NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

REPLY TO ATTN OF: GP April 5, 1971

MEMORANDUM

TO: KSI/Scientific & Technical Information Division
Attn: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General
Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures contained in the Code GP to Code USI memorandum on this subject, dated June 8, 1970, the attached NASA-owned U.S. patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,443,412

Corporate Source : Honeywell, Inc.

Supplementary Corporate Source :

NASA Patent Case No.: XNP-05297

Please note that this patent covers an invention made by an employee of a NASA contractor. Pursuant to §305(a) of the NAS Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of. . . ."

Gayle Parker

Enclosure:
Copy of Patent

N71-23811

May 13, 1969 JAMES E. WEBB 3,443,412
ADMINISTRATOR OF THE NATIONAL AERONAUTICS
AND SPACE ADMINSTRATION
CONVOLUTING DEVICE FOR FORMING CONVOLUTIONS AND THE LIKE
Filed May 17, 1967 Sheet 1 of 2

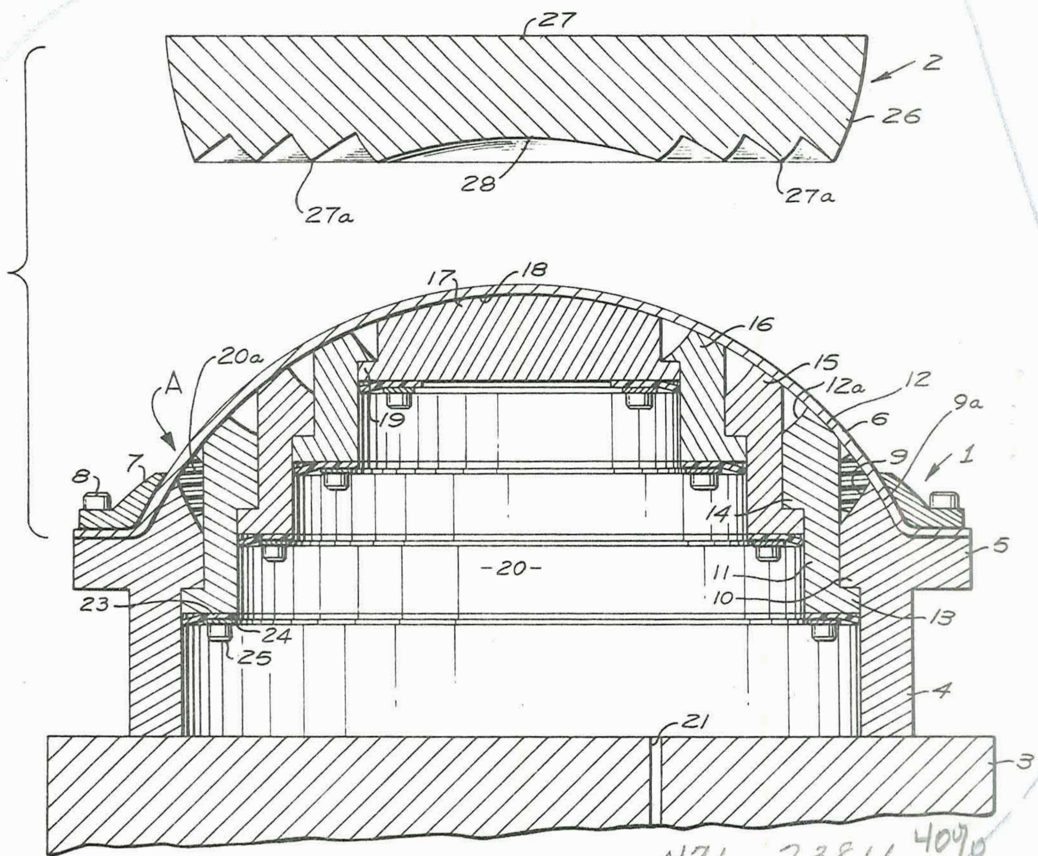

FIG. I.

N71-23811 40%

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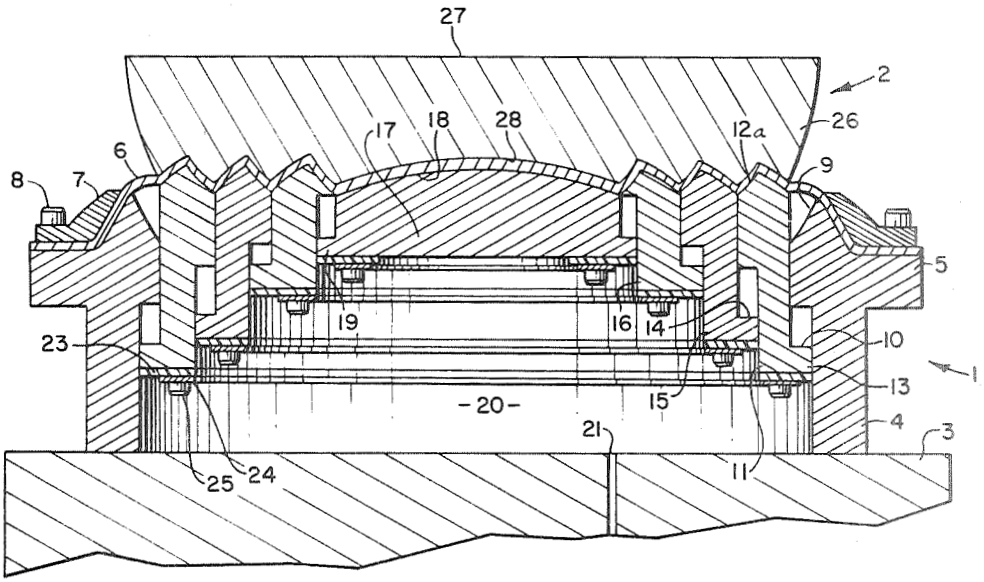

FIG. 2.

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United States Patent Office

3,443,412
Patented May 13, 1969

3,443,412

CONVOLUTING DEVICE FOR FORMING CONVOLUTIONS AND THE LIKE

James E. Webb, Administrator of the National Aeronautics and Space Administration, with respect to an invention of Raymond E. Michel, Minneapolis, and Dallas E. Nelson, St. Paul, Minn.

Filed May 17, 1967, Ser. No. 640,458
Int. Cl. B21d 22/10, 5/02; B21j 7/02
U.S. Cl. 72—354 3 Claims

ABSTRACT OF THE DISCLOSURE

This disclosure relates to a punch and die device for forming a series of convolutions in thin-gauge metal hemispheres without effecting a stretching of the stock metal. The device includes an opposed punch and die mechanism having grooved working surfaces which mate with the hemisphere sandwiched therebetween. The punch is formed of telescoping segments which are extended to an operative hemispheric configuration by pneumatic pressure. The die is coaxially aligned with the punch and extends in a single plane so that the hemisphere may be sandwiched between the working surfaces with the segments of punch being retracted progressively from the center, and the convolutions progressively formed as the working surfaces are progressively displaced toward each other. Since the blank is of a hemispheric configuration, the convolutions will be formed without effecting a stretching or drawing of the metal, thus the hemisphere is "crushed" or driven toward a planar configuration in the formation of the convoluted diaphragm.

Origin of the invention

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85–568 (72 Stat. 435; 42 USC 2457).

Background of the invention

Thin metal diaphragms have many uses and applications. For example, diaphragms are often employed in pumps, pressure gauges and various devices which require liquid barriers. A common use of metal diaphragms is in expulsion tanks such as those employed in providing propellants for space vehicles and the like. In expulsion tanks for propellants, diaphragms are used under pressure to force liquid or viscous propellant materials from the tanks. For control of propellants in a zero *g* environment and for minimum opposing force in the expulsion process, it is necessary to have convolutions formed in the diaphragm. These convolutions take the form of annular corrugations or convolutions.

There are many known methods for forming convolutions in diaphragms. One method commonly employed is explosive-forming wherein an explosive is used to produce greatly increased pressure in a fluid medium to force the diaphragm against a die having preselected ridges or grooves formed in a manner such that preselected convolutions are thus formed in the diaphragms. This method has several disadvantages, among which is a lack of sufficient control and economy.

Another method for forming convolutions involves a spinning process. This process has not been found to be particularly successful in that the valleys of the convolutions as typically formed, are in an extremely thin state thus resulting in loss of strength in the diaphragm. Another method for forming convolutions is a flexible structure such as that described in the U.S. patent to Keen et al., No. 3,115,678. In the patent, weights are utilized to form the desired shape in articles such as plastic carpets. Another typical example may be found in the U.S. patent to Milton et al., No. 1,550,387, in which a die and blank-holding means are employed. This method utilizes fluid pressures to deform metal articles. However, the problems of stretching metal arise when employing any of the aforementioned prior art techniques. This is of particular importance where formation of convolutions is necessary while the thickness of the metal being worked must remain constant.

Summary

The invention, in brief, comprises a pneumatically supported punch and die mechanism which includes a ring assembly comprising a series of pneumatically supported annular or cylindrical rings arranged in a sealed and telescoping relationship. Each of the rings includes a stop means provided to prevent excessive upward relative movement of the adjacent rings. A chamfered portion is formed at the upper surface of each of the rings, opposite the stop means which, with an adjacent section, forms a groove for establishing a convolution in a blank diaphragm. When fluid pressure is admitted to the interior of the ring assembly, the telescoped members are caused to extend upwardly until arrested by the stop members and thus form a resilient punch having a hemispheric configuration. With the members thus extended, a reinforcing ring is inserted in a selected one of the grooves, whereupon a blank diaphragm of very thin metal, in the form of a hemisphere, is inverted and over the upper surface of the punch. A die member, aligned in coaxial alignment and having a working surface comprising a mirror image of the working surface of the punch, is then forced into contact with the hemisphere. The ridges of the die are aligned in corresponding or mating relationship with the grooves formed by the chamfered surfaces of the ring members. Deformation of the diaphragm in opposition to the fluid pressure then occurs as the punch and die are driven or forced together. This results in a well-formed diaphragm having convolutions of predetermined configurations and a controlled thickness. By providing a cylindrical press for forming the convolutions, in combination with a yielding punch, the thickness of the metal in the convolutions is thus controlled to avoid stretching, and by providing the reinforcing ring, undesired buckling along the periphery of the diaphragm is thus obviated.

It is an object of this invention to provide an improved convolution-forming device for diaphragms and the like.

It is another object of this invention to provide means for maintaining the previously selected thickness of the metal in the convolutions of metal diaphragms.

It is still another object of the invention to provide a cylindrical press which operates against a yielding punch to minimize the fatigue stress or cold working of stock material in convolutions of a metal diaphragm during the formation of the convolutions.

Other objects and advantages of this invention will become apparent as the description proceeds, taken in conjunction with the drawings.

Description of drawing

FIGURE 1 is a view in cross-section of the punch and die mechanism constructed according to this invention prior to the convolution-forming; and

FIGURE 2 is a view in cross-section of the punch and die mechanism after the convolution-forming is nearly completed.

Description of preferred embodiments

Turning now to FIGURE 1, the convolution-forming mechanism, according to this invention, is shown in detail. The punch mechanism is indicated generally by reference numeral **1** and the die member is shown generally at **2**. A base member **3** is provided and serves to support a cylindical or annular wall **4** of the punch **1**. The wall **4** is rigidly secured, by any suitable means, to the base member **3** and has an outwardly extending flange **5** upon which a thin metal hemisphere **6**, in which convoluted markings are to be impressed, is attached preparatory to the forming operation of the device. In order to attach the hemisphere **6** to the punch **1** there is provided a ring clamp **7** removably secured to the flange **5** of the cylindrical wall or base member **4** by any suitable means such as, for example, screws **8**.

The cylindrical wall **4** extends upwardly from the base **3** and terminates in a sloping or concave arcuate inner surface **9** and an outer convex arcuate surface **9***a* which, in operation, engages the inner surface of the attached hemisphere blank **6**. From the upper portion of the inner surface of the wall **4** there is an inwardly extending flange or shoulder **10** which acts as a stop member for an adjacent reciprocating ring **11** of the punch member assembly. The adjacent ring member **11**, likewise, comprises an upwardly extending cylindrical metal ring which has a concave arcuate inner surface **12***a* and a convex arcuate surface **12** at its topmost outer portion. An outwardly extending shoulder **13** is provided adjacent the lower portion of the ring **11**. This shoulder coacts with the inwardly extending shoulder **10** to arrest upward motion imparted to the ring **11**. Near the mid portion of the ring **11**, there is provided an inwardly extending shoulder or flange **14** which serves as a stop member in arresting motion imparted to the adjacent ring member **15**.

As each of the ring members, here designated **11**, **15** and **16**, are constructed in a similar manner, description of a single one of the ring members is deemed adequate to provide an understanding of the invention. It is understood that the number of rings employed may be varied as needs dictate.

A center disc member **17** having a convex upper surface **18** formed to accommodate the shape of the metal diaphragm **6**, is provided at the center of the ring assembly. Likewise, and in a manner similar to the ring members, the disc **17** has an outwardly extending lower flange or shoulder **19** which serves as a stop member for limiting its upward travel relative to the adjacent ring member **16**. It is understood that the ring members, as well as the disc member **17**, are displaceable and are arranged in a telescoping relationship for reciprocal displacement. Also, it is deemed necessary that each joint, as formed at the points of contact between adjacent surfaces of the sliding members, be a wiping or running type seal. Such has been effected through the use of a flexible seal **23** held in place by a retaining ring **24** and a plurality of screws **25**. Consequently, it will be appreciated that all of the sliding members may be retracted toward the upper surface of the base **3** and subsequently extended to form above the base **3** an expanded and sealed chamber **20**.

The die **2** is formed from a suitable material, for example, metal, and comprises disc or block having an arcuate periphery **26**, a flat upper surface **27** and a bottom or working arcuate surface **28** so formed as to provide a plurality of annular ridges **27***a* extending downwardly in a common plane and aligned to mate with the grooves formed by the arcuate surfaces of the member **4** and ring members **11**, **15** and **16** to thus provide opposed working surfaces which, in effect, constitute mirror images and between which the hemisphere is to be operatively sandwiched. In practice it has been found that the material of the hemisphere tends to buckle or form an undesired dent at the periphery of the hemisphere at Point A, FIGURE 1, during the formation of convoluted hemispheres.

This is eliminated by employing a removable support ring **20***a* formed of suitable material such as, for example, a mixture of epoxy and alumina. The ring **20***a* comprises an annular ring having a cross section shaped generally in the manner shown in the drawings and is merely positioned or "dropped" into an operative position adjacent the convex arcuate surface **9** of the ring **4** prior to placing the hemisphere **6** over the punch **1**.

In operation, fluid such as air under pressure is introduced through suitable means, such as a bore or passage **21** into the chamber **20**. The chamber is defined by the wall member **4**, the ring members, and the disc portion **17** as well as the top surface of the base **3**. Fluid introduced will pressurize the chamber **20** forcing the ring members **11**, **15** and **16** and disc member **17** to their fully extended position, which occurs only when the stop members of all the elements are engaged, to thus form a dome-shaped punch. As shown in FIGURE 1, the ring **20***a* is inserted and the blank hemisphere or diaphragm **6** is positioned over the convex arcuate surfaces of the ring and disc members and secured in operative position by the ring **7** and screws **8**. Thus, the upper and outermost surfaces of the base **4**, the extended rings and the disc form a curvilinear surface conforming to the inner surface of the blank diaphragm **6**. The die **2** is then brought into contact with the metal hemisphere or diaphragm, by any suitable means and forced against hemisphere **6** and the punch **1**, FIGURE 2. The punch element, including the ring members **11**, **15** and **16**, and disc member **17**, yield against the force imparted to the die **2**, as better shown in FIGURE 2, and slide downwardly against the pressure of chamber **20** until the surface **26** of the die **2** is adjacent the surface **9** of base member **4** thus forming the convolutions in the diaphragm in a manner such that stretching or yielding of the metal is minimized. However, as will be appreciated, it is necessary to remove ring **20***a* prior to completion of the formation of the convolution in order to introduce a convolution of the metal of the hemisphere or diaphragm **6** at the point of its contact with the ring **20***a*.

To remove the thus convoluted diaphragm from the punch **1**, without deforming the diaphragm, the pressure in cavity **20** is reduced to ambient, while the assembly is closed, or mated, as shown in FIGURE 2. The die **27** is then raised to its maximum position, as shown in FIGURE 1. While the telescoping punch **1** remains in its retracted or telescope position, the convoluted diaphragm is lifted from the punch without interference.

Having described this invention, it is to be understood the invention provides a simplified punch and die assembly, whereby convolutions or corrugations may be readily formed in a conventional hemispherical diaphragm through a sequential formation beginning at the center of the blank without unduly stretching the blank material at the convolutions.

While the invention as described herein, is considered to be its preferred embodiment, it should be recognized that variations may be made without departing from the scope of the invention as defined by the appended claims.

What is claimed is:

1. In an assembly of the type employed in forming diaphragms which are provided with bellows-like corrugations therein, the improvement comprising:

at least a pair of telescoped cylindrical members, each having an arcuate transverse end surface extending downwardly and away from the longitudinal axis of the assembly and a disc member concentrically aligned within said cylindrical members having an external arcuate surface extending across the longitudinal axis of the assembly;

pneumatic means adapted to impart longitudinal displacement to one of the cylindrical members of said pair and to said disc member relative to both of the cylindrical members;

stop means acting against said pneumatic means

adapted to arrest the longitudinal displacement imparted by said pneumatic means, whereby the arcuate surfaces of said members and disc member may be brought into desired alignment to thus establish a continuous curved surface;

means defining a series of concentric annular grooves in the continuous surface; and

a reinforcing ring mounted in one of said grooves.

2. The combination of claim 1 wherein said reinforcing comprises an annular member having a generally wedge-shaped cross section configuration.

3. The combination of claim 1 wherein said continuous surface is of a hemispheric configuration and said grooves are fabricated by shaping the internal uppermost end surface of each of the members to thus form a surface which intersects each of the transverse arcuate surfaces and extends downwardly toward the longitudinal axis of the assembly.

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3,252,315	5/1966	Muench	72—354

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U.S. Cl. X.R.

72—382, 432