

CASE IPR2017-00526
CULTEC, INC. v. STORMTECH LLC
**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT TRIAL & APPEAL BOARD**

In re Patent of: Mailhot et al.
U.S. Patent No.: 8,672,583
Issue Date: Mar. 18, 2014
Appl. No.: 12/802,483
Filing Date: Jun. 7, 2010
Title: Corrugated Stormwater Chamber Having Sub-Corrugations

**DECLARATION OF RUSSELL L. HERLACHE IN SUPPORT OF INTER PARTES
REVIEW OF U.S. PATENT NO. 8,672,583**

I, Russell L. Herlache, declare as follows:

I. Background and Qualifications

1.) A copy of my *curriculum vitae* (CV) is attached to this declaration as Appendix A.

A. Experience

2.) I have spent my entire professional career, spanning over 46 years, in the field of engineering design and manufacturing and materials research, analysis, selection, and application.

3.) I am specifically experienced in plastics injection molding as well as extrusion and thermoforming, the manufacturing processes involved in the products in dispute.

4.) As part of that experience, I have worked for Penda Corporation, a manufacturer of thermoformed plastic chambers, and provided design, manufacturing and testing guidance.

5.) As a technical consultant, I have also provided design, manufacturing and testing guidance to Cultec for their injection molded and thermoformed chambers since May 2014.

6.) Furthermore, I am currently on the ASTM F17 and CSA 184 Standards Committees which govern these products.

7.) Since 1991, I have been teaching as an Adjunct Lecturer at Saginaw Valley State University. I currently teach classes on Engineering Cost Analysis and Materials Engineering, which includes both lecture and laboratory aspects, as a part of the curriculum for Mechanical, Electrical, and Engineering Management and Technology programs.

8.) From 1986 to 1988, I was an instructor at Delta College, University Center Michigan, where I taught courses on plastics processing and design.

9.) I also attended, participated in, and instructed numerous corporate and external training programs in areas of Plastic Product Design and Applications, including GE Plastics "Sharing the Knowledge," as well as courses in Statistical Process Control and Computer Aided Engineering.

10.) Further specific examples of my experience in the field include:

- Lead Plastics Engineer for the design, development and launch of the first plastic steering column housing in the automotive industry, which received the Bachner Award as part of the National Plastics Exhibition in 1976 for best use of nylon.
- Chair of MIOSHA Standards for Plastic Processing 1984 to present
- Developed and presented Plastic Product Design Courses for General Motors and Walbro Corporation.
- Member of the Fiat Chrysler RamBox team and Competition Presenter for the 2011 SPE Automotive Division Innovation Awards which was selected as best innovation in Body Exterior.

B. Education

11.) I received a Bachelor of Mechanical Engineering (B.M.E.) degree in Materials Science from General Motors Institute (now Kettering University) in 1974.

12.) I received a Master of Science (M.S.) degree in Industrial Operations and Engineering from the University of Michigan's Rackham Graduate School in 1983.

C. Patents

13.) I am an inventor listed on U.S. Patent Nos. 5,049,770, 5,345,679, and 5,481,938 and the first named inventor on U.S. Patent Nos. 5,173,065 and 5,788,917.

14.) The '770 patent was for an automotive air pump for emission control. Product was predominantly plastic and required the incorporation of structural design features to maximize stiffness and dimensional stability while minimizing assembly weight.

15.) The '065 patent was an improvement to an existing steering column electrical component which provided an integral insulation process method. Design considerations included determination of adequate draft and material thickness for optimal processing.

16.) The '938 patent was a plastic part design for the tilt position control of a steering column. The design required consideration of design stiffness and draft for optimal performance and processing.

17.) The '917 patent was an improvement to an insert molded steering column gear shift lever through the application of the gas assist injection molding process to create an integral wire channel for a control switch. The improvement resulted in a significant cost savings in manufacturing and reduced warranty and repair cost as a result of improved insulation and wire insertion.

18.) The '065 patent was the development of an alternative method and process to manufacture a key component for an energy absorbing steering column. The method provided the ability to integrate the downstream assembly process into the forming operation, thereby reducing the overall manufacturing cost.

19.) I also received additional insight into the patent process while working for Penda Corporation, where part of my responsibilities was to assist the Vice President of Engineering in Patent Application reviews, which included reviewing patent applications and renewals with the Vice President and our corporate Patent Attorney.

D. Understanding of Legal Standards

20.) I understand a patent claim to be invalid if every aspect of the claim is disclosed by a single prior art reference. I have been informed that this standard, commonly known as “anticipation,” is set forth in 35 U.S.C. § 102(a).

21.) I also understand a patent claim to be invalid if the differences between the claimed subject matter and the prior art are such that the claimed subject matter would have been obvious to a person of ordinary skill in the art at the time the invention was made. I have been informed that this standard, commonly known as “obviousness,” is set forth in 35 U.S.C. § 103.

22.) I have further been informed that, when considering if a patent claim would have been obvious, the following issues are considered: (i) the scope and content of the prior art; (ii) the differences between the prior art and the claims at issue; (iii) the level of ordinary skill in the art; and (iv) objective evidence of obviousness and non-obviousness.

23.) I have also been informed of the following principles regarding determining whether subject matter would have been considered obvious:

- A combination of familiar elements according to known methods is likely to be obvious when it yields predictable results.
- Changes in dimensions from an earlier design are likely to be obvious where they do not result in a difference in performance.

24.) I have been asked for my opinions regarding (i) the scope and content of the prior art to the '583 patent; (ii) the differences between the prior art and the claims of the '583 patent; (iii) the level of ordinary skill in the art of the '583 patent; and (iv) what, if anything, would have motivated those of ordinary skill in the art of the '583 patent to modify and/or combine features and teachings of the prior art.

25.) In forming my opinions, I have reviewed the following documents:

- The '583 Patent (Ex. 1001)
- File History of the '583 Patent at the USPTO (Excerpts in Ex. 1010)
- U.S. Patent No. 8,491,224 to Cobb et al. (Ex. 1002)
- U.S. Patent No. 4,360,042 to Fouss et al. (Ex. 1003)
- U.S. Patent No. 6,497,333 to Ellis et al. (Ex. 1004)
- U.S. Patent No. 3,855,799 to Martin et al.
- U.S. Patent No. 5,087,151 to DiTullio
- U.S. Patent No. 6,322,288 to DiTullio
- U.S. Patent No. 7,306,399 to Smith (Ex. 1006)
- U.S. Patent No. 4,759,661 to Nichols et al. (Ex. 1005)
- U.S. Patent No. 2,876,801 to November (Ex. 1007)
- U.S. Design Patent No. D613,819 to DiTullio
- U.S. Patent No. 6,123,113 to Pontbriand et al.
- U.S. Patent No. 4,113,818 to Drossbach
- U.S. Patent Application Publication No. US 2005/0111915 to Moore et al.
- EU Patent Application Publication Number 0 320 348 B1 to Serkes et al.

- Standards and Practices of Plastics Molders and Plastics Molded Parts Buyers Guide, Soc’y of The Plastics Ind., Inc. (1978)
- Rosato, DiMattia, & Rosato, Designing with Plastics and Composites A Handbook (1991) (Excerpts at Ex. 1008)
- R. Herlache, Plastic Part Design for Injection Molding, G.M. Seminar Handout (undated)

26.) My opinions set forth in this Declaration are based upon the foregoing materials as well as my education, training, research, knowledge, and experience.

II. Description of the Relevant Field and the Relevant Timeframe

27.) Based on the ‘583 patent and my understanding that the relevant timeframe is the time the invention was made, I understand the relevant timeframe to be immediately prior to June 5, 2009, which is the earliest priority date of the ‘583 patent.

28.) In my opinion, the relevant technological field of the subject matter claimed in the ‘583 patent is the design and manufacturing of plastic components, including load bearing components formed using a molding process.

29.) Given my extensive experience in this field over 46 years, as described above and reflected in my CV, I have an excellent understanding of the technology involved in this dispute during the relevant timeframe.

III. The Person of Ordinary Skill in the Relevant Field in the Relevant Timeframe

30.) I have been informed that “a person of ordinary skill in the art” is a hypothetical person with experience in and an understanding of the scientific and engineering principles applicable to the relevant field of technology. Such a person would have been aware of the prior art in the relevant field during the relevant timeframe and would have an ordinary level of creativity, rendering him or her capable of altering the designs of the prior art in obvious ways. I have also been advised that determining the level of ordinary skill in the art involves

consideration of: (1) the type of problems encountered in the art; (2) prior art solutions to those problems; (3) rapidity with which innovations are made; (4) sophistication of the technology in the art; and (5) the educational level of active workers in the field.

31.) In my opinion, a person of ordinary skill in the art of the '583 patent is an individual who has the training, experience and education to understand the underlying principles that are relevant to the creation and application of the process or product, and then apply that understanding of the existing practices and principles to develop a feasible concept by utilizing their knowledge and skill relating to the art. This can be accomplished by applying known techniques or concepts or the combination thereof that are related to the art. Specifically relating to the '583 patent, it would be a person who has training, experience and education sufficient to understand the application and performance requirements of underground storage chambers, and apply the principles of plastic product design that would result in a product that will meet the performance requirements.

32.) A person with a Bachelor's Degree in the fields of Mechanical Engineering, Civil Engineering, Materials or Plastics Process Engineering, and/or related fields and a minimum of 6 years of practice in the plastics industry would qualify as a person of ordinary skill in the art. Alternatively, other training and experience in the plastics industry could also qualify someone as a person of ordinary skill in the art. This opinion is based on my many years of personal experience as a Plastics Engineer and Engineering Supervisor in this field.

33.) Given my extensive experience in the relevant field over 46 years, I consider myself (both now and as of June 5, 2009) to be a person of a least ordinary skill in the art with respect to the '583 patent.

IV. Engineering Principles of the Relevant Technology

34.) The fundamental requirement of an underground chamber is to sufficiently resist buckling (collapse) when subjected to the forces of the surrounding underground environment and defined surface loads, taking into account the short and long term properties of the plastic material. The prime consideration to attain this strength and stiffness with any material is to optimize the moment of inertia at the highest stress points, where buckling is anticipated.

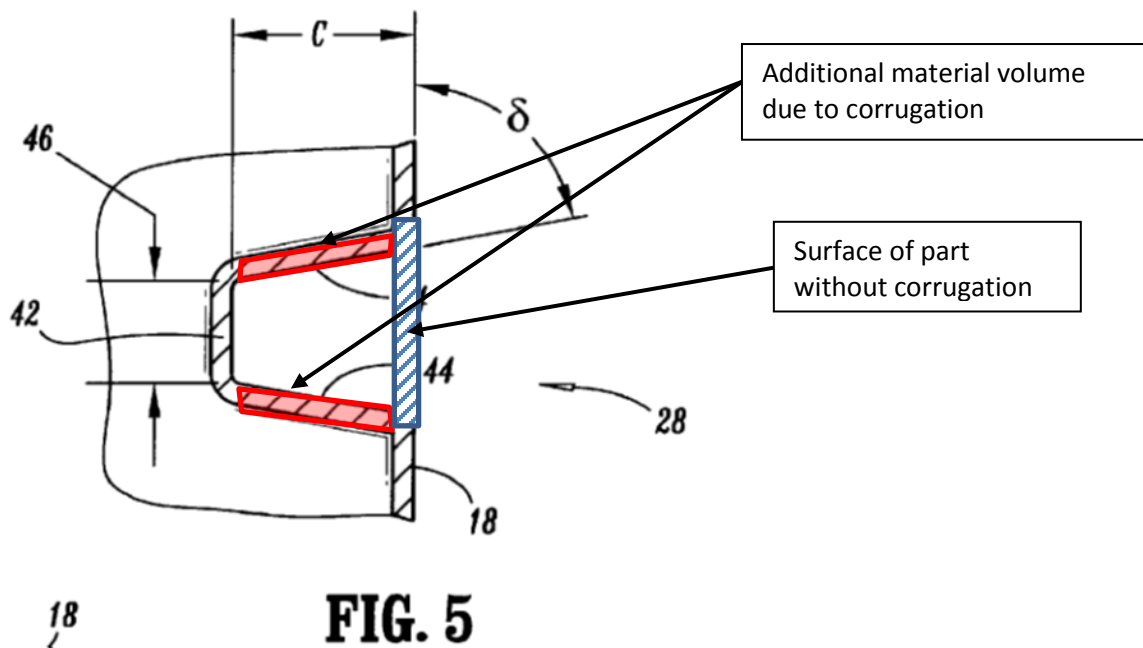
35.) The principle used is analogous to a wood beam that has a small thickness and a larger height, for example a 2 inch by 8 inch beam. If the load is applied on the 8 inch surface, there will be considerably more deflection when compared to the situation where the load is applied on the 2 inch surface. This principle is commonly applied in building construction, where floor and ceiling beams (joists) are oriented in a manner where the load is applied on the narrow surface so as to provide the optimal strength and stiffness to the floor or ceiling.

36.) Utilizing the principles of optimizing the moment of inertia to increase strength and stiffness, the moment of inertia is increased by increasing the height of a surface in the direction parallel to the direction of the applied force. Corrugations and ribs are a commonly used technique to achieve this increased height. As corrugations are added, the strength and stiffness can be increased. Sub-corrugations, either concave or convex to the parent surface, can also be added, which also increase the strength and stiffness. There are many ways to use corrugations to increase strength, including the use of corrugations that are continuous across a surface (described in, for example, Cobb (Ex. 1002), Moore, and Drossbach), sets of discontinuous corrugations (described in, for example, Ellis (Ex. 1004), Pontbriand, Serkes, and Martin), which may be staggered or overlapping (described in, for example, Ellis), stacked corrugations (like a sub-corrugation on top of a corrugation) (described in, for example, Cobb),

non-parallel sets of corrugations (described in, for example, Ellis), etc. All of these techniques are well known in the art.

37.) For example, the use of corrugations on underground pipes and chambers is known to improve their load bearing capability by increasing the wall stiffness. This principle is described and applied in any number of publications in the art, including, for example, Cobb (Ex. 1002), Fouss (Ex. 1003), Martin, and others.

38.) In addition to achieving sufficient chamber strength, however, chamber designers must also optimize the chamber's manufacturing, material, and shipping costs. For example, the addition of a corrugation or sub-corrugation to a previously flat surface requires additional material volume. This is illustrated in the following annotated Figure 5 from Ellis (Ex. 1004), in which the areas highlighted in red are additional material volume added as a result of the corrugation:



39.) Injection molding is the process by which most commercially feasible drainage chambers are manufactured. In an injection molding process, melted plastic is injected between

40.) This process also places constraints on chamber design, as design engineers must consider aspects of the design that will affect cure time and release of the chamber from the mold. The addition of corrugations and/or sub-corrugations, as a practical matter, creates additional contact area between the product and the mold (the tool used to form the product).

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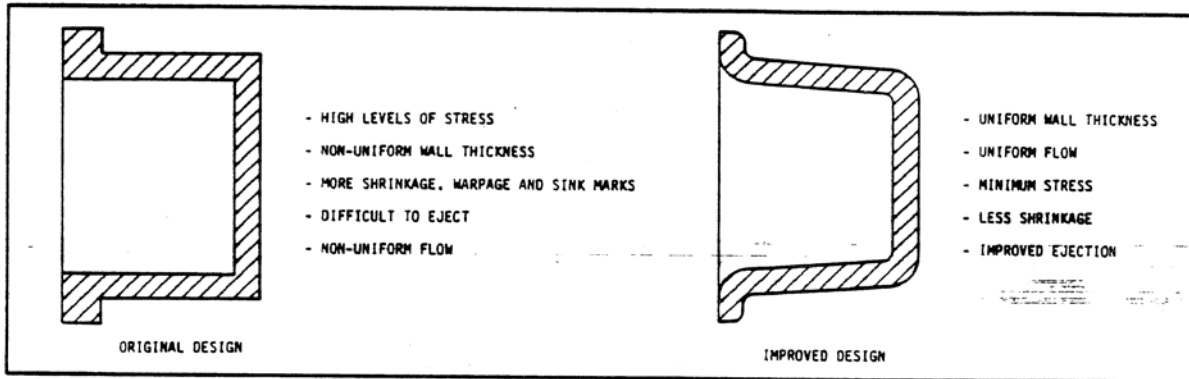
42.) As a result, more force is required to release the part from the mold and consequently the part must attain sufficient strength to be ejected from the mold without

distortion from the applied ejection force. The greater the surface area in contact, the greater the force required. Similarly, the longer the contact area extends, the greater the force required. The plastic part must be cooled to the point that it attains the required strength for ejection. As the required ejection force increases, so does the cooling time, thus reducing manufacturing efficiency.

43.) To improve this condition, the mold surface of corrugations and sub-corrugations are commonly tapered (i.e. draft is added) so that the part separates from the wall as soon as ejection begins. This commonly applied principle reduces the force required for ejection and thus decreases the required cooling time necessary to eject the part from the mold.

44.) “Draft” refers to the degree of taper of the feature or the angle of clearance designed to facilitate removal of parts from the mold. In the drawings below, the figure on the left has no draft, as the angles of the sidewalls are perpendicular to the base. This means that the mold and part will be in constant contact during extraction of the part from the mold, making extraction more difficult. On the other hand, the figure on the right shows a part with draft, or taper, which means that the sidewalls extend from the base at a positive angle. As the part separates from the mold surface, the draft immediately creates space between the mold and the part, reducing the force required for extraction. As noted, the design of parts to include draft is a common principle in the plastics molding field to facilitate mold removal from a finished product.

B. DRAFT ANGLES



An additional example of draft in the context of injection molded parts is illustrated in the below figure from page 811 of Rosato, DiMattia, & Rosato, *Designing with Plastics and Composites A Handbook* (1991) (Ex. 1008):

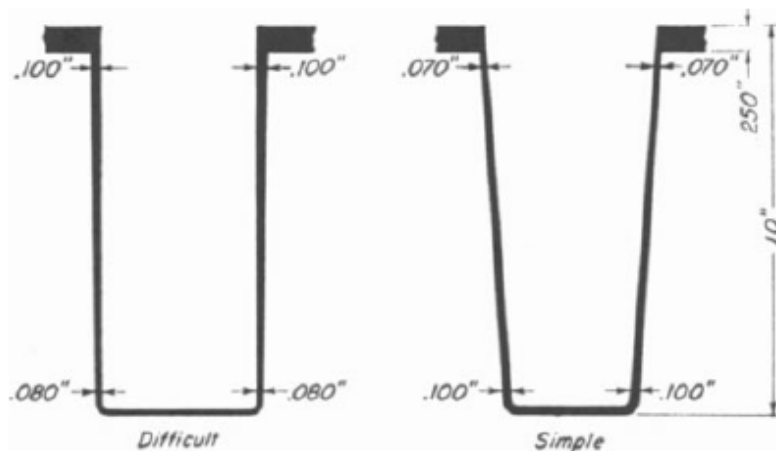


Figure 11-36. An example of designs for long-draw products. The left view has little clearance, but the right side is simplified by the clearance allowed by the walls' taper.

45.) Tapering of a load bearing feature is also a common technique for optimizing the strength of a part. As an example, pillars or support columns often taper from a wider base to a narrower top. The wider base requires a greater moment of inertia because the forces are larger closer to the base. Thus tapering has the advantages both of facilitating mold extraction and increasing the moment of inertia in areas subject to greater forces and more likely to buckle as a result.

46.) These principles are routinely applied in the design of stormwater chambers, which are often corrugated and in many cases include corrugations on the corrugations (sometimes called sub-corrugations). As those skilled in the art will understand, a corrugation creates three planes of surface area in contact with the mold, whereas a flat surface would have only one plane of surface area. Thus, adding corrugations increases the surface area and, thereby the force required to extract a finished product from a mold. By tapering a corrugation down to a termination point, the surface area is reduced (once the corrugation has terminated, the surface is flat) and the tapering required to reach the termination point increases “draft” and, therefore, facilitates release of the mold. In the case of a corrugation or sub-corrugation feature with a radial cross-section, the feature’s surface area would similarly be in full contact with the mold along that feature.

47.) The solution for optimal production and processing would be to taper those corrugation features perpendicular to the three planar surfaces (or along the radius in a conical manner) to allow for separation from the mold surface as soon as the ejection process begins. The tapered feature is generally created in both the core and cavity (male and female) sides of the mold to create a constant wall thickness, which optimizes material content and cooling time because of the avoidance of thicker walls in the feature due to inner and outer walls that are not parallel to each other. Tapering features such as corrugations is a well-known solution to avoid the issues associated with a corrugated plastic part.

V. Understanding of the ‘583 Patent

48.) The ‘583 patent (Ex. 1001) relates to corrugated stormwater chambers. The claims of the ‘583 patent claim a chamber with crest and valley corrugations and sub-

corrugations used to provide additional stiffness and strength to the chamber. Col. 3, l. 63 –

Col. 4, l. 9.

49.) For example, Claim 1 requires a chamber with the following elements:

- opposing side bases
- sidewalls forming an arch-curve
- a chamber top
- alternating crest and valley corrugations running transverse to the length of the chamber and with tapering width
- crest sub-corrugations with tapering height that terminate below the top of the chamber

Claim 5 adds the following additional elements:

- valley sub-corrugations terminating below the top of the chamber

50.) Each of these elements is based upon the principles discussed above and was known in the art at least as early as June 5, 2009, the relevant time frame. In fact, all of these principles were known well before 2009 and have been employed in many products across many applications of the plastic molding industry.

51.) Some of the other dependent claims add further elements relating to specific termination points of the sub-corrugations. For example, claim 6 requires that the valley sub-corrugations terminate above the side bases, thereby requiring that the sub-corrugations do not cover the entire valley corrugations. Claim 8 adds that the crest and valley sub-corrugations overlap when they do not span the entire corrugations. A person of ordinary skill in the art and aware of the engineering principles discussed in the context of plastic injection molding would have recognized the availability and value of arranging the features as claimed. All the added limitations are routine applications of the prior art and commonly known engineering principles recognizable by a person of ordinary skill.

52.) The ‘583 Patent’s specification itself reiterates many of the principles discussed above. For example, in column 9, lines 39-54, the ‘583 patent (Ex. 1001) discusses the well-known principle in the art that use of a sub-corrugation in an area of high stress increases the strength of the chamber, while a sub-corrugation would not be needed, necessarily, along the entire length of the chamber walls. Col. 9, ll. 39-54. Another example is the ‘583 patent’s discussion of tapering principles in columns 10 and 11. Col. 10, l. 66 – Col. 11, l. 11. These concepts are not newly introduced by the ‘583 Patent and were already well known to one of ordinary skill in the art, as discussed above.

VI. Teachings of the Prior Art

A. U.S. Patent No. 8,491,224 to Daniel P. Cobb et al. (Ex. 1002)

53.) Cobb discloses a plastic arch-shaped corrugated chamber having corrugation crests and valleys running transverse to the chamber length. Cobb also discloses crest sub-corrugations on the corrugation crests and valley sub-corrugations on the corrugation valleys. Col. 1, ll. 27-40. Cobb explains the engineering purposes of adding sub-corrugation features, which is to “increase the effective wall properties (area, moment of inertia and section modulus) that in turn increases the chamber wall’s load carrying strength, stiffness and moment strength.” Col. 8, ll. 7-20.

54.) Cobb discloses more than one type of sub-corrugation feature and teaches that alternative sub-corrugation designs can be employed depending on the requirements of a particular design. Cobb teaches that sub-corrugations can include raised portions, recessed portions, or combinations of both. Col. 8, ll. 16-20. Cobb also teaches that gas channels or other features can be included on the crests or in the valleys (as shown in Figure 19). Col. 9, ll. 6-10.

Cobb states that these features provide suitable stability and resistance to buckling, and those of skill in the art understood that this was accomplished without significantly increasing material content and without impacting manufacturing efficiency. Cobb also teaches that the sub-corrugation design should be tuned for a particular design in view of material cost and other factors. Col. 8, ll. 29-34. Based on this disclosure of Cobb, those of skill in the art would understand that the size, shape, and configuration of sub-corrugations can be varied as appropriate for a particular design project. This would include substituting one type of sub-corrugation for another, and tapering or adjusting the sizes of the features for a particular design.

55.) Cobb teaches that the wide, flat areas of the crest and valley corrugations of a chamber are the most likely to buckle under compression strain. Col. 8, ll. 11-16. This is a logical and well-understood principle related to the use of corrugations—it was commonplace to add corrugation or sub-corrugation features in wide, flat areas that were known to be susceptible to buckling. It was well known that wide, flat areas are ideal for corrugations and sub-corrugations because they provide for improved resistance to buckling with minimal additional material required and without affecting manufacturing efficiency.

56.) Cobb also discloses tapering the width of the corrugations and sub-corrugations. “A width of each of the multiplicity of corrugation crests may be greater toward the bottom of the chamber than at a top of the chamber. A width of each crest sub-corrugation feature may be greater toward the bottom of the chamber than at the top of the chamber. A width of each of the multiplicity of corrugation valleys may be less toward the bottom of the chamber than at the top of the chamber. A width of each valley sub-corrugation feature may be less toward the bottom of the chamber than at the top of the chamber.” Cobb, Col. 1, l. 64 – Col. 2, l. 5.

57.) Cobb also discloses tapering the height of the sub-corrugations. Cobb discloses “a general rule the sub-corrugations can be less deep ... as the crest/valley gets more narrow.” Col. 8, ll. 34-38.

58.) Cobb further discloses that the valley sub-corrugation can “gradually fade out” (decreasing both the width and the height of the sub-corrugation). Col. 8, ll. 60-66. One of ordinary skill in the art would recognize that the crest sub-corrugations can “gradually fade out” as well. Figures 12 and 13 also show corrugation features on the end caps, which are depicted to taper in both height and width.

59.) Figure 4, a top view of the chamber, also shows small arch drawing features on the sub-corrugations near the ends of the chamber. These features suggest that the sub-corrugations taper in height at those places, and possibly terminate below the line denoting the chamber’s apex.

60.) Cobb also very specifically describes the concept of varying the height and width of sub-corrugations to optimize material use while increasing the strength and stiffness of the chamber. Col. 8, ll. 29-38. Cobb provides an example of a sub-corrugation that has a height that is less than 10% of the corrugation height at locations above 1/3 of the chamber height. One of ordinary skill in the art would recognize that the sub-corrugation height could be varied at those locations, including at the chamber top. One such variation is the reduction of the sub-corrugation height to zero above a selected elevation. The selected elevation would depend on the structural requirements of the particular chamber. This is particularly true in view of the principles described in column 8, lines 29-38.

61.) I also note that Cobb states that its “description is intended by way of illustration and example only, is not intended to be taken by way of limitation, and that other changes and

modifications are possible.” Col. 11, ll. 22-27. This language, in view of the various teachings of Cobb, would motivate one of ordinary skill to alter the design disclosed to optimize for specific uses and applications when needed.

B. U.S. Patent No. 4,360,042 to James L. Fouss et al. (Ex. 1003)

62.) Fouss describes an arched chamber with crest corrugations, valley corrugations, and crest sub-corrugations. Col. 2, ll. 26-33, 39-42. Fouss discloses that the sub-corrugations “further increase the strength” of the chamber and that the disclosed “new and improved conduit construction is stronger, yet requires less material to manufacture,” highlighting the improved strength while optimizing material costs. Col. 1, ll. 45-52; Col. 2, ll. 43-47. As depicted in the figures, all of the corrugations and crest-sub-corrugations disclosed in Fouss terminate below the top of the chamber. Figs. 1, 3, 6. Fouss describes that this feature improves the portability of the chamber by permitting the chamber to be folded along its top. Col. 2, ll. 34-38; Fig. 6.

63.) Fouss also discusses the principle that the moment of inertia has a relationship to the strength and stiffness of the part. Col. 4, l. 60-Col. 5, l. 13. One of ordinary skill in the art reviewing this portion of Fouss would recognize that the relationship of the moment of inertia is dependent on the position of the arch and associated bending stress, which helps to define the corrugation configuration of a part.

64.) As can be seen in Figure 3 and related Figures 4 and 5, the height of the corrugations can taper as needed for strength and stiffness purposes. These figures illustrate the well-known principle that use of corrugations and/or sub-corrugations strengthens a corrugated plastic design, and that the height of corrugation and sub-corrugation features can be altered to deal with varying forces along the arch of a chamber. For example, the corrugations can have

greater height at sections subject to greater forces, as illustrated in Figure 5, and have lesser height (or no height at all) at sections subject to lesser forces, as illustrated in Figure 4.

65.) Fouss also depicts a chamber with no corrugations or sub-corrugations at all at the top of the chamber, demonstrating that corrugations may be terminated where not needed along a chamber's arch-curve. Fouss's specification provides that the corrugations are terminated at the top to permit folding, but the design retains its stiffness because the corrugations are not needed at the top where there are less substantial forces. Col 2, ll. 43-52. Fouss also shows that those of ordinary skill in the art recognized that improved manufacturability and optimized material content in the chamber could be achieved if the corrugations and sub corrugations were terminated below the top of the chamber, provided that the necessary design strength and stiffness for chamber performance is maintained.

66.) I also note that the examiner of the '583 patent cited Fouss for disclosure of the element of the '583 patent claims that the crest sub-corrugations terminate below the top. Based on the file history, it does not appear that the applicant contradicted the examiner's position on this claim element.

C. Ellis Patent (Ex. 1004)

67.) Ellis discloses further principles of strengthening plastic molded parts. In this case, the patent claims plastic bottles. Ellis discloses the use of discontinuous, overlapping corrugations around the circumference of the bottle for "increased strength and rigidity" of the container structure. Col. 2, ll. 42-54. The use of discontinuous overlapping corrugations "advantageously forms longitudinal stress paths to facilitate load compensation that increases axial stiffness and top-load strength." Col. 2, ll. 49-51. This configuration of corrugations

increases the “geometric strength and resistance to the deflection of side wall 14.” (Col. 5, ll. 59-61).

68.) Ellis further discloses the principle that discontinuous corrugations can be as effective as continuous corrugations at increasing the strength of the design. Col. 5, ll. 8-25, 34-45. As discussed, those familiar with the applicable principles will recognize that corrugations and sub-corrugations may not be necessary or even useful in certain areas where load forces don’t require them. These same principles are also illustrated in Cobb (Ex. 1002) and Fouss (Ex. 1003), as discussed above.

69.) Ellis also highlights the fact that the use of corrugations was a known technique for strengthening a plastic part without substantial increases in material cost or manufacturing cost. (Col. 2, ll. 51-54).

70.) Ellis specifically notes that its teachings can apply to other applications, “such as piping, columns or cylinders, paper/plastic cups and packaging material, which require added strength and rigidity in axial and/or sidewall deflection without the added requirements of additional panel wall thickness.” Col. 4, ll. 13-18. Ellis teaches that the corrugations can be added to any wall member that “requires additional deflective and/or axial rigidity.” (Col. 7, ll. 26-29). Ellis discusses application of its teachings to plastic containers that are subject to internal vacuum forces during filling or external side loads from a handler’s grip or from labeling operations. (Col. 1, ll. 33-36, 52-55). While such forces might be lower in intensity than the forces that an underground drainage chamber is subjected to, dealing with the forces requires the same engineering considerations and reliance on the same design principles. This is confirmed by the fact that Ellis deals with the forces in the same way as Cobb, Fouss, Smith, and Nichols: adding corrugations to improve strength against sidewall deflection while minimizing added

material. Those skilled in the art would recognize the applications of the principles of Ellis to, for example, underground pipes and chambers.

D. Smith Patent (Ex. 1006)

71.) U.S. Patent No. 7,306,399 to Smith relates to underground stormwater drainage chambers. Col. 1, ll. 16-19. Smith teaches to use corrugations to improve the strength of the chamber, but also to taper the width of the corrugations with increasing elevation from the base of the chamber. Col. 1, ll. 55-67. Smith teaches that the width variation improves the ability of the chamber to nest with other chambers for shipping purposes (col. 1, ll. 55-57), but it was also known that this width variation would improve the draft of the chamber for easier ejection of the part from a mold.

E. Nichols Patent (Ex. 1005)

72.) U.S. Patent No. 4,759,661 to Nichols et al. relates to plastic underground drainage chambers that have an arch shape and corrugations. (Col. 3, ll. 1-8). The corrugations are tapered to improve nesting of the chambers. (Col. 3, ll. 3-6). Again, this tapering of the corrugations was known to improve the draft of the chamber for easier ejection of the part from a mold.

VII. Comparison of the '583 Patent Claims to the Prior Art

A. Claim Limitations Disclosed by Cobb (Ex. 1002)

1. Claim 1

73.) Each limitation of the '583 Patent's Claim 1, requiring opposing side bases, a chamber top, and sidewalls extending from the bases to the top forming an arch curve, is shown by Cobb. In Figure 2, opposing side bases are labeled as 22 and 24. There is a line across the apex of the chamber that appears to indicate the top and sidewalls extend from the bases to the

chamber top to form an arch curve. Cobb also discusses “a plastic arch-shaped corrugated chamber” (Col. 1, l. 28) and “foot portions of the chamber” (Col. 2, ll. 38-47) which I interpret as opposing side bases.

74.) The further limitations of the ‘583 Patent’s Claim 1, requiring alternating crest and valley corrugations running transverse to the chamber length along the arch curve and wherein the crest corrugations decrease in width with increasing elevation and the valley corrugations increase in width with increasing elevation, are also shown in Cobb. Figure 19 and 20 show the alternating crest and valley corrugations (100, 102) running along the sidewalls. Figure 19 shows a cross-sectional profile of those corrugation features. Figure 20 depicts transition heights (H_{TC} , H_{TV}) below which the width of the crest corrugations tapers out, increasing, and the width of the valley corrugations tapers in, decreasing. As discussed at length above, the tapering principle is well known in the plastics molding industry as a means of facilitating part removal from a mold. Cobb also discusses its alternating crest and valley corrugations with tapering width in columns 1 and 2. Cobb states “A width of each of the multiplicity of corrugation crests may be greater toward the bottom of the chamber than at a top of the chamber. . . . [and] A width of each of the multiplicity of corrugation valleys may be less towards the bottom of the chamber than at the top of the chamber.” Col. 1, l. 64 – Col. 2, l. 3. Thus, Cobb discloses that the widest, flattest areas of the crest corrugations are below the H_{TC} line, while the widest, flattest areas of the valley corrugations are above the H_{TV} line. Figure 3.

75.) The remaining limitations in Claim 1 relate to crest sub-corrugations. The ‘583 Patent claims crest sub-corrugations running upwardly from the opposing side bases along a portion of the arch curve of crest corrugations, the crest sub-corrugations having a height less than the local height of the crest corrugations associated with it, the crest sub-corrugations

terminating at an elevation lower than the top of the chamber, and the crest sub-corrugations having a tapering height that diminishes with increasing elevation.

76.) Cobb states that “Each one of a multiplicity of the corrugation crests includes a respective crest sub-corrugation feature thereon.” Col. 1, ll. 32-34. Figures 1-4 depict crest sub-corrugations, and Figures 19 and 20 label them as 106. Figure 19 shows that the height (H_{SCC}) of the crest sub-corrugation feature (106) is less than the crest corrugation (100) height. Cobb also discusses the crest sub-corrugation height as no greater than 10% of the crest corrugation height, although this number is merely a description of the product and the 10% figure is arbitrary and would be subject to change by a person of ordinary skill in the art. Col. 8, ll. 39-45.

77.) Cobb also discusses crest sub-corrugations having a tapering height that decreases as elevation increases. Figure 20 shows the crest sub-corrugation feature (106) diminishing in width from the base to the H_{TC} line. Cobb also discusses that the height diminishes with increasing elevation as well. Cobb states “The height, thickness and width of the sub-corrugation features may be established so that the sub-corrugations are stiff enough (e.g. high enough moment of inertia about their horizontal axis) to keep as much of the reaming of the corrugation crest/valley stable in local buckling as practicable when considered in view of added material cost, etc. For a substantially fixed sidewall thickness, as a general rule **the sub-corrugations can be less deep** (shorter height H_{SCC} or H_{SCV}) **as the crest/valley gets more narrow**. The sub-corrugations could also stay the same depth and get more narrow.” Col. 8, ll. 29-38 (emphasis added). The crest corrugations get more narrow with increasing elevation which means the crest sub-corrugations will get less deep with increasing elevation. One of ordinary skill in the art would recognize this disclosure and apply the tapering principles

discussed above, especially in view of the desire to optimize processability and material utilization.

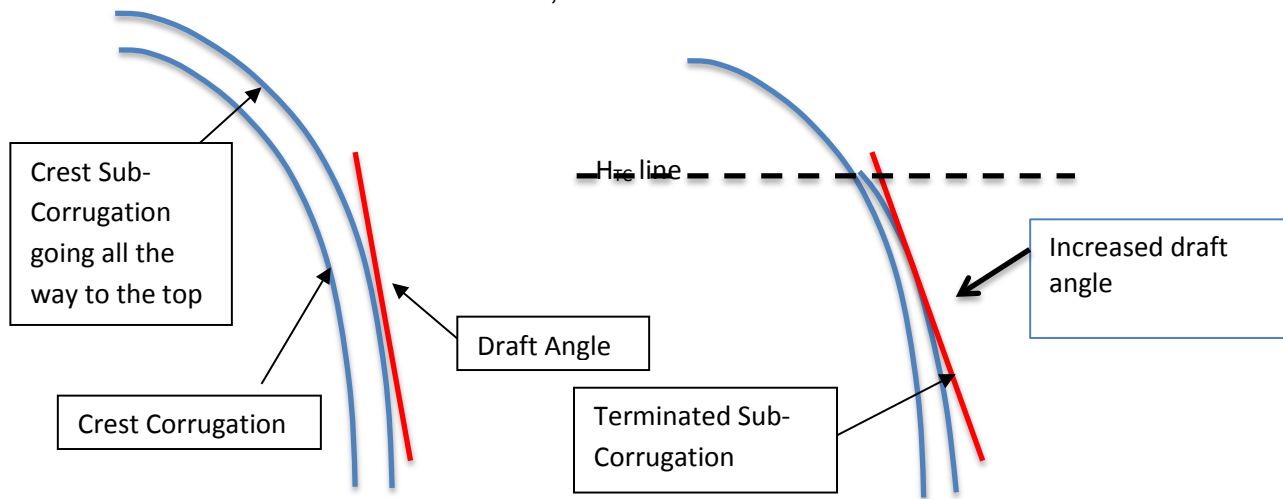
78.) This leaves only the limitation of Claim 1 that the crest sub-corrugations terminate below the chamber top. While I believe that Cobb can be interpreted as disclosing this limitation, at the very least Cobb suggests it. In column 8, Cobb discusses the crest sub-corrugations having tapering height. Col. 8, ll. 35-37. Column 8 also describes, as an example, a chamber wherein the crest sub-corrugation has a height less than 10% of that of the corrugation along “portions” above an elevation of 1/3 the height of the chamber. Col. 8, ll. 39-49. One of ordinary skill reading this disclosure in view of figure 20 would recognize that the example indicates a crest sub-corrugation height of 10% above the H_{TC} line. It would require only an ordinary level of creativity to envision a variation on the example provided in column 8 wherein the height of the crest sub-corrugation tapers down to nothing at the H_{TC} elevation. Thereby, the crest sub-corrugation would run along only a portion of the crest corrugation and terminate below the chamber top, as required in Claim 1. A person of ordinary skill would be further motivated to make such an alteration by the language later in column 8 referring to valley sub-corrugations that “gradually fade out” in both width and height. Col. 8, ll. 56-66. One of ordinary skill in the art would recognize that the crest sub-corrugations can “gradually fade out” as well, and configure the design of sub corrugations to minimize the height as much as practical to optimize processability, material utilization, and nesting characteristics.

79.) Furthermore, Figure 4 appears to show several crest sub-corrugations running along only a portion of the crest and terminating below the chamber top. The crest sub-corrugations near the ends of the chamber depicted have two arch lines as they track toward the chamber top. One of ordinary skill in the art could interpret those lines as indicating tapering

height of those crest sub-corrugations. While it is unclear, it very well may be that the crest sub-corrugations have tapered down to nothing by the second of those arched lines, showing crest sub-corrugations which terminate below the chamber top. At the very least, these lines would have motivated one of skill in the art to consider such a design choice, especially when considering the other teachings of Cobb and the engineering principles well known in the industry.

80.) In any event, I see very simple reasons why someone would have modified the crest sub-corrugations of Cobb to terminate below the chamber top. A person of ordinary skill in the art, reading Cobb, would understand that sub-corrugations are most useful in the wide flat areas of the corrugations. The widest parts of the crest corrugations of the chamber of Cobb are below the H_{TC} line, as shown in Figure 19 and also in Figure 3. Cobb also would remind a person of ordinary skill in the art that the widest parts of the crest corrugations (i.e., the parts below the H_{TC} line) are the most susceptible to buckling.

81.) A person of ordinary skill in the art also understood at that time that tapering the sub-corrugations to termination at, for example, the H_{TC} line would reduce material costs and improve the draft of the chamber for better mold release. Cobb in fact teaches to adjust sub-corrugation design in view of material costs. Terminating the crest sub-corrugation at the H_{TC} line also would have reduced surface area and increased the draft angle to facilitate removal of the chamber from the mold, and thus make the chamber easier to manufacture. This is illustrated in the schematic drawing below:



82.) A chamber having the profile on the right would require a lower force to remove it from the mold than a chamber having the profile on the left, in which the sub-corrugation extends along the entire arch of the chamber.

83.) Thus, modifying the Cobb chamber in this manner would have required no more than using the familiar technique of tapering to conserve material cost and chamber weight, while improving manufacturability, and while employing strengthening features in the part of the crest corrugation that is most in need of reinforcement. This modification was well within the abilities of one of ordinary skill in the art—in fact, adjustments in the size, shape, and type of sub-corrugations used in a design would have been considered routine. Furthermore, one of ordinary skill in the art would have expected this modification to work, given Cobb's teaching that the widest areas of the crest corrugations are the best candidates for the addition of sub-corrugations.

84.) Ellis and Fouss each provide further evidence that this modification would have been routine. Ellis shows that it was known to use terminated corrugations for strengthening purposes, while minimizing additional material cost and part weight. Fouss shows that it was

known to use sub-corrugations that terminated below the chamber top in an underground drainage chamber. Both of these references show that one of ordinary skill in the art would not have been surprised that a chamber according to Cobb with crest sub-corrugations that terminate below the chamber top would work for its intended purpose. In my opinion, it would have been obvious to modify the chamber of Cobb so that the crest sub-corrugations terminate below the chamber top.

2. *Claim 2*

85.) Claim 2 of the '583 Patent incorporates Claim 1 and adds the requirement that the sub-corrugations have tapering width that diminishes with increasing elevation. Cobb discloses this limitation in Figure 20, which depicts a crest sub-corrugation feature (106) with diminishing width from the base at least up to the H_{TC} line. Cobb also discusses tapering width of crest sub-corrugations both in columns 1 and 2 and in column 8. Col. 1, l. 66 – Col. 2, l. 1; Col. 8, ll. 34-38. Those of ordinary skill in the art would know to configure the design of sub-corrugations to minimize the height as much as practical to optimize processability, material utilization, and nesting characteristics.

3. *Claim 3*

86.) Claim 3 of the '583 Patent incorporates Claim 1 and adds the requirement that the crest sub-corrugations extend about one quarter to two-thirds of a height of the chamber. As discussed above with respect to claim 1, my opinion is that there were strong motivations to modify the chamber of Cobb so that the crest sub-corrugations terminate at the H_{TC} line. Figure 20 shows that the H_{TC} line is approximately two-thirds of the height of the chamber. Thus, for the same reasons discussed above, there were strong motivations to terminate the crest sub-corrugation between about one quarter to two-thirds of the height of the chamber. Also as

discussed above, those of ordinary skill in the art would have expected this modification to work. In my opinion, it would have been obvious to terminate the crest sub-corrugations between about one quarter to two-thirds of the height of the chamber.

4. *Claim 4*

87.) Claim 4 of the '583 Patent incorporates Claim 1 and adds the requirement that the maximum width of each crest sub-corrugations is no more than one-third of a local width of the associated crest corrugation. Cobb shows crest sub-corrugations and crest corrugations in cross-section in Figure 19. The width of the sub-corrugation 106 appears to be close to one-third of the width of the corrugation. In any event, I believe the claimed relationship between corrugation and sub-corrugation width is arbitrary and would have been obvious, as I am aware of no particular or unexpected benefits that do or could result from this specific feature.

5. *Claim 5*

88.) Claim 5 incorporates Claim 1 and adds valley sub-corrugations. Claim 5 requires the valley sub-corrugations to run down from the chamber top along “part or all” of the valley corrugations, to have a height less than the valley’s depth, and to terminate below the top of the chamber. Cobb discloses valley sub-corrugations in the Figures and throughout the specification. Figure 20 labels the valley sub-corrugation 108. Column 1 states “Each one of a multiplicity of the corrugation valleys may include a valley sub-corrugation feature thereon.” Col. 1, ll. 35-36. Column 8 discusses valley sub-corrugations with a height less than 10% of the depth of the valley, as an example. Col. 8, ll. 50-56. The valley sub-corrugation feature depicted in Figure 19 also has a height (H_{scv}) less than the valley depth.

89.) Cobb also discloses a valley sub-corrugation that runs along part or all of the valley corrugation. In Figure 20, the valley sub-corrugation runs all the way from the top to the

side bases, covering the whole valley sub-corrugation. In column 8, Cobb discloses an example where the valley sub-corrugation gradually fades out to nothing as it moves downwardly toward the side base. Col. 8, ll. 56-66. A possible and reasonable interpretation of this portion of Cobb is that the valley sub-corrugations taper in height and width to the point that they fade out entirely. Col. 8, ll. 56-66. One of ordinary skill in the art could interpret this to disclose a sub-corrugation feature that runs along only part of the valley corrugation.

90.) Cobb also discloses valley sub-corrugations that terminate below the chamber top for the same reasons. The valley sub-corrugations in Figure 20 terminate at the opposing side bases, which are at an elevation lower than the top of the chamber. And Cobb discusses a design alteration wherein the valley sub-corrugations fade out, which would create a termination elevation somewhere below the chamber top as well. Col. 8, ll. 56-66.

6. *Claim 6*

91.) Claim 6 incorporates Claim 5 and adds the requirement that the valley sub-corrugations terminate above the opposing side bases. As already discussed, one reasonable interpretation of Cobb is that it discloses valley sub-corrugations terminating above the side bases. Cobb talks about valley sub-corrugations that “gradually fade out when moving downward along the chamber sidewall” due to tapering height and width. Col. 8, ll. 56-66.

92.) Additionally, there were strong motivations for those of ordinary skill in the art to modify the valley sub-corrugations to terminate above the side bases. As discussed above, Cobb teaches to use sub-corrugations in the widest, flattest parts of the corrugations. Cobb’s valley corrugations are widest at the top of the chamber, and become narrower below the H_{TV} line. Those of ordinary skill in the art would have understood that the portions below the H_{TV} line were least likely to need the additional strength of a sub-corrugation. A clear motivation to try

fading out and terminating the valley sub-corrugations below the H_{TV} line would have been to reduce material cost and chamber weight by removing the valley sub-corrugations where they were least useful. This type of modification would have been, again, a routine matter of optimizing the overall performance and cost of the design.

93.) Thus, those skilled in the art could interpret Cobb to disclose that the valley sub-corrugations terminates above the side bases or, at the very least, would recognize the possibility of a design with valley sub-corrugations terminating above the side bases. In my opinion, it would have been obvious to terminate the valley sub-corrugations above the chamber side bases.

94.) Ellis provides additional evidence that the features of claim 6 would have been within the grasp of those of ordinary skill in the art. Terminating the valley sub-corrugations above the side bases would have likely resulted in a staggered, overlapping relationship between the valley sub-corrugations and the crest sub-corrugations. Ellis shows that this arrangement was well known.

7. Claim 7

95.) Claim 7 incorporates Claim 6 and requires that the valley sub-corrugations taper and diminish in both height and width as they run down the chamber walls. This is disclosed in Cobb in column 8 which states “the valley sub-corrugation feature may remain relatively uniform when moving from the top of the chamber downward in elevation until a transition height H_{TV} is reached, at which elevation the sub-corrugation feature 108 begins to gradually fade out (e.g. width (relative to side elevation view, where width of the sub-corrugation is measured in the lengthwise axis of direction of the chamber) of the feature decreases and cross-sectional height of the feature decreases) when moving further downward along the chamber sidewall.” Col. 8, ll. 56-66. Cobb further discloses a variation wherein the tapering occurs

“constantly with elevation.” Col. 9, ll. 27-30.

8. *Claim 8*

96.) Claim 8 of the ‘583 Patent incorporates Claim 5 and requires the valley sub-corrugations to terminate at a point on each opposing side above the opposing side bases and requires the crest sub-corrugations to run up from the opposing side bases and terminate at an elevation higher than the valley sub-corrugations’ termination points. As discussed above, modifying the crest sub-corrugations to terminate below the chamber top at, for example, the H_{TC} line, and modifying the valley sub-corrugations to terminate above the side bases and below, for example, the H_{TV} line were matters of routine design optimization. The result of this routine optimization would have been the elements of claim 8.

97.) Additionally, the arrangement of the termination elevations of the respective crest and valley sub-corrugations required in this claim is simply an application of the well understood principle that overlapping the corrugations increases the strength of the design. Essentially this claim language requires that the crest and valley sub-corrugations overlap to some extent along the sidewalls. It was commonly understood to avoid a design with areas of unreinforced sidewalls, as such areas were known to be susceptible to failure. Ellis shows that the principle of using staggered, overlapping sets of discontinuous corrugations was well known to plastic part designers. This technique simply ensures no weak area is created between the termination elevations, as a person of ordinary skill would no doubt recognize and apply the same principle.

98.) Nothing in Claim 8 requires any innovation beyond an understanding of well-known principles in the plastics molding industry. In my opinion, the claimed relationship between valley and crest sub-corrugations would have been obvious.

9. *Claim 9*

99.) Claim 9 is dependent on claim 5 and adds the limitation that a maximum width of each valley sub-corrugation is no more than one-third of a local width of the associated valley corrugation. The width of the valley sub-corrugation 108 shown in cross section in Figure 19 of Cobb appears to be close to one-third of the width of the valley corrugation. In any event, I believe the claimed relationship between corrugation and sub-corrugation width is arbitrary and would have been obvious, as I am aware of no particular or unexpected benefits that do or could result from this specific feature.

10. Claim 10

100.) Claim 10 requires the valley sub-corrugations to have lower termination ends on the sidewalls of the chamber, the crest sub-corrugations to have upper termination ends on the sidewalls of the chamber, and that the crest sub-corrugation upper termination ends are higher in elevation than the valley sub-corrugation termination ends. This arrangement appears to be essentially the same as that claimed in claim 8. Accordingly, my opinions stated above with respect to claim 8 apply also to this claim.

11. Claim 11

101.) Claim 11 depends on claim 1 and recites a first plurality and a second plurality of valley sub-corrugations. The first plurality of valley sub-corrugations runs downwardly from the top of the chamber along part or all of a valley corrugation and terminates at terminal ends above the elevation of the opposing side bases. The second plurality of valley sub-corrugations runs along a valley corrugation upwardly from an opposing side base in the direction of said terminal ends of the first plurality of valley sub-corrugations.

102.) In my opinion, altering the valley sub-corrugation design of Cobb so that one set ran down from the top of the chamber and a second set ran up from the side bases would also

have been a routine design choice. Cobb states that sub-corrugations could comprise “one or more raised portions and/or one or more recessed portions.” Col. 8, ll. 18-20. This would have been understood to include one or more raised sub-corrugations in series along the valley corrugation.

103.) Further, Ellis shows that using discontinuous sets of corrugations was a known technique for strengthening plastic molded parts. Those of ordinary skill in the art would have reasonably expected such sets of sub-corrugations to work in the chamber of Cobb. In my opinion, the claimed sets of valley sub-corrugations would have been an obvious modification.

12. Claim 12

104.) Claim 12 depends on claim 1 and recites a plurality of valley sub-corrugations running downwardly from the top of the chamber and having a width that is constant. Figure 20 of Cobb shows valley sub-corrugations with a constant width from the top of the chamber to the H_{TV} line. In my opinion, terminating the valley sub-corrugations at that line would have been a routine modification. It would be entirely within the ability of one of ordinary skill in the art to retain the constant width of the feature to that termination point.

105.) Additionally, there are a number of reasons why one would have designed a chamber with valley sub-corrugations having a constant width. First, those of ordinary skill in the art would know that the mold required to make such a chamber would be easier to fabricate than a mold for a chamber with tapering valley sub-corrugations. Second, a chamber with constant width valley sub-corrugations would have been expected to separate more uniformly from its mold as compared to a chamber with multiple and/or varying angles. In my opinion, it would have been obvious to employ constant width valley sub-corrugations in the chamber of Cobb.

13. Claim 13

106.) Claim 13 incorporates Claim 1 and adds valley sub-corrugations with tapering height that diminishes with elevation. As pointed out above, Cobb discloses valley sub-corrugations with tapering height. To reiterate, Cobb states “as a general rule the sub-corrugations can be less deep . . . as the crest/valley gets more narrow” (Col. 8, ll. 35-37) and states “cross-sectional height of the feature decreases when moving further downward along the chamber sidewall.” Col. 8, ll. 64-66. These sections of Cobb disclose valley sub-corrugations with tapering height that diminishes with elevation.

14. Claim 14

107.) Claim 14 includes many of the limitations discussed above with respect to Claim 1, but alters the language slightly. The elements recited in Claim 14 that are not also recited in Claim 1 are also disclosed by Cobb. Claim 14 recites flanges associated with the opposing side bases. In Figure 2, Cobb illustrates opposing side bases 22 and 24 with flanges extending outwardly.

108.) Claim 14 also recites limitations requiring a second plurality of sub-corrugations running in valley corrugations at the top of the chamber and downwardly toward the opposing side bases. This “second plurality of sub-corrugations” is equivalent to the valley sub-corrugations claimed in the claims above and is disclosed in Cobb. Claim 14 requires the second plurality of sub-corrugations to run downwardly to an elevation which is less than the elevation of the termination points of the first plurality of sub-corrugations. This limitation is very similar to others discussed above and is disclosed in Cobb.

109.) In Figure 20, Cobb discloses valley sub-corrugation that run all the way from the top to terminate at the opposing side bases. The opposing side bases are below any termination

points of the crest sub-corrugations, thus disclosing “a second plurality of sub-corrugations” terminating at an elevation below the termination points of “a first plurality of sub-corrugations.”

110.) In column 8, Cobb also discloses an example where the valley sub-corrugations gradually fade out to nothing as they move downwardly toward the side base. Col. 8, ll. 56-66. Cobb describes valley sub-corrugations tapering in height and width to the point that they fade out entirely. Col. 8, ll. 56-66. One of ordinary skill in the art may interpret this to disclose a sub-corrugation feature that terminates above the opposing side bases. In that instance, it would be obvious to a person of ordinary skill in the art to employ a design wherein the valley sub-corrugations terminate at an elevation below the termination of the crest sub-corrugations. Doing so would ensure that no weak area is created in a gap between the termination elevations of the respective crest and valley sub-corrugations. Essentially, this claim language requires that the crest and valley sub-corrugations overlap to some extent along the sidewalls, employing the well understood principle that overlapping the corrugations increases the strength of the design. One of ordinary skill in the art would no doubt recognize the application of that principle to this particular arrangement of features.

15. Claim 15

111.) Claim 15 incorporates Claim 14 and requires tapering of both the width and depth of each sub-corrugation along part or all of the associated crest and valley corrugations. Cobb discloses crest and valley sub-corrugations with tapering height and/or width. Both columns 2 and 8 of the Cobb specification disclose crest sub-corrugations with greater width towards the bottom of the chamber than towards the top. Col. 2, ll. 23-27; Col. 8, ll. 34-38. Column 8 also discloses that the “sub-corrugations can be less deep . . . as the crest/valley gets more narrow.” Col. 8, ll. 34-38. In Cobb, the crest corrugations get more narrow with increasing elevation and

the valley corrugations get more narrow with decreasing elevation, as shown in Figure 20 below.

Figure 20 also shows crest sub-corrugation width decreasing with increasing elevation. And

Figure 20 depicts valley sub-corrugations (108) with diminishing width as they get closer to the

base. Finally, column 8 describes an embodiment wherein both height and width diminish (e.g.

“gradually fade out”) as the valley sub corrugations approach the opposing side bases. Col. 8, ll.

35-38, 50-66. One of ordinary skill in the art would recognize that the crest sub-corrugations can

“gradually fade out” as well. Claim 15 is disclosed by Cobb.

16. Claim 16

112.) Claim 16 incorporates Claim 14 and requires the elevations of the termination points of the first plurality of sub-corrugations (crest sub-corrugations) to be the same. It is common practice in the plastics molding industry to design components of a consistent height or elevation, for purposes including: part extraction from molds, creation of a symmetric product that is easier to stack, and simpler tooling construction. This practice is reflected in numerous publications spanning many applications of plastic molding and would have been routine and obvious to a person of ordinary skill in the art. A chamber having consistent termination points for the crest sub-corrugations would also exhibit consistent load distribution. Cobb reflects this principle, as uniformity is displayed across the crest and valley corrugations and sub-corrugations in each of the figures. The crest sub-corrugations of Cobb all terminate at the same point.

17. Claim 17

113.) Claim 17 incorporates Claim 14 and adds the requirement that a width of the second plurality of sub-corrugations (i.e., valley sub-corrugations) running in a valley corrugation is constant. This is the same feature claimed in claim 12, and I incorporate my

opinions with respect to that claim here.

18. Claim 18

114.) Claim 18 incorporates Claim 14 and adds the requirement that each of the second plurality of sub-corrugations (valley sub-corrugations) to have tapering height which diminishes with decreasing elevation as they approach the side bases. Again, Cobb discloses valley sub-corrugations with tapering height. To reiterate, Cobb states “as a general rule the sub-corrugations can be less deep . . . as the crest/valley gets more narrow” (Col. 8, ll. 35-37) and states “cross-sectional height of the feature decreases when moving further downward along the chamber sidewall.” Col. 8, ll. 64-66. These sections of Cobb disclose “a second plurality of sub-corrugations” with tapering height that diminishes with elevation.

19. Claim 19

115.) Independent Claim 19 recites most of the claim elements of Claim 1, but adds the element of claim 3 that the crest sub-corrugations extend about one quarter to two-thirds of a height of the chamber. I incorporate my opinions discussed above with respect to this feature here.

20. Claim 20

116.) Independent Claim 20 also recites most of the claim elements of Claim 1, but adds the element that a maximum width of each crest sub-corrugation is no more than one-third of a local width of the associated crest corrugation. This additional feature is the same as recited in claim 4. I incorporate my opinions discussed above with respect to this feature here.

21. Claim 21

117.) Claim 21 recites most of the claim elements of Claim 1, but adds limitations for valley sub-corrugations as required in Claim 5. Claim 21 requires the valley sub-corrugations to

run down from the chamber top along “part or all” of the valley corrugations, to have a height less than the valley’s depth, and to terminate below the top of the chamber. Cobb discloses valley sub-corrugations in the figures and throughout the specification. Figure 20 labels the valley sub-corrugation 108. Column 1 states “Each one of a multiplicity of the corrugation valleys may include a valley sub-corrugation feature thereon.” Col. 1, ll. 35-36. Column 8 discusses valley sub-corrugations with a height less than 10% of the depth of the valley, as an example. Col. 8, ll. 50-56. The valley sub-corrugation feature depicted in Figure 19 also has a height (H_{scv}) less than the valley depth.

118.) Cobb also discloses a valley sub-corrugation that runs along part or all of the valley corrugation. In Figure 20, the valley sub-corrugation runs all the way from the top to the side bases, covering the whole valley sub-corrugation. In column 8, Cobb discloses an example where the valley sub-corrugation gradually fades out to nothing as it moves downwardly toward the side base. Col. 8, ll. 56-66. Cobb describes valley sub-corrugations tapering in height and width to the point that they fade out entirely. Col. 8, ll. 56-66. One of ordinary skill in the art would interpret this to disclose a sub-corrugation feature that runs along part of the valley corrugation.

119.) Cobb also discloses valley sub-corrugations that terminate below the chamber top for the same reasons. The valley sub-corrugations in Figure 20 terminate at the opposing side bases, which are at an elevation lower than the top of the chamber. And Cobb discusses a design alteration wherein the valley sub-corrugations fade out, which would create a termination elevation somewhere below the chamber top as well.

B. Claim Limitations Obvious in View of Cobb and Fouss

120.) One limitation of the '583 patent in claim 1 is that the crest sub-corrugations terminate below the top of the chamber. This limitation is found in claim 1, and repeated in claims 14, 19, 20, and 21.

121.) Fouss shows a stormwater chamber with corrugations and sub-corrugations that terminate below the top of the chamber. The primary purpose of this feature in Fouss is to permit the chamber to fold for ease of storage and transportation. Col. 2, ll. 49-52. Fouss also notes, however, that the chamber remains sufficiently strong without corrugation or sub-corrugation features at the top and that terminating the features below the top saves on material costs. Col. 2, ll. 44-48. Fouss shows that those of ordinary skill in the art could expect an underground drainage chamber to work even if crest sub-corrugation features were terminated below the top of the chamber.

122.) My assessment of Fouss is supported by the file history of the '583 Patent at the patent office. The examiner cited to Fouss in rejecting the application and specifically stated that Fouss disclosed many of the claim limitations including crest sub-corrugations terminating at an elevation below the top of the chamber.

123.) It would be obvious to combine the teachings of Cobb and Fouss to arrive at the claimed invention with the specific limitations discussed above.

C. Rationale for Combining Cobb and Fouss

124.) A person of ordinary skill in the art would have been motivated to combine Cobb and Fouss for several reasons. First, both Cobb and Fouss disclose arch-shaped stormwater chambers comprised of molded plastic. Cobb, Col. 1, ll. 13-16; Fouss, Col. 1, ll. 10-12. Both present designs and an arrangement of features intended to improve the chambers' strength and stiffness under load forces. Cobb, Col. 1, ll. 20-24; Fouss, Col. 2, ll. 44-48.

125.) Cobb notes “It is to be clearly understood that the above description is intended by way of illustration and example only, is not intended to be taken by way of limitation, and that other changes and modifications are possible.” Col. 11, ll. 22-25. This would motivate a person of ordinary skill in the art to alter Cobb’s design where the engineering principles would permit or require for specific applications.

126.) Fouss notes that its “conduit construction is stronger, yet requires less material to manufacture.” Col. 2, ll. 44-48. A person of ordinary skill motivated by saving on material costs and improving draft of the design would recognize that the chamber of Cobb could be altered with the teachings of Fouss to terminate the crest sub-corrugations below the chamber top. A person of ordinary skill would also recognize that doing so would not weaken Cobb’s design, as understood by Fouss’s teachings and the commonly known principles in the plastics molding industry. Fouss also teaches that an advantage of terminating the corrugations below the chamber top is improved portability of the chamber. A person of ordinary skill in the art seeking to improve the portability of a chamber disclosed by Cobb could modify it according to Fouss so that the corrugations terminated below the chamber top. The resulting chamber would accomplish the objectives of the designing engineer and would match the claims of the ‘583 Patent.

D. Claim Limitations Obvious in View of Cobb and Ellis

127.) The combination of Cobb and Ellis makes several of the ‘583 Patent’s claim limitations obvious. Ellis’s teachings on the use of discontinuous corrugations and overlapping corrugations disclose limitations in the ‘583 Patent’s claims relating to termination points of the crest and valley sub-corrugations and placement of the sub-corrugations along “parts” or “portions” of the associated corrugations.

128.) For example, Claim 1 claims crest sub-corrugations that run “along a portion” of the crest corrugation. Similarly, Claim 5 claims valley sub-corrugations running along “part or all” of the valley corrugation. Ellis shows a bottle with corrugations running around portions of the circumference of the bottle, applying the principle known by those of ordinary skill that “improved strength and rigidity” can be achieved using discontinuous corrugations. Col. 2, ll. 42-54; Col. 5, ll. 8-25, 34-45.

129.) Ellis also discusses the principle that overlapping discontinuous corrugations over a cross-sectional axis helps to ensure no weakened area is created. These teachings are well known by those of ordinary skill in the plastics molding industry and apply to applications other than plastic bottles, including underground plastic tubing and stormwater chambers. Thus Ellis discloses the limitations present in many of the ‘583 Patent’s claims requiring crest and valley sub-corrugations to overlap when they are discontinuous. Such limitations are required in Claims 8, 10, and 14 of the ‘583 Patent, for example. Similar teachings are also present in Serkes and are well known by those of ordinary skill in the art.

130.) Ellis shows that it was known in the art that selective termination of corrugations could be used to strengthen curved plastic parts (including chambers) against sidewall deflection while conserving material costs.

E. Rationale for Combining Cobb and Ellis

131.) A person of ordinary skill in the art would have been motivated to combine Cobb and Ellis because both involve applying principles of plastic molding to improve strength and rigidity of the designs. Cobb, Col. 1, ll. 20-24; Ellis, Col. 2, ll. 42-44. Specifically, both provide for the use of corrugations to increase the strength and stiffness of a curved plastic surface.

While Ellis claims applications to plastic bottles, it notes that the principles apply to other applications, including plastic piping. Ellis, Col. 4, ll. 13-18.

132.) A person of ordinary skill in the art and aware of the teachings of Cobb and Ellis and motivated by saving material costs and improving draft would likely design a chamber with sub-corrugations running along only parts of the corrugations. Not having sub-corrugations where not necessary, for example in areas with lower stress forces, would save on material costs. Furthermore, tapering sub-corrugations down to nothing would increase draft and improve the ease with which the finished products could be removed from the molds.

133.) Ellis would also motivate a person of ordinary skill to ensure that the discontinuous crest and valley sub-corrugations would overlap to ensure no areas of weakness are created. These principles are well known in the art and are claimed in certain claims of the '583 Patent. A person of ordinary skill aware of the teachings of Cobb and Ellis would recognize that all the limitations of the '583 Patent's claims are disclosed, and the arrangements claimed are merely an application of the engineering principles well known in the industry. The chamber resulting from a combination of the teachings of Cobb and Ellis would accomplish the engineering objectives of the design of the '583 Patent.

VIII. Overall Conclusions and Information

134.) For my efforts in connection with the preparation of this declaration, I have been compensated at my standard hourly rate for this type of consulting work. My compensation is in no way contingent on the results of this or any other proceeding relating to the '583 patent.

135.) I hereby declare that all statements made herein of my own knowledge are true and accurate and that all statements made herein upon information and belief are believed to be true. I make all statements herein with the understanding that willful false statements are

punishable by fine or imprisonment, or both. I have been informed that any such willful false statements may bring sanctions under 18 U.S.C. § 1001.

Dated: January 4, 2017


Russell L. Herlache

APPENDIX A

Russell L. Herlache

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SUMMARY

Experienced Technical Consultant and University Level Adjunct Lecturer for Engineering Design, Materials Application and Engineering Cost Analysis. Professional experience includes Project, Design, Quality, Materials, Manufacturing and Process Engineering with broad knowledge of plastics, metals, and composites including part design, tooling and processing as well as purchasing, costing, validation and project management. Demonstrated effectiveness in reducing cost and improving performance and quality with existing and new products with proven ability to plan and manage product launches for new programs with a diverse supplier base.

- University Level Adjunct Lecturer in Engineering Design, Materials Selection and Cost Analysis
Significant experience in developing, planning and conducting organizational Technical Training
- Product, Materials, Tooling, Testing, Analysis, Reliability, and Product and Process Design expertise
- Extensive experience in Extrusion, Injection Molding, Thermoforming, Blow Molding, & Lamination
- Over \$60 million in cumulative savings through materials, design and process innovations
- Hold five US Patents for plastic component applications and one Defensive Publication
- Effective negotiator with ability to develop innovative win/win strategies for the customer and supplier.
- Extensive knowledge of Industry Standards, including CSA, BBA, ANSI, ASTM, FMVSS
Experienced in Global Supply Chain Management

EDUCATION and PUBLICATIONS

Undergraduate: 1974 BME Materials Science Major, General Motors Institute, (now Kettering University) Flint, MI.
Thesis: *A Feasibility Study and Material Selection for a Plastic Steering Column Housing*

Graduate: 1983 MS Industrial Operations and Engineering Rackham Graduate School, University of Michigan, Ann Arbor, MI Thesis: *The Safety Aspects of Robots*

Video: General Motors Education and Training 1983: *Robotic Safety*

Paper: SPE Foam Conference Paper Seattle, WA *Advances in Testing Techniques for Polymer Foam Products Used in Structural Long-term Applications* Co-authored with Patrick Harrell, Michelle Zwick, and Martin Gibler, 2016

PATENTS

5,049,770 Electric motor-driven impeller-type air pump
5,173,065 Contact ring assembly and method
5,345,679 Method of making plastic ball sleeve assembly
5,481,938 Position control apparatus for steering column
5,788,917 Method of making a plastic article

PROFESSIONAL EXPERIENCE

Saginaw Valley State University
Adjunct Lecturer

1991 to 2016

University Level Instructor for ME250 Materials Engineering Lecture and Lab, and ME306 Engineering Cost Analysis which are part of the curriculum for Mechanical, Electrical and Engineering Management and Technology programs. Past nominee for the Mary H. Anderson Adjunct Faculty Award

Russell L. Herlache Technical Consulting
Proprietor, Technical Consultant

2014 to Present

Contract consultant for numerous clients to assist at process trials, provide analysis, interpret test results and assist in approval to ASTM, CSA and BBA Standards for new and existing plastic applications, including water management and land drainage systems

Wellman Plastics

2012 to Jan 2014

Technical Service Manager

Technical Service Support for plastic design material selection and processing support for existing and potential customers. Activities included the development and presentation of technical research material, customer material process training and approvals, and research and development for new products and applications. Materials included compounded nylons, polypropylene, and nylon/propylene alloys, and, with a focus on post consumer recycled products primarily in the automotive product segment. Retired from position in January 2014.

Durakon Industries / Penda Corporation

2004 to Feb 2012

Senior Technical Consultant

Lead Materials Engineer and consultant for materials identification, design, analysis, selection, testing and validation and reliability analysis for metals, plastics and composites used in new and existing applications in transportation and construction. Focus on cost savings and quality improvement through innovative materials application and process development. Key accomplishments included:

- 40% reduction in material cost for electrostatic dissipative bed liner plastic film laminate
- 10% overall system cost reduction for the GM Avalanche truck,
- Instrumented stress analysis and Weibull Reliability Analysis for tonneau covers
- Material development, process development and launch of a semi-conductive battery tray for increased safety of hybrid vehicles.
- Material selection, product validation, development supplier management and launch of 6'4" Dodge Ram Box for Chrysler. Product won Body Exterior Award in 2011 SPE Automotive Competition

Reported to the Vice President of Advanced Engineered Products with responsibility for patent reviews, internal and external technical presentations and negotiations. Currently a committee member of CSA (Canadian Standards Association) B184 for Subsurface Storm Water Management Chambers (approved in 2011) and ASTM F17 Storm water Management Chambers

Johnson Controls

2003 to 2004

Contract Tooling Engineer

Tracked progress of over 40 molds at 10 Tooling Sources for the interior components of the 2005 Mercedes SUV. Conducted all tool design reviews and participated in process trials to document and provide weekly progress reports to JCI and Daimler Management. Launch was successful, meeting all requirements as defined by the customer.

Oldford and Associates, Acra Plastics and VitroCo

2002 to 2003

Sales Engineer and Technical Consultant

Scheduled performed and analyzed plastic processing trials with processing aids to optimize additive dispersion reduce cycle time and improve material properties. Also provided technical training, product design, tooling and processing analysis for customers in the RV, automotive, medical and packaging fields.

Delta College

1985 to 1988

Adjunct Instructor

Taught Plastic Process and Design Courses at the College and at Walbro Corporation, a client of the College.

Delphi Steering/General Motors Corporation

1969 to 2002

Business Line Purchasing Manager and Global Chemical Commodity Manager (1998 – 2002)

Administered over \$150 Million in Annual Purchase Value, with direct management of a staff of 6 buyers and support staff, as well as indirect management of 7 other buyers in Mexico, South America, Europe, India, and Australia. Activities included strategy development, group performance analysis and reporting, global negotiation,

staff management and supervision to achieve quality, cost and timing performance objectives. Purchasing management responsibilities included rubber, molded plastic, raw thermoplastic resin, packaging materials, lubricants and outside operations including heat treatment. Assignment was linked to all other Delphi Divisions through Delphi Chemical Commodity group, where high level strategies were developed to optimize purchasing performance for all of Delphi.

- All programs delivered at or below target cost
- Negotiated component and investment savings of over 10%
- Reduced component cost over 15% with a patented process for Lever Manufacturing
- Reduced shipping protection cost 80% with a closed loop recycling process

Senior Buyer (1993 to 1998)

Managed over \$35 Million in Annual Purchase Value for molded and formed plastic products. Processes covered included injection, compression and blow molding, extrusion, die cut foam, ultrasonic and hot plate welding, decorating and assembly. Activities included strategy development, quotation, analysis, negotiation, contract award and administration, to achieve Quality, Cost and Timing Performance Targets. Assignment was linked to all other Delphi Divisions through membership on the Delphi Plastic Components Commodity Team, where higher level strategies were developed to optimize Purchasing performance for all of Delphi.

- Met or exceeded all timing, quality, and cost objectives with average 5% annual savings
- Conducted numerous supplier development workshops that produced significant additional cost reduction through product redesign and material substitution
- Recognized by General Motors for recycling activity with the President's Council Honors Award.
- Gave presentations on Delphi Steering Recycling Activities for SAE International, and Continuous
- Improvement from PICOS activities at the General Motors of Canada Symposium
- Led corporate wide team to develop plastic regrind and reuse
- Led Purchasing team to launch tilt lever designs that reduced cost over 40%
- Cited by the Coalition of Northeastern Governors for Individual Achievement for Leadership in Recycling Activities

Senior Manufacturing Project Engineer (1983 to 1993)

Responsible for manufacturing program management for internal injection molding. Activities included supervision of five other Plastics Engineers, project planning, process analysis, Statistical Process Control, and process debug, personnel administration, economic analysis, budgeting, and cost estimating for plastic program tooling and capital.

- Designed, Developed, planned and executed numerous metal to plastic substitutions for steering system components resulting in over 60% weight and over 50% cost reductions.

Prior Positions (1969 to 1983)

- Cooperative engineering Student, Plastics Engineer, Safety Engineer
- Monitored compliance with MIOSHA regulations and called upon as an Expert Witness for General Motors Corporation in a MIOSHA Hearing.
- Recipient of Bachner Award 1976 SPI (Society of the Plastics Industry) for development of the best use of nylon in the plastics industry for the development of a plastic steering column housing.
- ANSI and MIOSHA Committee Member and Committee Chair for MIOSHA Plastics Processing Regulations

OTHER EXPERIENCE

Taught Plastics Design and Technology for Delta College and Delphi, as well as Safety and Robotics classes for GMI and General Motors; Chairman of Michigan Department of Labor, Standards Division, Part 62 Standards Advisory Committee for Plastic Processing; SAE, SPE, ASTM and CSA member; Past member of ANSI B 11.13 Machine Standard; St. John Vianney Parish Council President; Kochville Township Planning Commissioner; and Recording Secretary for the Knights of Columbus Council 4232.