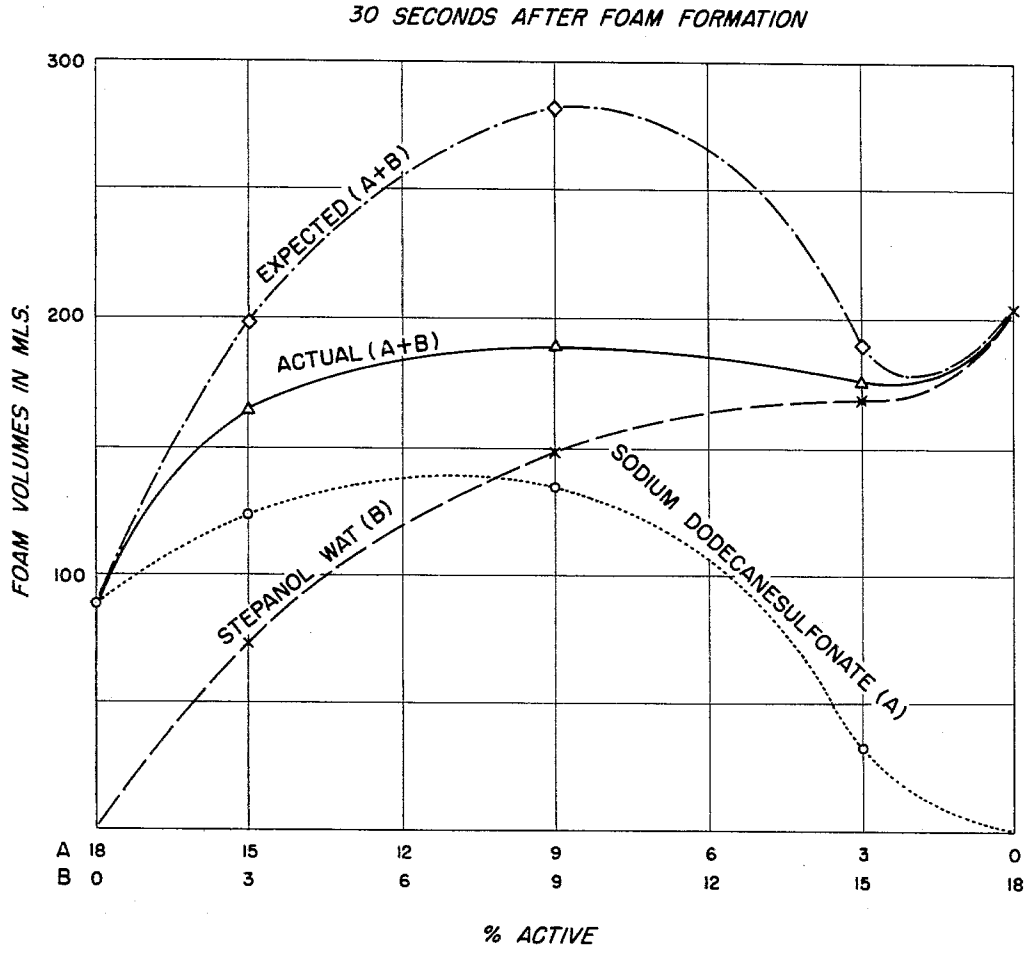

FIG. 7A

INVENTOR.
WILLARD M. BRIGHT
BY Brumbaugh, Free, Graves & Donohue
his ATTORNEYS

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (NON-BUILT) AND STEPANOL WAT (NON-BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

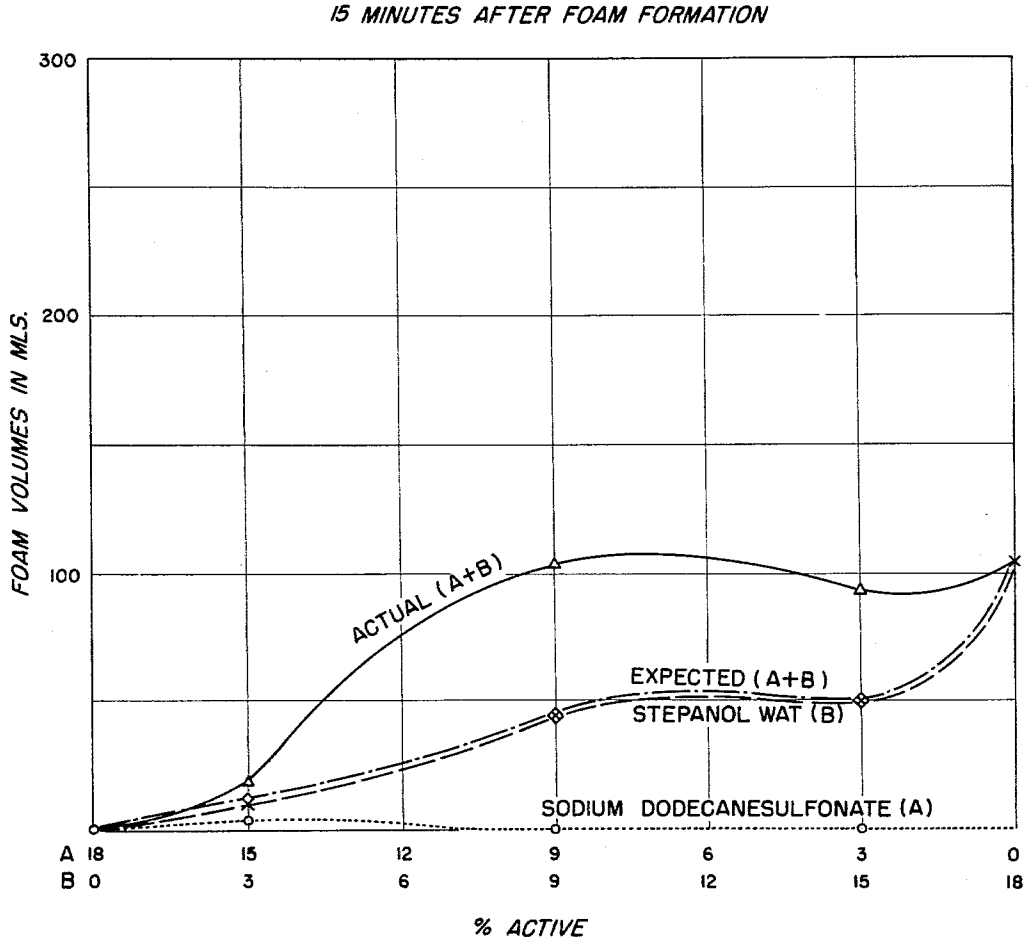

FIG. 7B

INVENTOR.
WILLARD M. BRIGHT
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his ATTORNEYS

Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2. 1960 20 Sheets-Sheet 15

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (SULFATE BUILT) AND STEPANOL WAT (NON-BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

30 SECONDS AFTER FOAM FORMATION

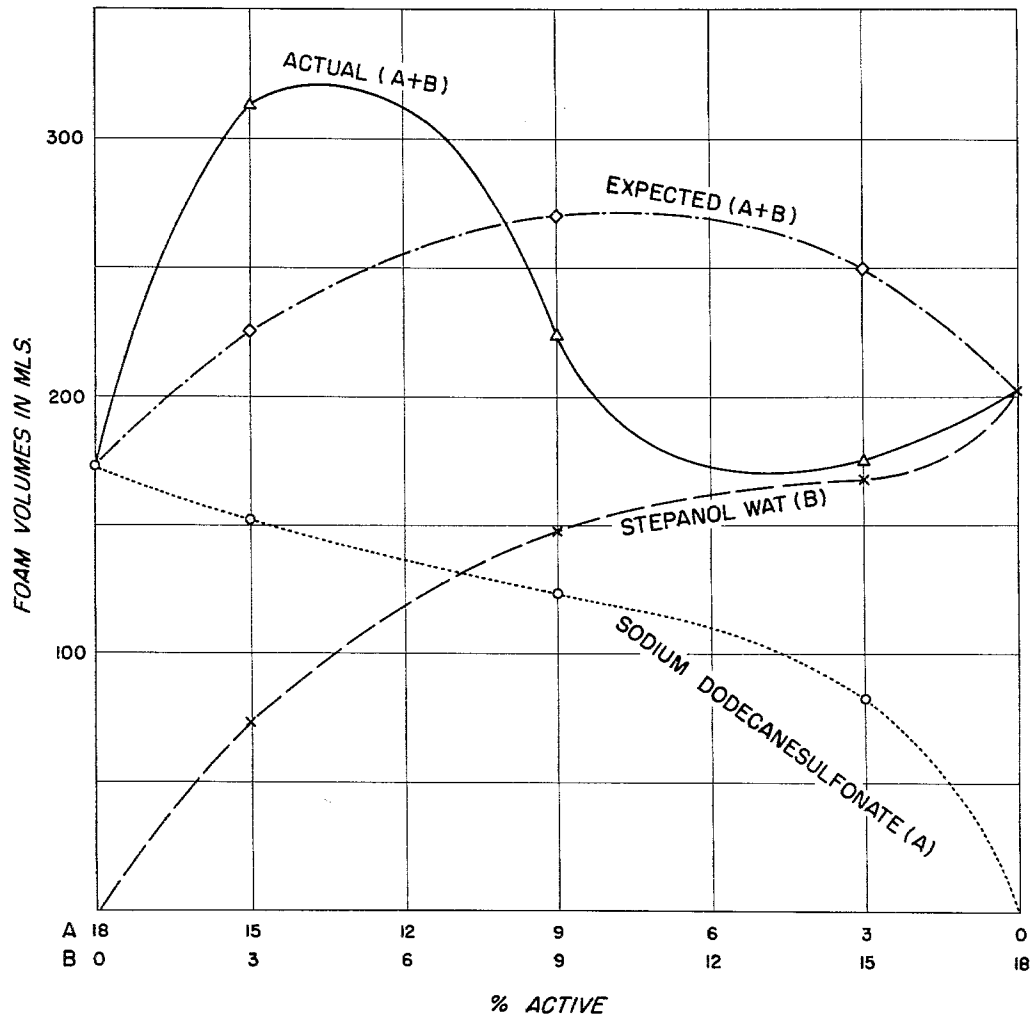

FIG. 8A

INVENTOR.
WILLARD M. BRIGHT
BY Brumbaugh, Free, Graves & Donohue
his ATTORNEYS

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (SULFATE BUILT) AND STEPANOL WAT (NON-BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

15 MINUTES AFTER FOAM FORMATION

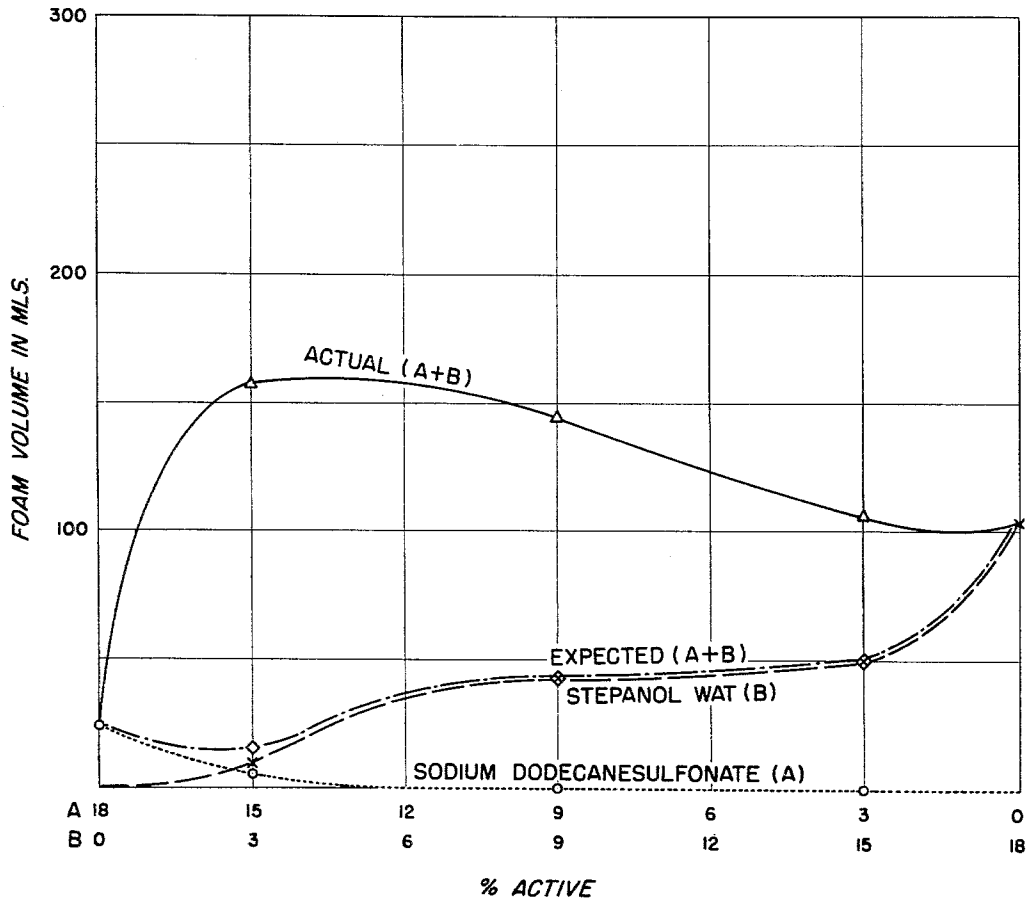

FIG. 8B

INVENTOR.
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his ATTORNEYS

Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2. 1960 20 Sheets-Sheet 17

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (NON-BUILT) AND TRITON X-100 (NON-BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

30 SECONDS AFTER FOAM FORMATION

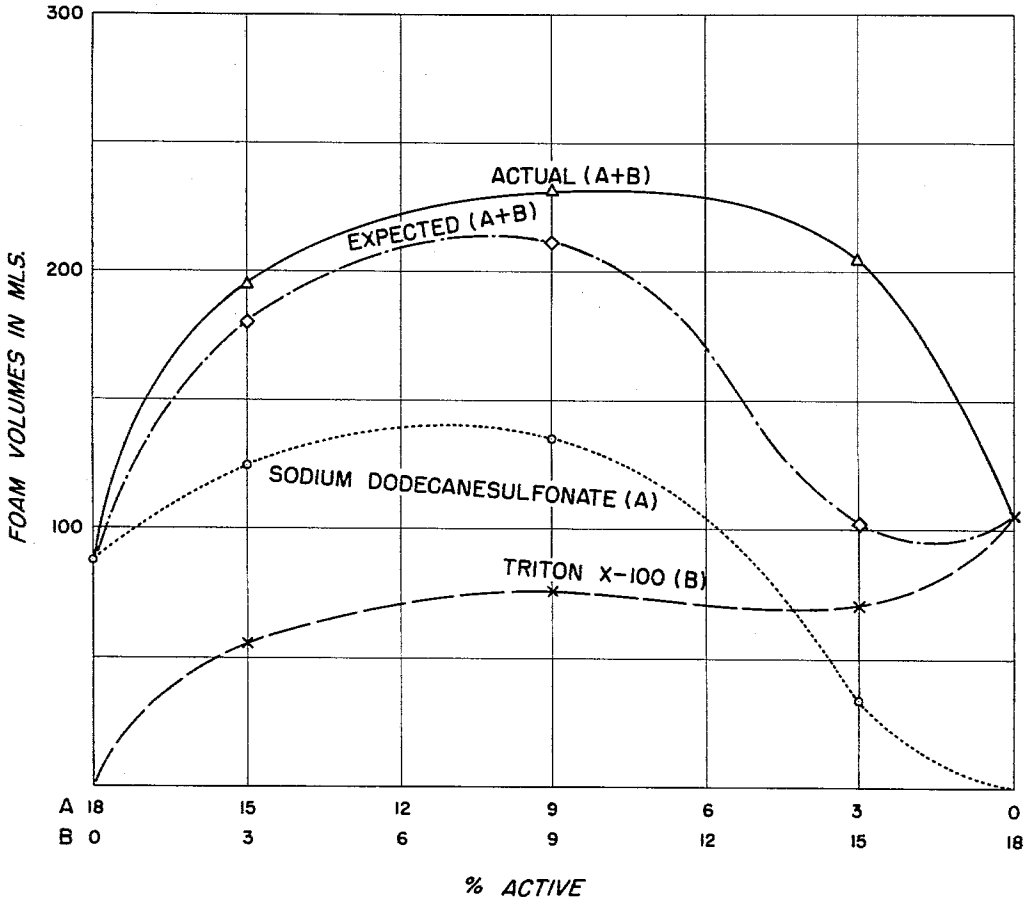

FIG. 9A

INVENTOR.
WILLARD M. BRIGHT
BY Brumbaugh, Free, Graves & Donohue
his *ATTORNEYS*

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (NON-BUILT) AND TRITON X-100 (NON-BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

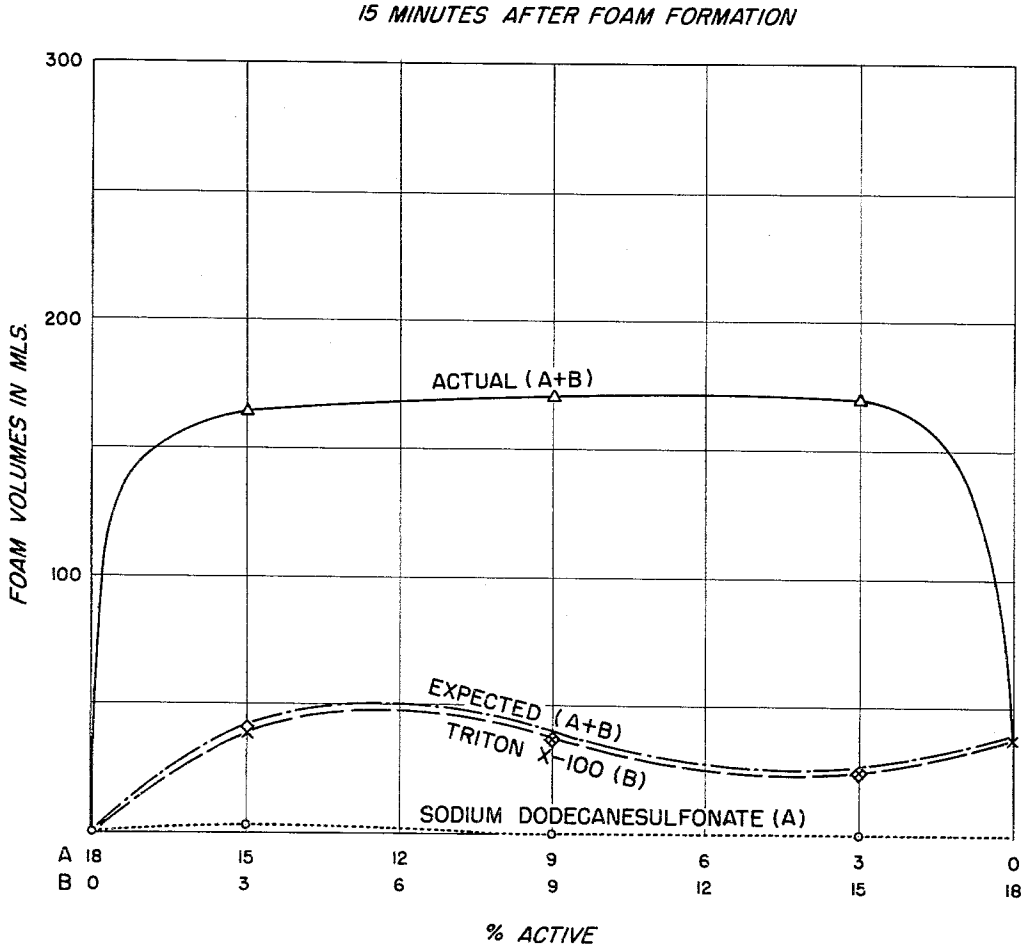

FIG. 9B

INVENTOR.
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his ATTORNEYS

Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2. 1960 20 Sheets-Sheet 19

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (NON-BUILT) AND ARMEEN (8D) (NON-BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

30 SECONDS AFTER FOAM FORMATION

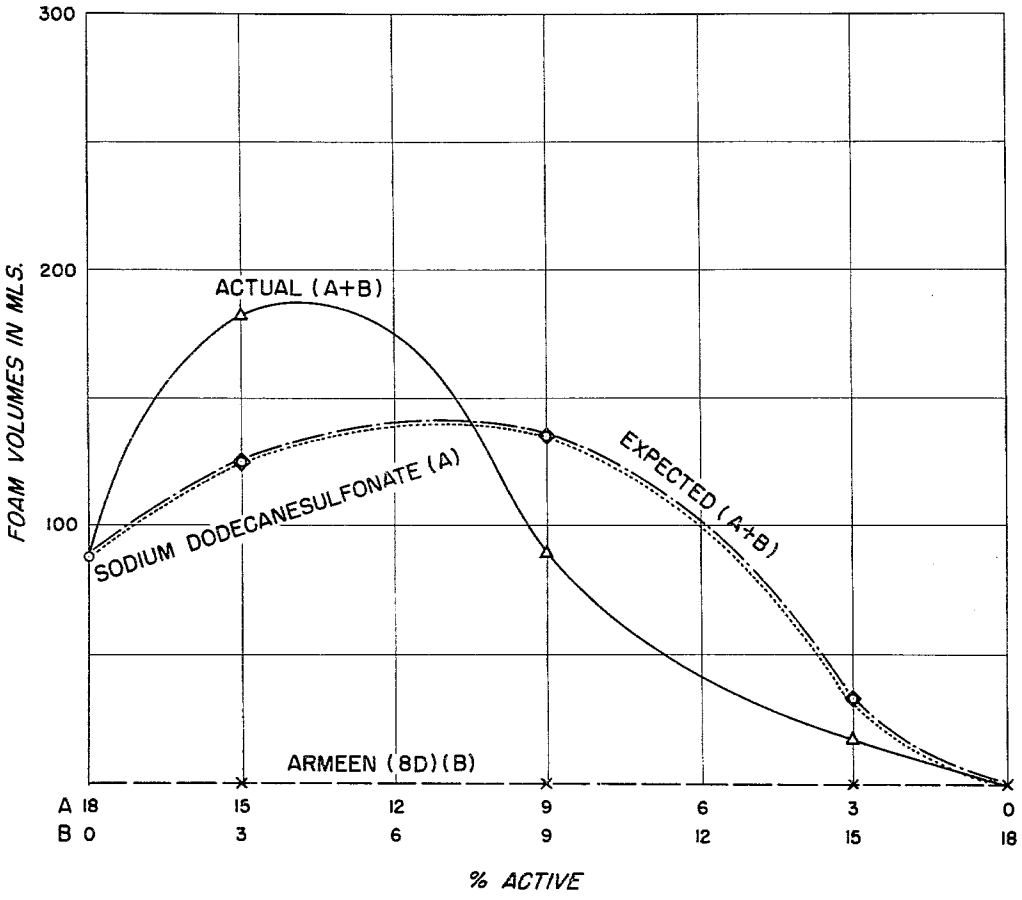


FIG. 10A

INVENTOR.
WILLARD M. BRIGHT
BY Brumbaugh Free, Graves & Donohue
his ATTORNEYS

Jan. 18, 1966 W. M. BRIGHT 3,230,174
SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE
Filed Aug. 2, 1960 20 Sheets-Sheet 20

CYLINDER FOAM VOLUMES OF SODIUM DODECANESULFONATE (NON-BUILT) AND ARMEEN (8D) (NON-BUILT), SINGLY AND IN COMBINATION WITH EACH OTHER.

15 MINUTES AFTER FOAM FORMATION

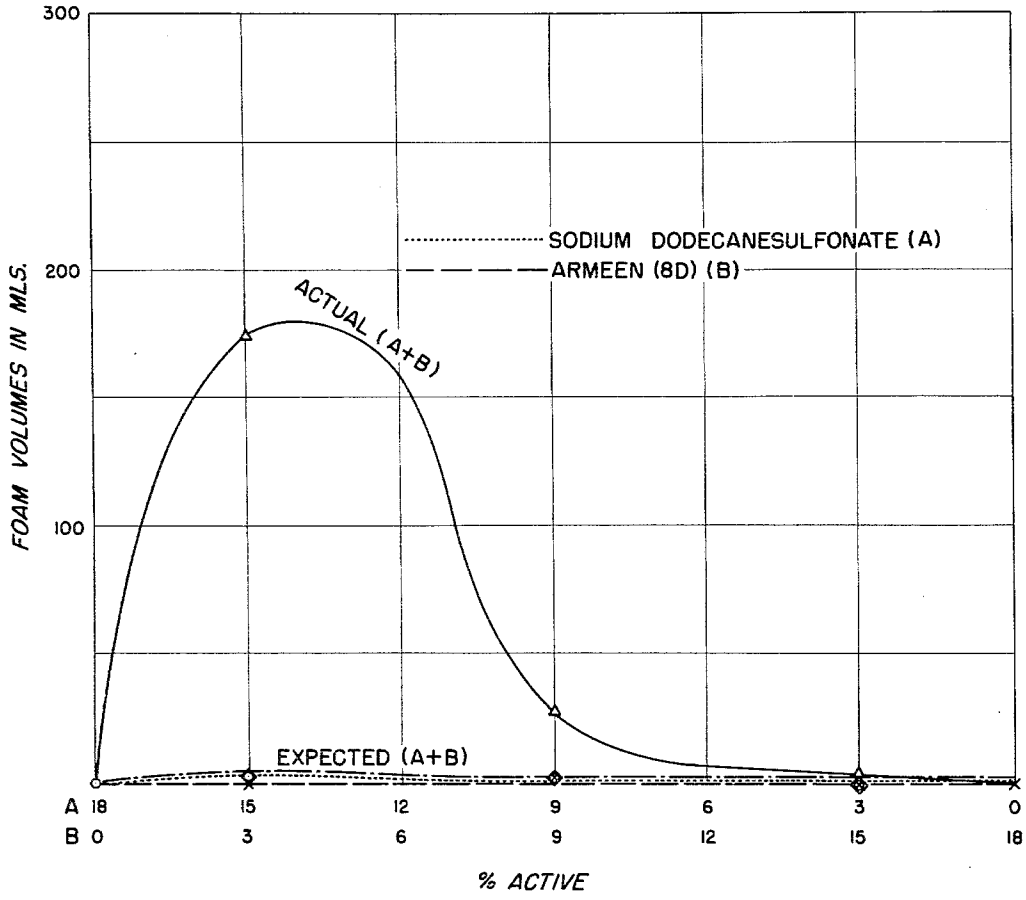


FIG. 10B

INVENTOR.
WILLARD M. BRIGHT
BY Brumbaugh Free, Graves & Donohue
his ATTORNEYS

United States Patent Office 3,230,174 Patented Jan. 18, 1966

3,230,174

SYNERGISTIC COMBINATION OF SODIUM DODECANE SULFONATE AND TRIETHANOLAMINE LAURYL SULFATE

Willard M. Bright, Ridgewood, N.J., assignor to Lever Brothers Company, New York, N.Y., a corporation of Maine

Filed Aug. 2, 1960, Ser. No. 47,043
2 Claims. (Cl. 252—152)

The present invention relates to new synthetic detergent compositions and, more particularly, it relates to synergistic combinations of alkane sulfonates with anionic, cationic, and non-ionic surfactants.

The foaming characteristics of a wetting agent or detergent are important for many reasons and very largely determine the manner in which such materials may be used.

The amount of solution held in a foam and the stability of the foam are particularly important when the detergent is used outside of a container, for example, in hair shampoo or shaving cream. The suitability of a shampoo appears to depend mainly upon whether it can form, when agitated in aqueous solution, a strong and wet foam which can keep a sufficient quantity of the detergent solution in the hair so that thorough washing is effected before the solution runs off.

Superior foaming characteristics are also desired in shaving cream. A stable foam capable of retaining a large amount of the wetting agent in solution around the hairs soften them and enables them to be cut more easily by the razor while a "stiff" foam holds the hairs upright on the skin and allows the blade to cut them at a right angle to their length, thereby providing a close, clean shave.

Furthermore, foams are of great industrial importance in flotation operations, such as the concentration of mineral ores. A foam or froth capable of carrying the richer portion of a crushed ore is produced and either skimmed off or caused to flow to a collecting point as it rises to the top of the liquid body. The essence of such flotation operations is stability and control of foam.

It is thus an object of the present invention to provide new wetting and detergent compositions of improved foaming characteristics.

Another object is to provide synergistic combinations of alkane sulfonates with other surfactants.

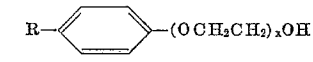
Other objects of the present invention and advantageous features thereof will become apparent as the description proceeds.

It has now been found that long chain alkane sulfonates form synergistic foaming compositions with several species of detergents. Such synergistic combinations may be formed with anionic, cationic and nonionic detergents. Suitable anionic detergents include alkoxy hydroxy propane sulfonates wherein the alkoxy group contains from 12 to 18 carbon atoms. Examples of such anionic detergents are:

sodium-3-dodecyloxy-2-hydroxy propane sulfonate,
sodium-3-tridecyloxy-2-hydroxy propane sulfonate,
sodium-3-tetradecyloxy-2-hydroxy propane sulfonate,
sodium-3-pentadecyloxy-2-hydroxy propane sulfonate,
sodium-3-hexadecyloxy-2-hydroxy propane sulfonate,
sodium-3-heptadecyloxy - 2-hydroxy propane sulfonate, and
sodium-3-octadecyloxy-2-hydroxy propane sulfonate. Another example of a suitable anionic detergent is lauryl sulfate.

Nonionic surfactants which may be used with long chain alkane sulfonates to form the synergistic foaming

compositions of the present invention include the condensates of alkyl phenol with ethylene oxide. Such compounds have the following formula:



wherein R is an alkyl group containing from 8 to 12 carbon atoms, and x may be 9 or 10.

An example of a suitable cationic surfactant is octylamine.

The long chain alkane sulfonates may contain up to 14 carbon atoms. Examples of such compounds are:

sodium-1-decane sulfonate,
sodium-1-undecane sulfonate,
sodium-1-dodecane sulfonate,
sodium-1-tridecane sulfonate, and
sodium-1-tetradecane sulfonate.

It will be appreciated that it is not possible to set forth specific limits for these mixtures since the synergistic properties vary depending on the particular detergents used.

Such synergistic mixtures may be formed with built as well as non-built anionic, cationic, and non-ionic surfactants. In the case of built actives, formulations of the following compositions may be employed.

Phosphate-built formula Ingredient:	Percent
Organic detergent active	18.0
Sodium tripolyphosphate	15.0
Tetrasodium pyrophosphate	25.0
Sodium silicate, R.U. (2.4 ratio)	6.0
Sodium carboxymethyl cellulose	0.5
Sodium sulfate and misc.	35.0
	100.0

Sulfate-built formula Ingredient:	Percent
Organic detergent active	10.0–18.0
Sodium sulfate and misc.	90.0–82.0

Cylinder foam volumes were used as a measure of synergism because small differences in foam volumes are easily detected in this type of test. In addition, the numbers by which the detergents are graded are read by markings on the cylinder rather than being assigned according to the operator's judgment. Thus, the measurements in the cylinder test are not subject to human error. Even less subject to human error is the foam volume decay reading made after the foam has remained undisturbed in the cylinder for a period of 15 minutes. This reading represents a measure of foam stability and is considered as more significant than the initial foam volumes. Readings were taken of the foam volumes of the individual components of each combination. Only those combinations whose actual foam volumes were substantially above the arithmetic sum of the foam volumes of the individual components of each combination are considered synergistic combinations.

The expected foam volumes of the present combinations show deviations from the mean ranging from plus or minus 21 ml. to plus or minus 48 ml., and averaging plus or minus 35 ml. Thus, synergism is considered to exist only in cases where actual foam volumes are more than 35 ml. above the excepted foam volumes. To illustrate, in graph 1B the plot for actual foam volumes representing uncorrected experimental data (average of duplicate tests), lies above the expected foam volume throughout the entire range of combinations. Only those combinations, however, containing between 7.0% and 17.0% sodium decane sulfonate are considered synergistic combinations since these foam volumes are at least 35 ml. greater than the expected foam volumes. All evaluations of synergism were made in this fashion.

The cylinder foam volumes were determined by the following procedure:

1.4 grams of the detergent were dissolved in 1 liter of water having a hardness of 180 p.p.m. of alkaline earth carbonates, of which ⅔ is calcium and ⅓ is magnesium, on a molar basis. 100 ml. of this solution were placed in a 500 ml. mixing cylinder immersed in a water bath to the 500 ml. mark. The temperature of the water bath was adjusted to maintain the temperature of the detergent solution in the cylinder at 120° F. When the temperature of the solution reached 120° F. (which required approximately 20 minutes), the cylinder was removed from the bath and then stoppered and shaken by hand, using ten vigorous double strokes in 5 seconds. The stopper was immediately removed and the cylinder replaced in the bath. The initial reading of foam volume was taken 30 seconds after shaking, and a second measurement was made after the cylinder had remained unstoppered in the bath for 15 minutes.

Although in most instances water of 180 p.p.m. hardness was employed, the poor water solubility of several alkane sulfonates, particularly those of more than 14 carbons, necessitated the use of distilled water. These cases are so indicated. The solutions used were prepared in such fashion as to maintain corresponding concentrations of organic detergent active in both built and nonbuilt solutions.

The combinations discussed herein were organized into anionic, non-ionic and cationic groups, depending on the surfactant in combination with the alkane sulfonate. The following binary detergent systems were examined:

I. ALKANE SULFONATES IN COMBINATION WITH ANIONIC SURFACTANTS

	Alkane sulfonate	Anionic surfactant	Builder
1	Sodium-1-decane sulfonate	LHES	Sodium sulfate.
2	Sodium-1-dodecane sulfonate	THES	Do.
3	do	THES	Phosphate.
4	do	THES	None.
5	do	LHES	Sodium sulfate.
6	Sodium-1-tetradecane sulfonate	LHES	Do.
7	Sodium-1-dodecane sulfonate	Stepanol WAT	None.
8	do	do	Sodium sulfate.

II. ALKANE SULFONATES IN COMBINATION WITH NON-IONIC SURFACTANTS

	Alkane sulfonate	Non-ionic surfactant	Builder
9	Sodium-1-dodecane sulfonate	Triton X-100	None.

III. ALKANE SULFONATES IN COMBINATION WITH CATIONIC SURFACTANTS

	Alkane sulfonate	Cationic surfactant	Builder
10	Sodium-1-dodecane sulfonate	Armeen 8D	None.

The following terms were employed in the data tables to describe synergism:

None
Slight
Moderate
Considerable

The figures bear identification numbers in their upper right hand corners. Reference is made to these numbers at the head of the data tables.

Although the values of single component foam volumes have been presented graphically, they were omitted from the data tables.

In all cases, FIGURE A represents the volume of foam recorded after 30 seconds while FIGURE B the volume after 15 minutes. The concentrations used are indicated in each figure. FIGS. 1A and 1B show the synergism produced from mixtures containing sodium decane sulfonate and LHES. FIGS. 2A and 2B, 3A and 3B, and 4A and 4B reveal the synergistic effect produced from mixtures of sodium dodecane sulfonate and THES. The synergism shown by mixtures of sodium dodecane sulfonate and LHES is depicted in FIGS. 5A and 5B while that of mixtures of sodium tetradecane sulfonate and LHES is given by FIGS. 6A and 6B. FIGS. 7A and 7B as well as 8A and 8B show the synergistic effect produced by mixtures of sodium dodecane sulfonate and Stepanol WAT. In FIGS. 9A and 9B are shown the synergism exhibited by mixtures of sodium dodecane sulfonate and Triton X-100 while FIGS. 10A and 10B indicate that produced by mixtures of sodium dodecane sulfonate and Armeen 8D.

In the description the following abbreviations and trade names have been used:

LHES=sodium-3-dodecyloxy - 2 - hydroxy propane sulfonate
THES=sodium-3-octadecyloxy-2-hydroxy propane sulfonate
Stepanol WAT=triethanolamine salt of lauryl sulfate
Triton X-100=condensate of octyl phenol with 9–10 moles of ethylene oxide
Armeen 8D=octylamine

I. ALKANE SULFONATES IN COMBINATION WITH ANIONIC SURFACTANTS

Example 1.—Sodium decane sulfonate and LHES*

Builder: Sodium sulfate
180 p.p.m. water, 120° F.
Figures 1A and 1B

[Foam volumes, ml.]

Percent sod. decane sulfonate	Percent LHES	Initial		15 mins. aging	
		Actual	Expected	Actual	Expected
18.0	0	10	10	0	0
15.0	3.0	188	118	153	88
9.0	9.0	280	198	180	135
3.0	15.0	350	288	220	198
0	18.0	308	308	210	210
Synergism	Moderate; in combinations containing betw. 1.0% and 16.5% sod.- 1-decane sulfonate, whole composition basis.			Slight to moderate; in combinations containing betw. 7.0% and 17.0% sod. decane sulfonate, whole composition basis.	

Example 2.—Sodium dodecane sulfonate and THES

Builder: Sodium sulfate
180 p.p.m. water, 120° F.
Figures 2A and 2B

[Foam volumes, ml.]

Percent sod. dodecane sulfonate	Percent THES	Initial		15 mins. aging	
		Actual	Expected	Actual	Expected
10.00	0	108	108	4	4
8.75	1.25	190	76	133	7
7.50	2.50	210	68	163	18
5.00	5.00	220	66	130	30
2.50	7.50	140	63	87	38
1.25	8.75	102	59	80	43
0	10.00	60	60	50	50
Synergism	Considerable; in combinations contg. approx. 1.0% to 9.75% sod. dodecane sulfonate, whole combination basis.			Considerable; in combinations contg. approx. 1.3% to 9.5% sod. dodecane sulfonate, whole combination basis.	

*Where no specific reference is made to the position of the SO_3Na group, as in the above case, the group is in the -1-position. Thus ,sodium decane sulfonate is identical to sodium-1-decane sulfonate.

Example 3.—Sodium dodecane sulfonate and THES

Builder: Phosphates
180 p.p.m. water, 120° F.
Figures 3A and 3B

[Foam volumes, ml.]

Percent sod. dodecane sulfonate	Percent THES	Initial		15 mins. aging	
		Actual	Expected	Actual	Expected
18.00	0	260	260	0	0
15.75	2.75	260	233	170	29
13.50	4.50	260	225	150	22
9.00	9.00	230	175	133	29
4.50	13.50	145	128	83	35
2.25	15.75	165	103	90	48
0	18.00	73	73	38	38
Synergism	Slight to moderate; in combinations contg. approx. 2.25% to 13.5% sod. dodecane sulfonate, whole composition basis.			Considerable; in combinations contg. approx. 3.1% to 17.7% sod. dodecane sulfonate, whole composition basis.	

Example 4.—Sodium dodecane sulfonate and THES

Builder: None
180 p.p.m. water, 120° F.
Figures 4A and 4B

[Foam volumes, ml.]

Percent sod. dodecane sulfonate	Percent THES	Initial		15 mins. aging	
		Actual	Expected	Actual	Expected
100.0	0	375	375	250	250
87.5	12.5	360	315	305	225
75.0	25.0	338	300	285	170
50.0	50.0	410	271	353	49
25.0	75.0	338	243	275	70
12.5	87.5	265	178	198	64
0	100.0	120	120	73	73
Synergism	Moderate to considerable; in combinations contg. approx. 6.2% to 97.5% sod. dodecane sulfonate, whole composition basis.			Considerable; in combinations contg. approx. 3.1% to 91.6% sod. dodecane sulfonate, whole composition basis.	

Example 5.—Sodium dodecane sulfonate and LHES

Builder: Sodium sulfate
180 p.p.m. water, 120° F.
Figures 5A and 5B

[Foam volumes, ml.]

Percent sod. dodecane sulfonate	Percent LHES	Initial		15 mins. aging	
		Actual	Expected	Actual	Expected
18.0	0	174	174	23	23
13.5	4.5	335	317	230	127
9.0	9.0	411	355	258	165
4.5	13.5	365	378	225	165
0	18.0	365	365	218	218
Synergism	None			Moderate to considerable; in combinations contg. approx. 2.0% to 17.5% sod. dodecane sulfonate, whole composition basis.	

Example 6.—Sodium tetradecane sulfonate and LHES

Builder: Sodium sulfate
Distilled water, 120° F.
Figures 6A and 6B

[Foam volumes, ml.]

Percent sod. tetradecane sulfonate	Percent LHES	Initial		15 mins. aging	
		Actual	Expected	Actual	Expected
18.0	0	413	413	315	315
15.0	3.0	465	536	385	393
9.0	9.0	435	498	343	298
3.0	15.0	473	493	276	266
0	18.0	398	398	165	165
Synergism	None			Slight; in combinations contg. approx. 6.5% to 9.5% sod. tetradecane sulfonate, whole composition basis.	

Example 7.—Sodium dodecane sulfonate and Stepanol WAT

Builder: None
180 p.p.m. water, 120° F.
Figures 7A and 7B

[Foam volumes, ml.]

Percent sod. dodecane sulfonate	Percent stepanol WAT	Initial		15 mins. aging	
		Actual	Expected	Actual	Expected
18.0	0	88	88	0	0
15.0	3.0	165	198	19	13
9.0	9.0	188	283	104	43
3.0	15.0	175	191	93	50
0	18.0	203	203	105	105
Synergism	None			Slight to moderate; in combinations contg. approx. 2.5% to 13.5% sodium dodecane sulf. whole composition basis.	

Example 8.—Sodium dodecane sulfonate and Stepanol WAT

Builder: Sod. Dodecane sulfonate, Sodium sulfate Stepanol WAT, non-built
180 p.p.m. water, 120° F.
Figures 8A and 8B

[Foam volumes, ml.]

Percent sod. dodecane sulfonate	Percent stepanol WAT	Initial		15 mins. aging	
		Actual	Expected	Actual	Expected
18.0	0	174	174	23	23
15.0	3.0	313	225	158	16
9.0	9.0	225	271	145	43
3.0	15.0	175	251	108	50
0	18.0	203	203	105	105
Synergism	Moderate; in combinations contg. approx. 11.0% to 17.25% sod. dodecane sulf., whole composition basis.			Moderate to considerable; in combinations contg. 1.75% to 18.0% sod. dodecane sulf., whole composition basis.	

II. ALKANE SULFONATES IN COMBINATION WITH NON-IONIC SURFACTANTS

Example 9.—Sodium dodecane sulfonate and Triton X–100

Builder: None
180 p.p.m. water, 120° F.
Figures 9A and 9B

[Foam volumes, ml.]

Percent sodium dodecane sulfonate	Percent Triton X–100	Initial		15 mins. aging	
		Actual	Expected	Actual	Expected
18.0	0	88	88	0	0
15.0	3.0	195	180	165	41
9.0	9.0	230	210	170	38
3.0	15.0	205	103	170	25
0	18.0	105	105	38	38
Synergism	Slight to moderate; in combinations contg. approx. 0.75% to 7.0% sod. dodecane sulf., whole combination basis.			Considerable; entire range of combinations.	

III. ALKANE SULFONATES IN COMBINATION WITH CATIONIC SURFACTANTS

Example 10.—Sodium dodecane sulfonate and Armeen 8D

Builder: None
180 p.p.m. water, 120° F.
Figures 10A and 10B

[Foam volumes, ml.]

Percent sodium dodecane sulfonate	Percent Armeen 8D	Initial		15 mins. aging	
		Actual	Expected	Actual	Expected
18.0	0	88	88	0	0
15.0	3.0	183	125	175	3
9.0	9.0	88	135	28	0
3.0	15.0	18	33	4	0
0	18.0	0	0	0	0
Synergism	Moderate; in combinations contg. approx. 12.25% to 16.75% sod. dodecane sulf., whole composition basis.			Considerable; in combinations contg. approx. 9.5% to 18.0% sod. dodecane sulf. whole composition basis.	

As many and varied modifications of the subject mat- of this invention will become apparent to those skilled in the art from the detailed description given herein, it should be understood that this invention is to be limited only in accordance with the appended claims.

I claim:

1. A synergistic foaming composition comprising from about 2.5 to about 13.5 parts sodium dodecane sulfonate and from about 15.5 to about 4.5 parts triethanolamine lauryl sulfate, respectively; said composition having an actual foam volume after 15 minutes aging more than 35 ml. above the expected foam volume and having a maximum actual synergistic foam volume of at least about 110 ml.

2. A synergistic foaming composition comprising from about 1.75 to about 17.7 parts sodium dodecane sulfonate and from about 16.25 to about 0.3 part triethanolamine lauryl sulfate, respectively; said composition having an actual foam volume after 15 minutes aging more than 35 ml. above the expected foam volume and having a maximum actual synergistic foam volume of at least about 160 ml.

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