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DESCRIPTION

Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to a method of manufacturing a stamped antenna, and more specifically, to a method of manufacturing an antenna that includes a first partial initial stamping of the antenna from a sheet of metal, and a subsequent complete stamping of the antenna.

RELATED ART

[0002] As communication technology continues to advance, the use of antennas is becoming more widespread and possible applications are broadening. Various types of antennas are not only used for large scale communication, but also for small scale communication between devices for identification purposes and even for electronic device charging.

[0003] Near field communication (NFC) devices are becoming popular for transferring data between two devices that are in proximity of each other. NFC establishes a radio connection between two devices having a NFC antennas, such as smart phones, as well as NFC tags, which are unpowered devices that contain a NFC chip having a NFC antenna. NFC devices, when in close proximity, can engage in two-way communication with one another. This two-way communication allows the devices to transfer data back and forth. Additionally, a NFC device can engage in one-way communication with a NFC tag, such that the NFC device can obtain data from the tag, but cannot transfer information to the tag. NFC tags can be employed for managing the inventory and sale of a wide variety of goods, as well of identification of data pertaining to goods. Accordingly, NFC tags may be used for retaining data that a user can obtain through engaging the tag with a NFC device.

[0004] Similarly, radio frequency identification (RFID) tags are finding increased and widespread use as more systems are developed and placed into service for managing the inventory and sale of a wider variety of goods. These RFID tags are applied to the goods and employ electronic circuitry responsive to radio frequency (RF) signals for providing readily monitored identification data relating to the goods.

[0005] NFC devices, NFC tags, and RFID tags all include an antenna connected to other circuit components. Because there is pressure to keep devices small, it follows that it is desirable that the antennas for these devices are compact and thin, resulting in antennas having thin widths, and narrow traces with small spacing between the traces. As technology advances, the desire for even more compact articles carrying NFC and RFID antennas increases.

[0006] NFC and RFID antennas typically occupy a substantial portion of the area dimensions of the article employing the antenna, and are often constructed of a relatively thin copper foil for flexibility and for maximum effectiveness. Many antennas are currently manufactured by a process involving photochemical etching. The photochemical etching process can often be expensive compared to other metal working techniques.

[0007] Accordingly, what would be desirable, but has not yet been provided, is a method of manufacturing an improved antenna.

SUMMARY OF THE INVENTION

[0008] The present invention relates to a method of manufacturing a stamped antenna. A sheet of metallic material is provided and a first partial stamping is performed on the metallic material. The first partial stamping forms an antenna including traces, contacts, carriers connected to the traces, and tie-bars between the traces. A pressure sensitive adhesive is then bonded to the traces of the antenna. A second complete stamping is then performed on the antenna, including pressure sensitive adhesive, to remove the carriers and tie-bars.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The foregoing features of the disclosure will be apparent from the following Detailed Description, taken in connection with the accompanying drawings, in which:

FIG. 1 is a diagrammatic illustration of a sequential manufacturing line for manufacturing an antenna;

FIG. 2A is a top view showing a near field communication antenna biscuit of the present disclosure after a first stamping;

FIG. 2B is a top view showing an example of a single near field communication antenna of the present disclosure stamped for a first time;

FIG. 3A is a top view of a pressure sensitive adhesive pad of the present disclosure;

FIG. 3B is a perspective view of the pressure sensitive adhesive pad of **FIG. 3A** with the

release liner partially removed showing the pattern of adhesive;

FIG. 3C is a top view of the pressure sensitive adhesive pad of **FIG. 3A** with the release liner fully removed showing the pattern of adhesive;

FIG. 4 is a perspective view of a fixture for receiving a pressure sensitive adhesive and first stamped antenna for further processing;

FIG. 5 is a perspective view the pressure sensitive adhesive pad of **FIG. 3C** on the fixture of **FIG. 4;**

FIG. 6 is a perspective view the near field communication antenna biscuit of **FIGS. 2A-2B** on the fixture including the pressure sensitive adhesive of **FIG. 5;**

FIG. 7 is a top view the near field communication antenna biscuit of **FIGS. 2A-2B** and the pressure sensitive adhesive of **FIG. 5** on the fixture;

FIG. 8 is a perspective view of the release liner being placed on the near field communication antenna biscuit that has been placed onto the fixture;

FIG. 9 is a top view of the near field communication antennas and release liner after a second stamping;

FIG. 10 is a perspective view of the near field communication antennas after a second stamping of **FIG. 9** with the release liner detached from the antennas;

FIG. 11 is a top view of a single near field communication antenna of the present disclosure after a second stamping;

FIG. 12 is a top view of a ferrite shield assembly sheet of the present disclosure;

FIG. 13 is a perspective view of a near field communication antenna biscuit on a fixture prior to application of a ferrite layer;

FIG. 14 is a perspective view of the near field communication antenna biscuit of **FIG. 13** with the ferrite shield assembly sheet of **FIG. 12** being placed thereon;

FIG. 15 is a top view of the near field communication antenna biscuit with a ferrite layer applied;

FIG. 16 is a top view of an individual near field communication antennas with a ferrite layer applied;

FIG. 17 is a bottom view of an individual near field communication antennas with a ferrite layer applied;

FIG. 18 is a top view of a pallet that can be used for manufacturing a stamped antenna;

FIG. 19 is a perspective view of the pallet of **FIG. 18**;

FIG. 20 is a perspective view of the near field communication antenna biscuit of **FIG. 2** being placed onto the pallet of **FIG. 18;**

FIG. 21 is a top view of a ferrite shield assembly sheet placed on a first fixture or pallet;

FIG. 22A is a top view of the ferrite shields on the first fixture;

FIG. 22B is a top view of the plurality of antennas on a second fixture or pallet;

FIG. 22C is a top view of a plurality of adhesive cards;

FIG. 23 is a top view of an adhesive card, an antenna, and a ferrite shield, showing the order that they are applied;

FIG. 24 is an exploded view of a completed antenna including a ferrite shield; and

FIG. 25 is a plan view of a sample manufacturing process for applying the ferrite shields.

DETAILED DESCRIPTION

[0010] The present invention relates to a method of manufacturing a stamped antenna.

[0011] FIG. 1 is a diagrammatic illustration of a sequential manufacturing line for manufacturing a stamped antenna and provides a general overview of the manufacturing process. It should be understood by one of ordinary skill in the art that this manufacturing process can be employed in the manufacture of any antenna that includes thin traces, e.g., antennas used in radio frequency identification tags, inductive charging circuitry, etc. The antennas are manufactured at a plurality of stations that are arranged sequentially about the manufacturing line **10.** A supply reel **12** feeds an antenna material, e.g., a thin sheet of copper such as copper foil, to a first station **14** that includes a first precision high-speed stamping press for performing a first partial stamping of the antenna. **FIG. 2A** is a top view showing a group of near field communication antennas **16** after a first partial stamping by the first stamping press. After the first stamping, the antennas **18a-e** include tie bars **20** and carriers **22** to add stability and support to the partially stamped antennas. After each group of antennas, the copper sheet is cut so that a near field communication antenna biscuit is created having a group of antennas, e.g., five as shown in **FIG. 2A.** The biscuit **16** includes antennas **18a-e** connected with carriers **22** and a series of tie bars **20** that extend between the antennas **18a-3** and within each respective antenna **18a-e.** Further, the tie bars **20** within each antenna **18a-e,** and between the antennas **18a-e,** support the antennas **18a-e** and prevent the antennas **18a-e** from being misshapen. The biscuit **16** also includes a plurality of pilot holes **24,** which will be discussed in greater detail.

[0012] FIG. 2B is a top view of an individual antenna **18a** from the near field communication

antenna biscuit **16** showing the individual antenna **18a** in greater detail. As can be seen in **FIG. 2B,** the antenna **18a** includes an intricate shape of thin traces **26** connected to two paddles **28** or contacts. The traces **26** are interconnected by the series of tie bars **20** and connected to the carriers **22.** The series of tie bars **20** and carriers **22** provide stabilization, support, and strength for the thin traces **26** of the antenna **18a** so that the traces **26** can be further processed without risk of breakage. At a second station 27, the two contacts **28** could be gold plated.

[0013] At a third station **29,** a pressure sensitive adhesive (PSA) pad **30** is placed onto a fixture **32** or jig. **FIG. 3A** is a top view of a PSA pad **30** including a release liner **34. FIG. 3B** is a perspective view of the PSA pad **30** of **FIG. 3A** with the release liner **34** partially removed. **FIG. 3C** is a perspective view of the PSA pad **30** with the release liner **34** completely removed. Removal of the release liner **34** exposes a plurality of adhesive areas **36,** having the general shape of the antennas. The PSA pad **30** includes a release liner **34,** adhesive areas **36,** and a plurality of die cut holes **38.** The PSA pad **30** of **FIGS. 3A-3C** includes five adhesive areas **36** to match the five antenna **18a-e.** The adhesive areas **36** are located and shaped to match the five antenna **18a-e** such that the antenna traces **26** and contacts **28** are bonded with the adhesive areas **36.** The plurality of die cut holes **38** could be positioned along the perimeter of the PSA pad **30.** The die cut holes **38** match with any fixture pins **42** on the fixture **32** or jig, as well as the pilot holes **24** of the antenna biscuit **16,** and facilitate alignment of the PSA pad **30** on the fixture **32,** and alignment of the PSA pad **30** with the antenna biscuit **16.**

[0014] FIG. 4 is a perspective view of a fixture **32** for receiving the PSA pad **30** and the antenna biscuit **16.** The fixture **32** includes a body **40** and a plurality of pins **42** for alignment of the PSA pad **30** and the antenna biscuit **16.**

[0015] FIG. 5 is a perspective view of the PSA pad **30** on the fixture **32** of **FIG. 4.** The PSA pad **30** is placed over the fixture **32** so that the plurality of pins **42** are inserted into the die cut holes **38** of the PSA pad **30.** The release liner **34** of the PSA pad **30** is removed prior to placing the PSA pad **30** onto the fixture **32.**

[0016] The antenna biscuit **16** is then transferred to the third station **29** to be aligned with the PSA pad **30** and the fixture **32. FIG. 6** is a perspective view of the group of antennas **16** of **FIG. 1** on the fixture **32** having a PSA pad **30** already placed thereon. The plurality of fixture pins **42** extend through the die cut holes **38** of the PSA pad **30** and facilitate alignment of the PSA pad **30** and the near field communication antenna biscuit **16.** The near field communication antenna biscuit **16** is placed onto the fixture **32** so that the fixture pins **42** extend through the pilot holes **24. FIG. 7** is a top view showing the near field communication antenna biscuit **16** and the PSA pad **30** on the fixture **32.** As can be seen, the traces **26** of each antenna **18a-e** overlap an adhesive portion **36** of the PSA pad **30.** The previously removed release liner **34** is then placed on top of the near field communication antenna biscuit **16** as shown in **FIG. 8.** Placing the release liner **34** over the near field communication antenna biscuit **16** protects the PSA pad **30** during additional stamping processes.

[0017] The fixture **32,** PSA pad **30** and antenna biscuit **16** are transferred to a fourth station **44** for bonding the antenna biscuit **16** with the PSA pad **30.** The fourth station **44** includes rollers that provide pressure for activating the PSA **30** and bonding the antenna biscuit **16** with the PSA pad **30.** Once bonded, the antenna biscuit **16,** now with a PSA layer **30,** is advanced to a fifth station **46** that includes a second precision high-speed stamping press for performing a second antenna stamping. The second stamping press performs a second stamping operation on the antenna biscuit **16** wherein the tie bars **20** are stamped and removed from each antenna **18a-e.** The second stamping press stamps through the foil that makes up the tie bars **20,** the PSA bonded to the tie bars **20,** and the release liner **34.** The carriers **22** will fall away upon stamping of the tie bars **20** because the carriers **22** are generally outside the adhesive area **36** of the PSA pads **30.** As such, the second stamping operation effectively removes each individual antenna **18a-e** from the antenna biscuit **16** so that each antenna **18a-e** is by itself, but supported by the PSA pad **30. FIG. 9** is a top view of the antenna biscuit **16,** PSA pad **30,** and release liner **34** after the secondary stamping. The antenna biscuit **16** and PSA pad **30** cannot be seen because they are covered by the release liner **34.** As can be seen, the plurality of tie bars **20** and carriers **22** have been stamped out and removed. The second stamping process can also stamp a plurality of guide holes **48** for future ferrite shield application, which will be discussed in greater detail.

[0018] Once the second stamping is complete the release liner **34** can be peeled away, as shown in **FIG. 10,** which is a perspective view showing the release liner **34** removed from the antenna biscuit **16.** When the release liner **34** is removed, five individual and disconnected antennas **18a-e** bonded to a single piece PSA pad **30** remain. In one embodiment, the PSA pad **30** may be cut so that each individual antenna **18a-e** is separated from one another. **FIG. 11** is a top view of an individual antenna **18a** after the second stamping and separated from the other individual antennas **18b-e.** The completed antenna **18a** no longer includes a tie bar **20** connecting the traces **26** or the contacts **28.** The completed antennas **18a-e** can then be sent to a sixth station **50** where they are packaged for distribution.

[0019] In an alternative embodiment, the antenna biscuit **16** and PSA pad **30** of **FIG. 10,** e.g., without the release liner **34,** could be sent to an alternative sixth station **52** where instead of being cut into individual antennas, they are instead bonded with a ferrite shield. **FIG. 12** is a view of a ferrite shield **54** assembly sheet that may be used. The ferrite shield assembly sheet **54** includes a liner **56,** a series of ferrite shields **58,** and a plurality of pilot holes **60.** The ferrite shield assembly sheet **54** is generally sized, dimensioned, and arranged so that each individual ferrite shield **58** generally overlaps a respective antenna **18a-e** of the antenna biscuit **16.**

[0020] FIG. 13 is a perspective view of the antennas **18a-e** and PSA pad **30** sub-assembly placed on a fixture, with the antennas **18a-e** facing upward and the PSA pad **30** abutting the fixture **62.** The fixture **62** includes a body **64** and a plurality of guide pins **66** that are aligned with and inserted into the guide holes **48** the PSA pad **30.** As shown in the perspective view of **FIG 14,** the ferrite shield assembly sheet **54** of **FIG. 12** is placed on to the fixture **62** such that the guide pins **66** of the fixture **62** are aligned with and inserted into the pilot holes **60** of the ferrite shield assembly sheet **54.** The ferrite shield assembly sheet **54** is oriented such that the

series of ferrite shields **58** are facing the copper antennas **18a-e.** When the ferrite shield assembly sheet **54** is placed on the fixture **62,** the ferrite shields **58** overlap the antennas **18a-e,** such that there is one ferrite shield **58** for each individual antenna **18a-e.** The ferrite shields **58** are then bonded to the respective antenna **18a-e** by means that are known in the art, for example, a vacuum adhesive. Once bonded, the ferrite shield liner **56** can be removed, leaving a series of five individual antenna **18a-e** each having a ferrite shield **58** bonded thereto, as shown in **FIG. 15.** The antennas **18a-e,** held together as a group by the PSA pad **30,** can be cut into individual antenna **18a-e** and the PSA pad **30** can be removed. **FIGS. 16-17** show an antenna **18a** having a ferrite shield **58.**

[0021] FIGS. 18-20 show an alternative embodiment in which a pallet **70** is used in place of the fixture **32.** The pallet **70** includes a body **72,** a handle **74** extending from the body **72,** a plurality of pilot holes **76,** a plurality of guide pins **78,** and a plurality of removed sections **80.** The plurality of pilot holes **76** are positioned to match guide pins of a stamping machine so that the pallet **70** is properly aligned when engaged with the machine. The plurality of guide pins **78** facilitate positioning a PSA pad **30,** antenna biscuit **16,** and ferrite shield assembly sheet **54** during manufacturing. The guide pins **78** ensure that the PSA pad **30** and antenna biscuit **16** are located such that the tie bars **20,** carriers **22,** and portions that need to be cut by pressing are positioned over the removed sections **80.** The removed sections **80** allow a die to be pressed through the PSA pad **30** and the antenna biscuit **16,** thus facilitating removal of the tie bars **20** and carriers **22.**

[0022] FIGS. 21-25 shown another method for applying a ferrite shield layer. **FIG. 21** is a top view of a ferrite shield assembly sheet **82** placed on a first fixture or pallet **84.** The ferrite shield assembly **82** includes a liner **86** and a plurality of ferrite shields **88.** The ferrite shield assembly **82** is placed on the first fixture **84** such that the ferrite shields **88** are face down on the first fixture **84,** e.g., adjacent the first fixture **84,** and the liner **86** is face up. The first fixture **84** can include a vacuum or magnets that hold the ferrite shields **88** in place. Accordingly, the liner **86** can be removed from the ferrite shields **88,** and the ferrite shields **88** will be retained in place by the fixture **84.**

[0023] FIG. 22A is a top view of the ferrite shields **88** on the first fixture **84. FIG. 22B** is a top view of the plurality of antennas **18a-e** on a second fixture or pallet **90. FIG. 22C** is a top view of a plurality of adhesive cards **92.** Each of the plurality of adhesive cards **92** includes a bottom release liner (not shown), a top liner **94,** an adhesive area **96,** an two alignment holes **98.** The bottom release liner is a continuous liner that spans one or more of the adhesive cards such as the five adhesive cards **92** shown, and is removed during assembly to expose the adhesive areas **96.** The top liner **94** is cut into a square/rectangle that extends beyond the edges of the adhesive area **96.** The two alignment holes **98** facilitate alignment of the adhesive cards **92** with a pick-up pad.

[0024] FIG. 23 is a top view of an adhesive card **92,** an antenna **18a,** and a ferrite shield **88,** showing the order that they are assembled. As shown in **FIG. 23,** the adhesive card **92** is first applied to the antenna **18a,** and then the ferrite shield **88** is applied over the antenna **18a** and

onto the adhesive card **92.** This application process is discussed in greater detail in connection with **FIG. 25. FIG. 24** is an exploded side view of a completed antenna **100** including a ferrite shield **88.** The completed antenna **100** includes a plurality of layers that include, from top to bottom, the top liner **94,** the adhesive area **96,** the antenna **18a,** and the ferrite shield **88.**

[0025] FIG. 25 is a plan view of a sample manufacturing process for applying the ferrite shield **88.** Once the PSA **30** is bonded with an the antenna biscuit at the fourth station **44** of **FIG. 1,** the antenna biscuit with PSA layer **30** can be transferred to a loading station **102,** where it is loaded onto a conveyor belt or track **104.** The antenna biscuit is transferred to a second or complete stamping station **106** where the tie-bars are removed and the antennas are singulated by a second stamping process, which is in accordance with the fifth station **46** of **FIG. 1,** described above. The individual antennas are delivered by the conveyor **104** to a pallet loading station **108** where the antennas are placed on a pallet or plate. The pallet could be configured like the pallet **70** shown in **FIGS. 18-20.** The pallet can hold any number of antennas, such as five antennas, for example. The pallet with antennas is then conveyed to an assembly station **110.**

[0026] The assembly station **110** could include a robotic device **112,** which could have 3-axis movement, an adhesive applicator **114,** and a robotic cylinder **116.** The assembly station **110** receives the antennas and attaches the ferrite shields **88.** In preparation for applying the ferrite shields **88** to the antennas, the adhesive applicator **114** removes the bottom liner of the adhesive cards **92,** rolls the removed bottom liner onto a scrap roller, and places each adhesive card **92** into a tray of the robotic cylinder **116.** The robotic cylinder **116** transfers the adhesive cards **92** to the robotic device **112.** The robot device **112** could be a robotic pick-up pad that could be a vacuum pad attached to the end of an arm of the robotic device **112** to pick up the adhesive cards **92.** The robotic device **112** includes pilot pins that engage the alignment holes **98** of the adhesive cards **92** and locate/align the adhesive cards **92.** Once the adhesive cards **92** are ready for transferring, the robotic device **112** moves the adhesive cards **92** into alignment over the antennas, which are transferred by the pallet **70.** The robot **112** then stamps the adhesive cards **92** onto the antennas, such that the adhesive areas **96** engage the antennas, and picks the antennas up. Next, the robotic device **112** moves the adhesive card **92** and antenna sub-assembly over the first fixture **84** containing the ferrite shields **88,** and stamps down on the ferrite shields **88** to bond the ferrite shields **88** to the antennas and the adhesive cards **92.** The antennas, including adhesive cards **92** and ferrite shields **88,** are then transferred along the conveyor belt to a pick-and-pack station **118** where the antennas are removed from the conveyor **104,** scrap is removed, and the antennas are packaged.

Patentkrav

1. Fremgangsmåde til fremstilling af en antenne, omfattende:

tilvejebringelse af en plade af metallisk materiale;

udførelse af en første udstansning af pladen af metallisk materiale for at danne mindst en antenne, idet den mindst ene antenne inkluderer spor, kontakter, en bærer forbundet til sporene, og mindst en forbindelsesstang forbundet mellem sporene;

tilvejebringelse af en pude med mindst et tryksensitivt klæbeområde, det mindst ene tryksensitive klæbeområde tilvejebragt på puden i alt væsentligt i samme form som sporene af den mindst ene antenne;

bringning af det mindst ene tryksensitive klæbeområde på linje med sporene af den mindst ene antenne, efter at den mindst ene antenne er blevet udstanset for første gang;

klæbning af det mindst ene tryksensitive klæbeområde til sporene af den mindst ene antenne, efter at den mindst ene antenne er blevet udstanset for første gang, og det mindst ene tryksensitive klæbeområde er blevet bragt på linje med sporene af den mindst ene antenne; og

udførelse af en anden udstansning af den mindst ene antenne og det mindst ene tryksensitive klæbeområde for at fjerne den mindst ene bærer og den mindst ene forbindelsesstang forbundet med sporene.

2. Fremgangsmåden til fremstilling af en antenne ifølge krav 1, hvor den første udstansning danner mere end en antenne som en gruppe forbundet af mindst en forbindelsesstang eller bæreren.

3. Fremgangsmåden til fremstilling af en antenne ifølge krav 2, hvor puden inkluderer mere end ét tryksensitivt klæbeområde.

4. Fremgangsmåden til fremstilling af en antenne ifølge krav 3, hvor den mere end ene antenne er adskilt fra hinanden efter den anden udstansning.

5. Fremgangsmåden til fremstilling af en antenne ifølge krav 1, hvor bæreren inkluderer mindst et pilothul, og puden inkluderer mindst et

udstanset hul.

6. Fremgangsmåden til fremstilling af en antenne ifølge krav 5, yderligere omfattende:

anbringelse af antennen udstanset for første gang på en holder med mindst en holderstift, idet holderstiften indsættes gennem det mindst ene pilothul;

anbringelse af puden på holderen, idet holderstiften indsættes gennem det mindst ene udstansede hul;

hvor holderstiften bringer den første udstansede antenne og puden på linje, således at det mindst ene tryksensitive klæbeområde af puden er placeret på sporene af antennen.

7. Fremgangsmåden til fremstilling af en antenne ifølge krav 6, hvor holderen er en palet.

8. Fremgangsmåden til fremstilling af en antenne ifølge krav 1, hvor pladen af metallisk materiale er kobber.

9. Fremgangsmåden til fremstilling af en antenne ifølge krav 1, yderligere omfattende:
klæbning af en ferritskærm til den mindst ene antenne udstanset for anden gang.

10. Fremgangsmåden til fremstilling af en antenne ifølge krav 9, hvori bæreren inkluderer et pilothul, puden inkluderer et første og et andet udstanset hul, og ferritskærmen inkluderer et pilothul.

DRAWINGS

Drawing

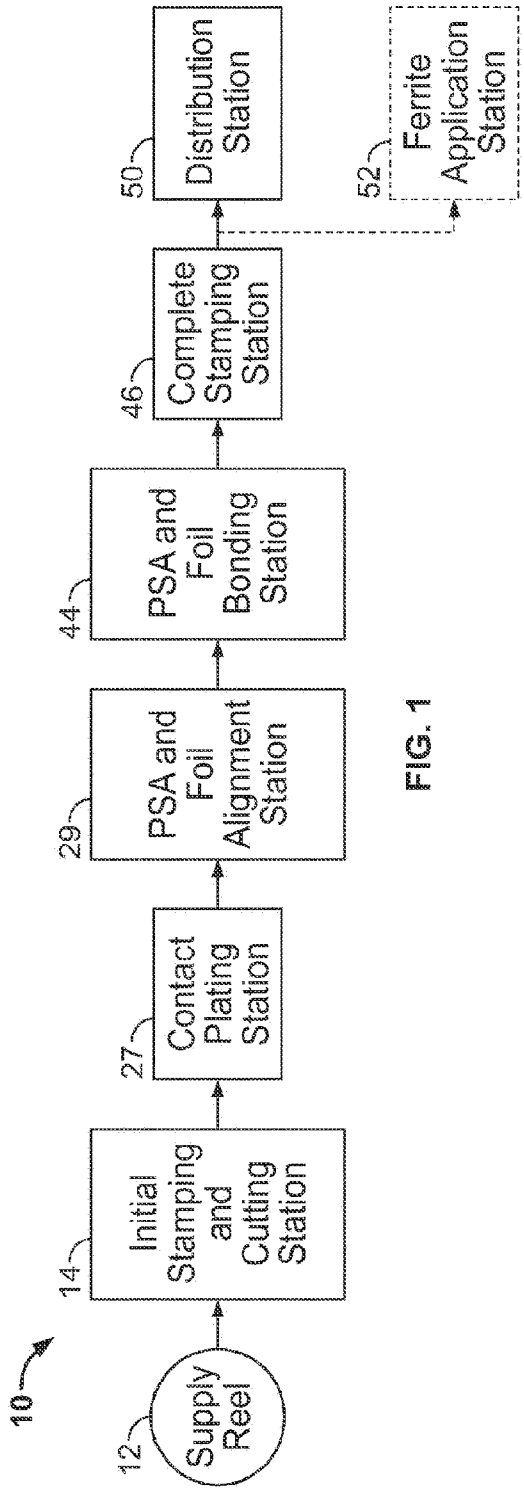


FIG. 1

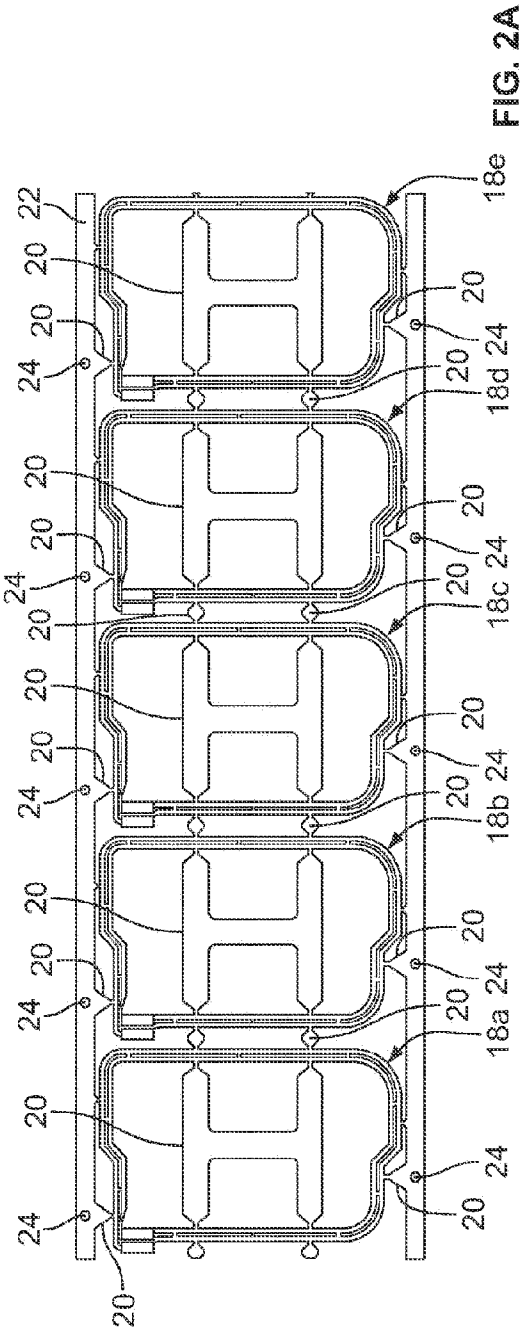
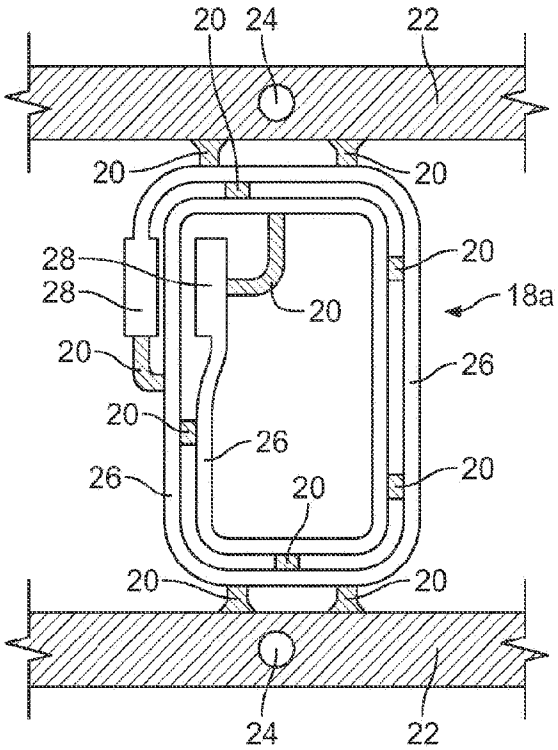


FIG. 2A


20
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18a
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20
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FIG. 2B

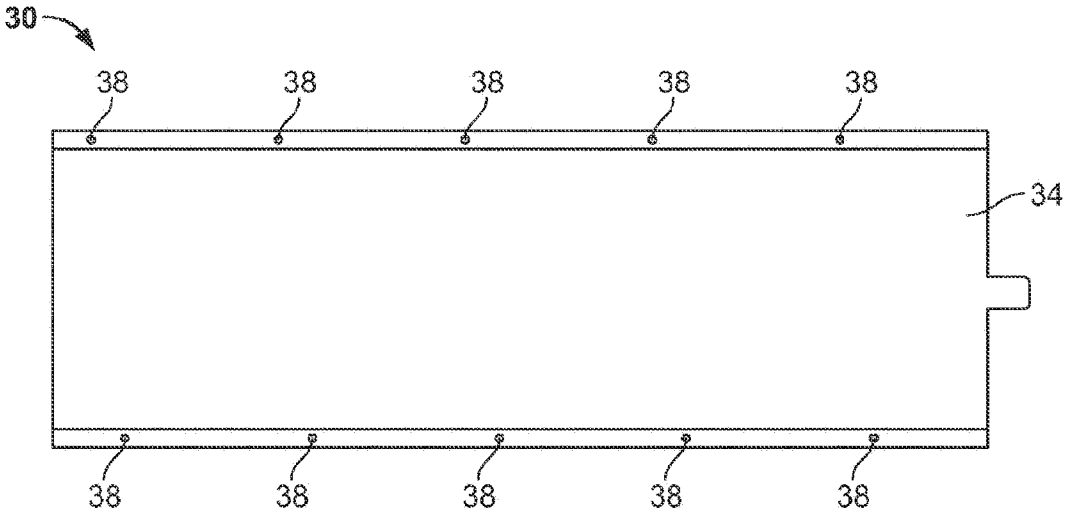
30
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FIG. 3A

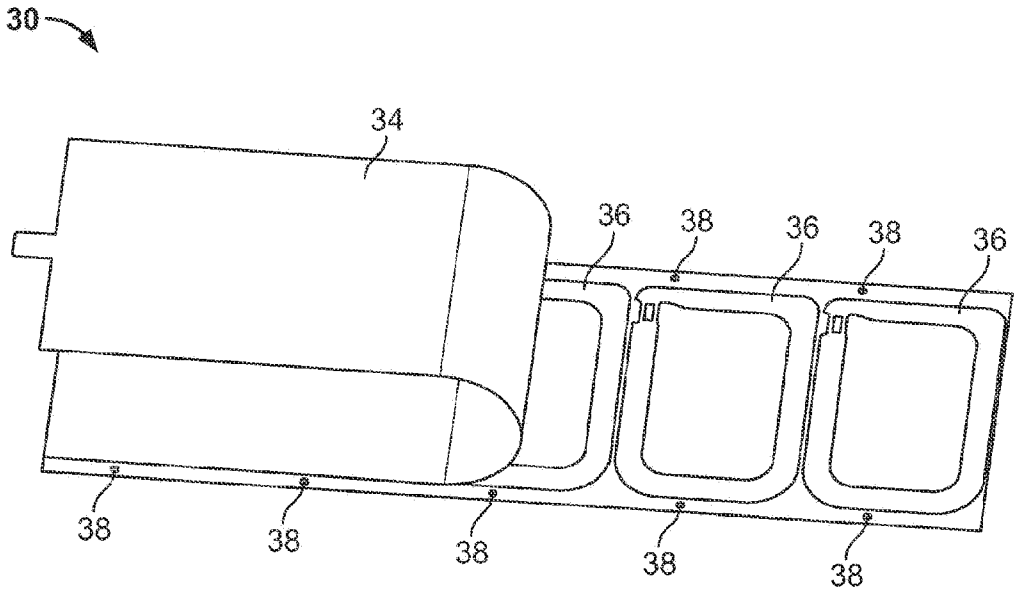
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FIG. 3B

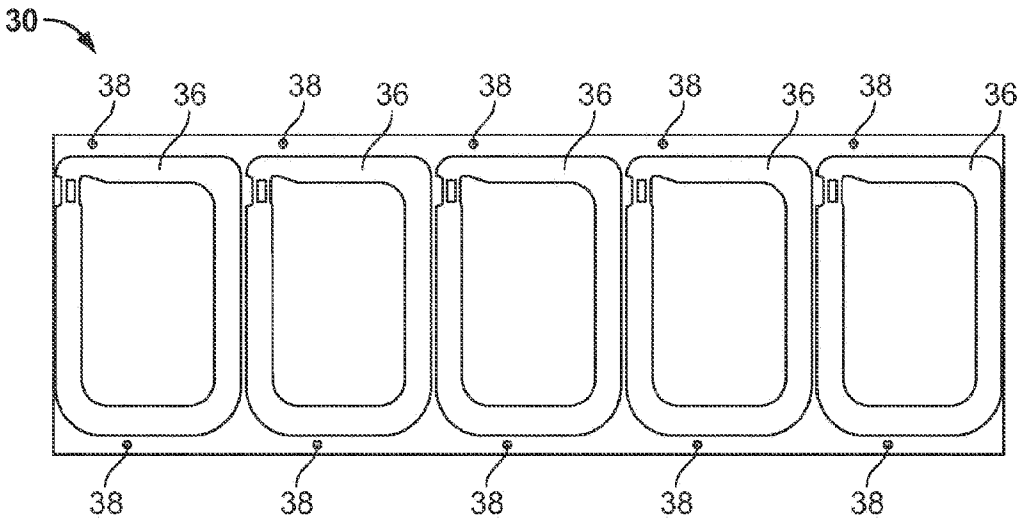
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FIG. 3C

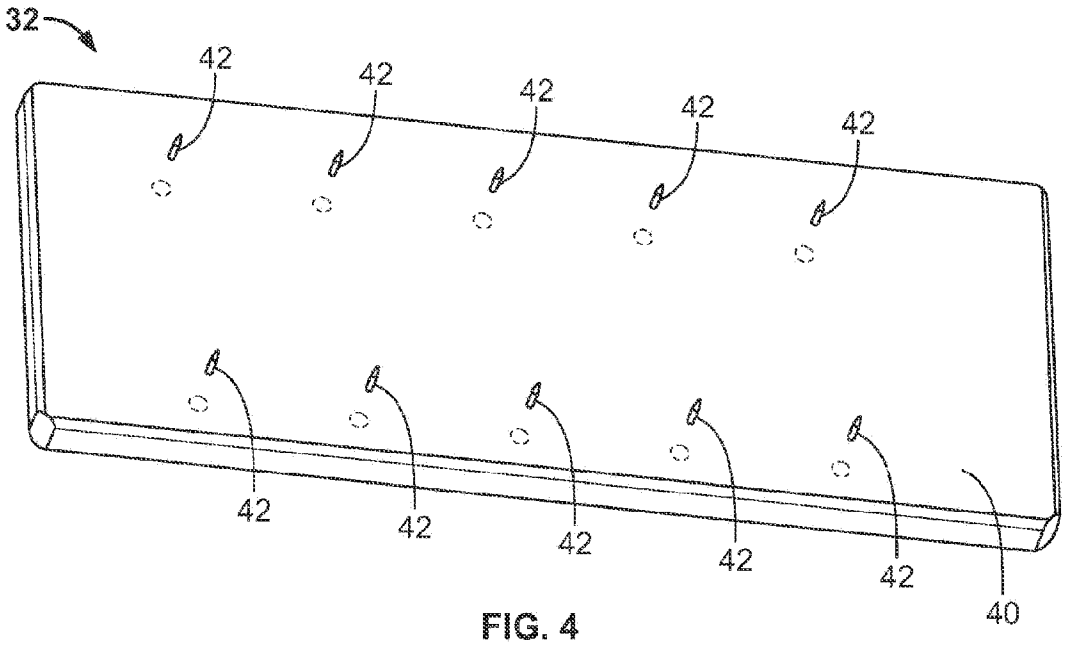
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FIG. 4

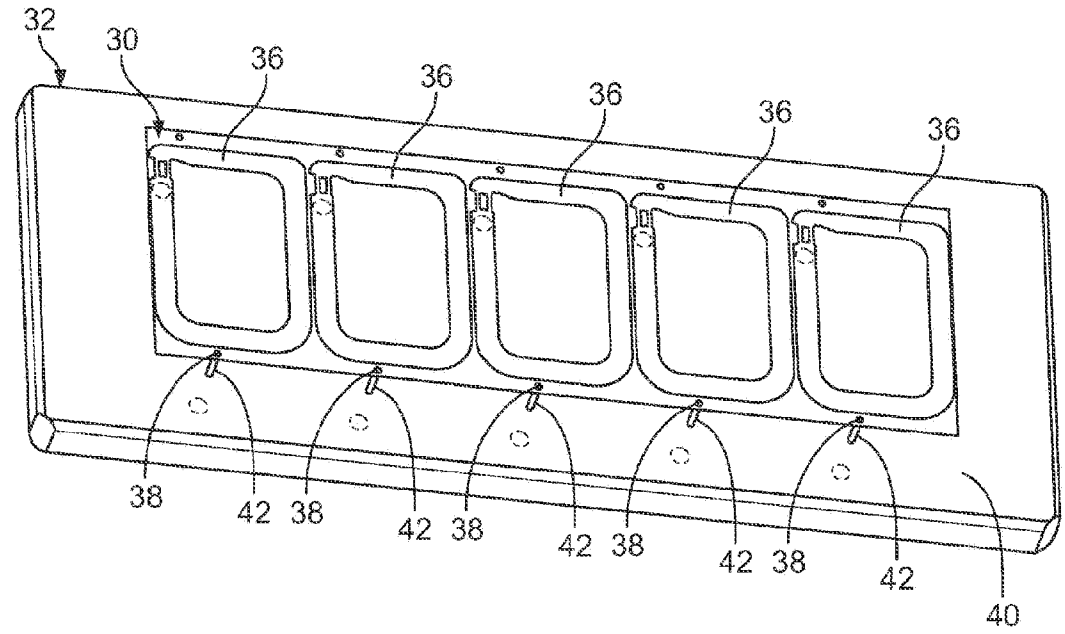
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FIG. 5

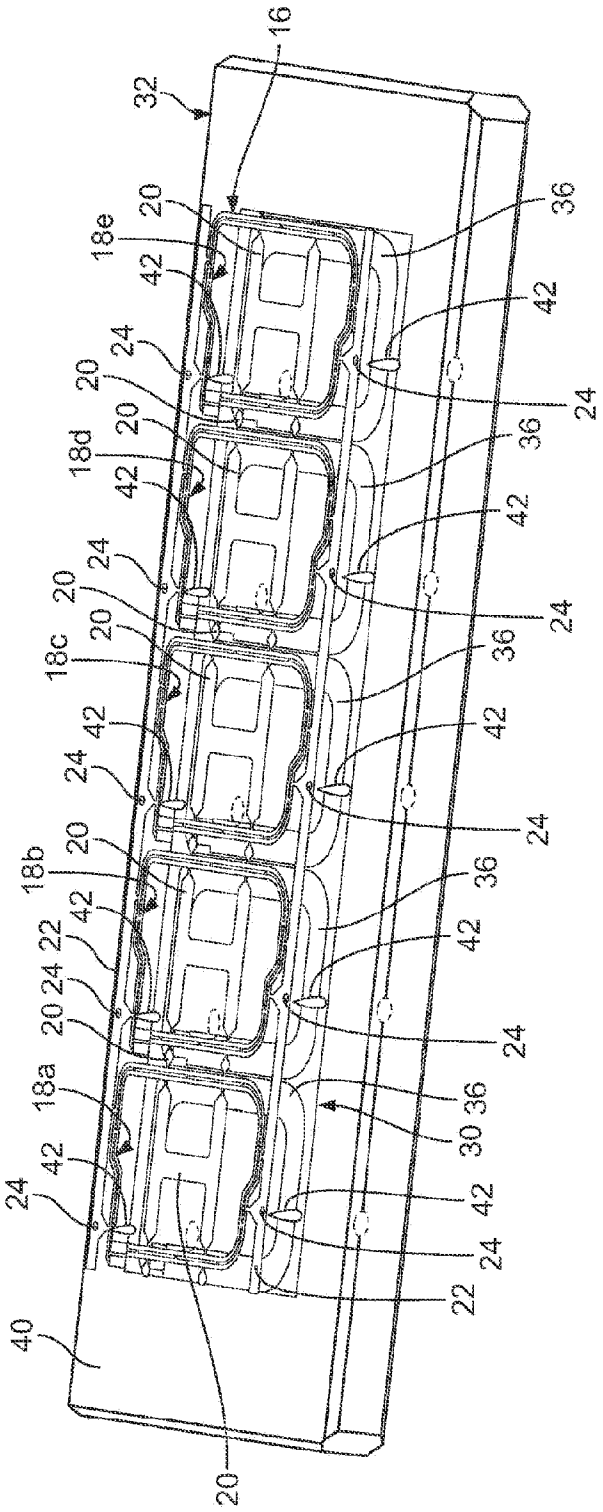

FIG. 6

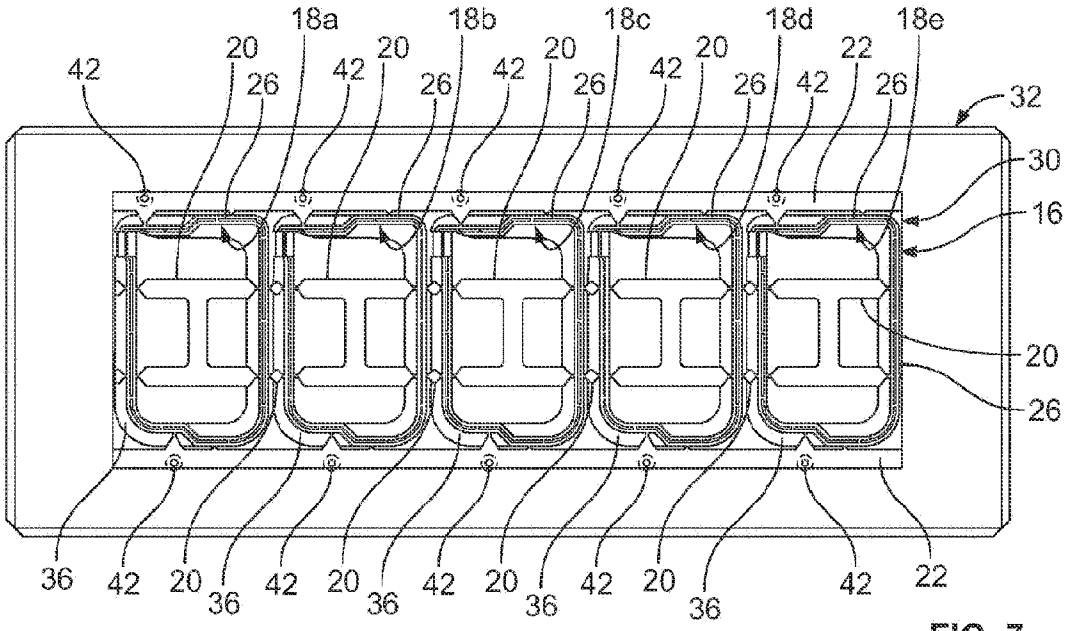

FIG. 7

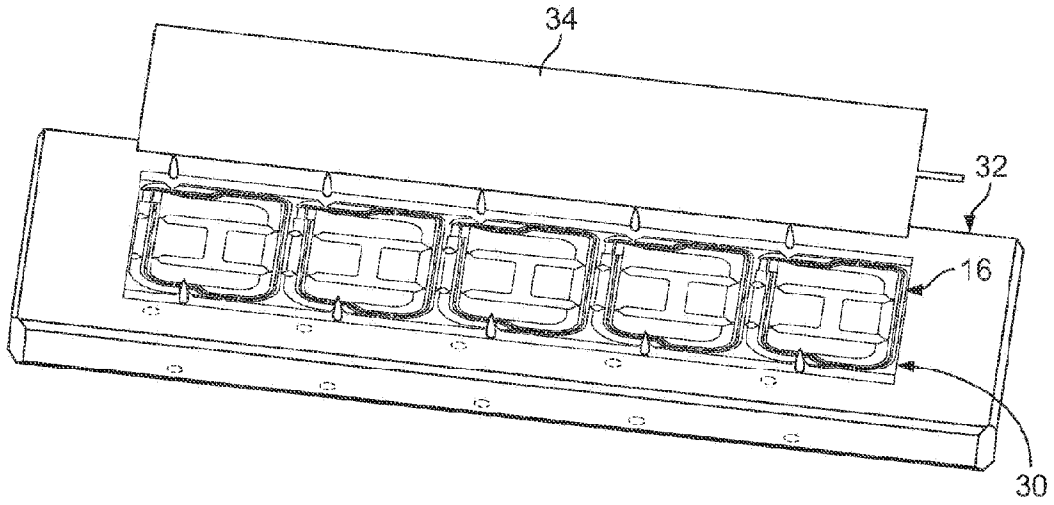

FIG. 8

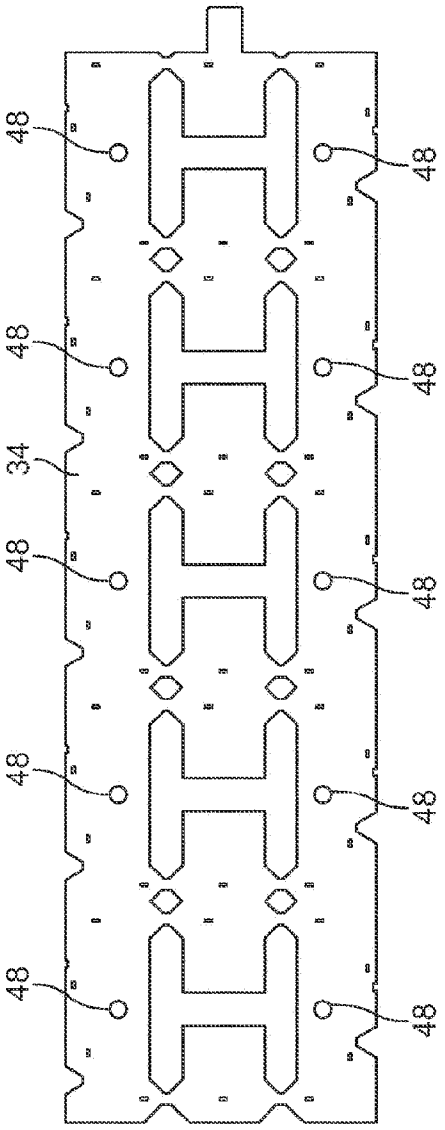

FIG. 9

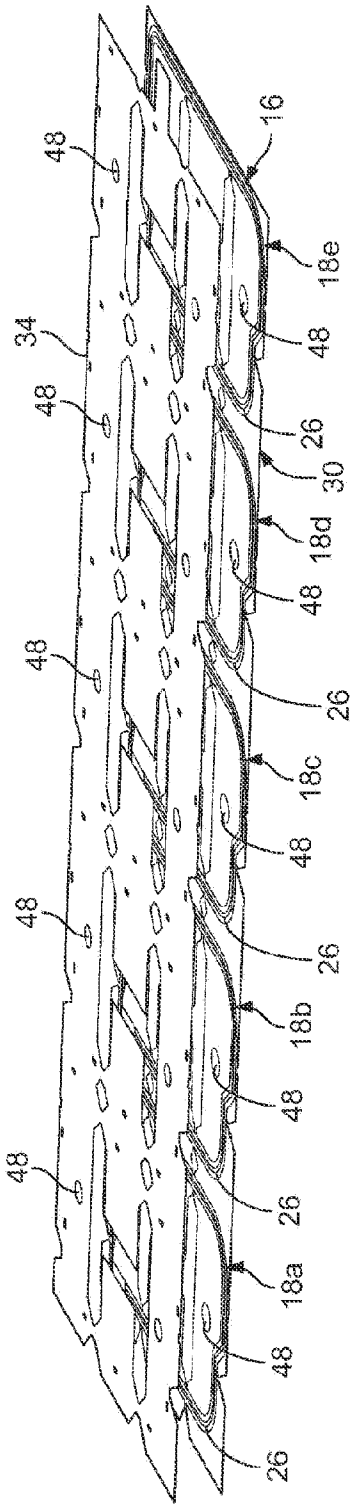

FIG. 10

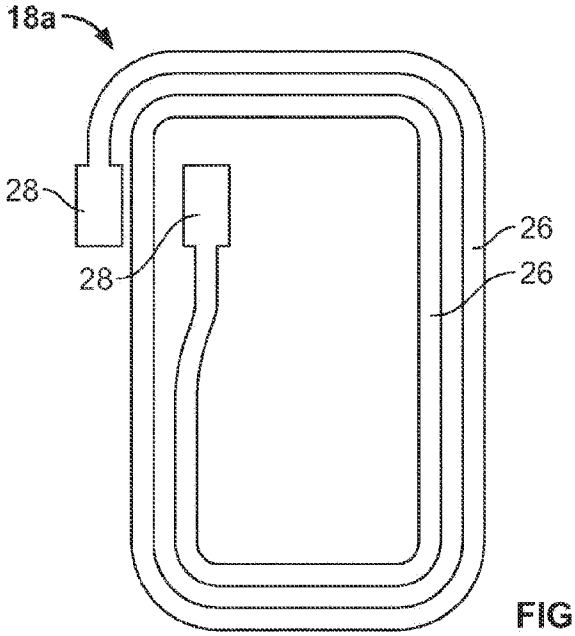

FIG. 11

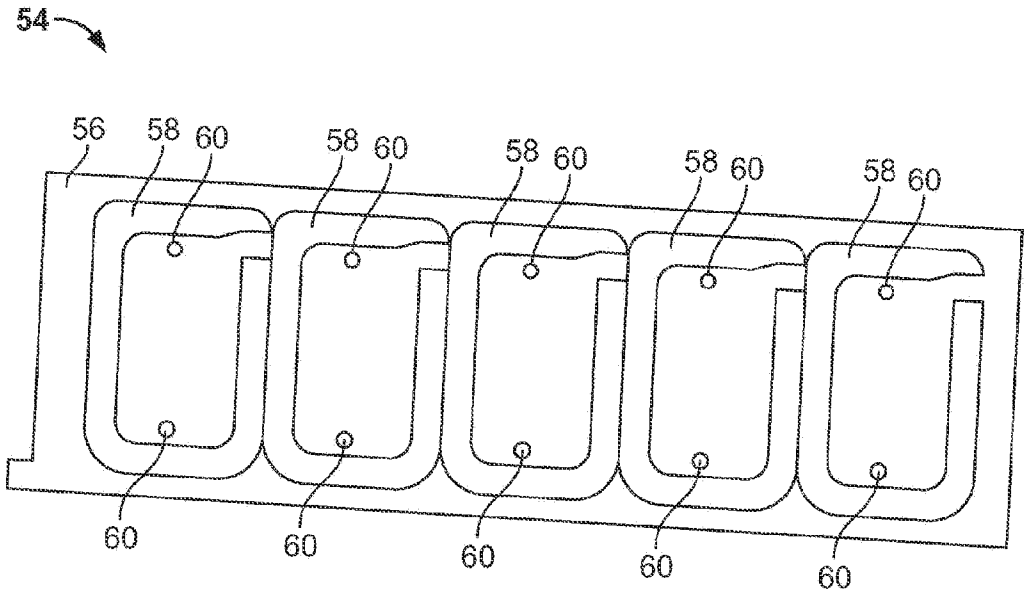

FIG. 12

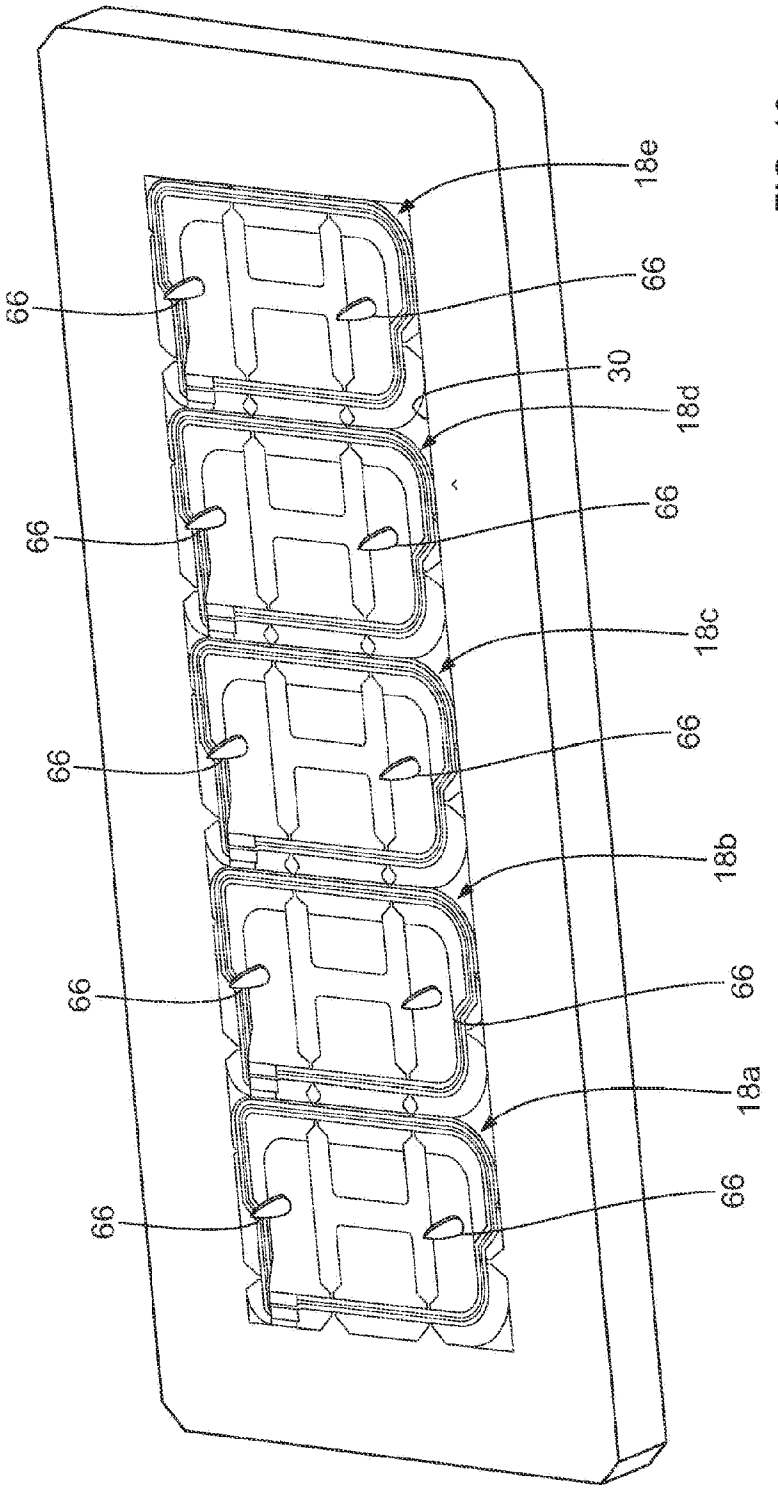

FIG. 13

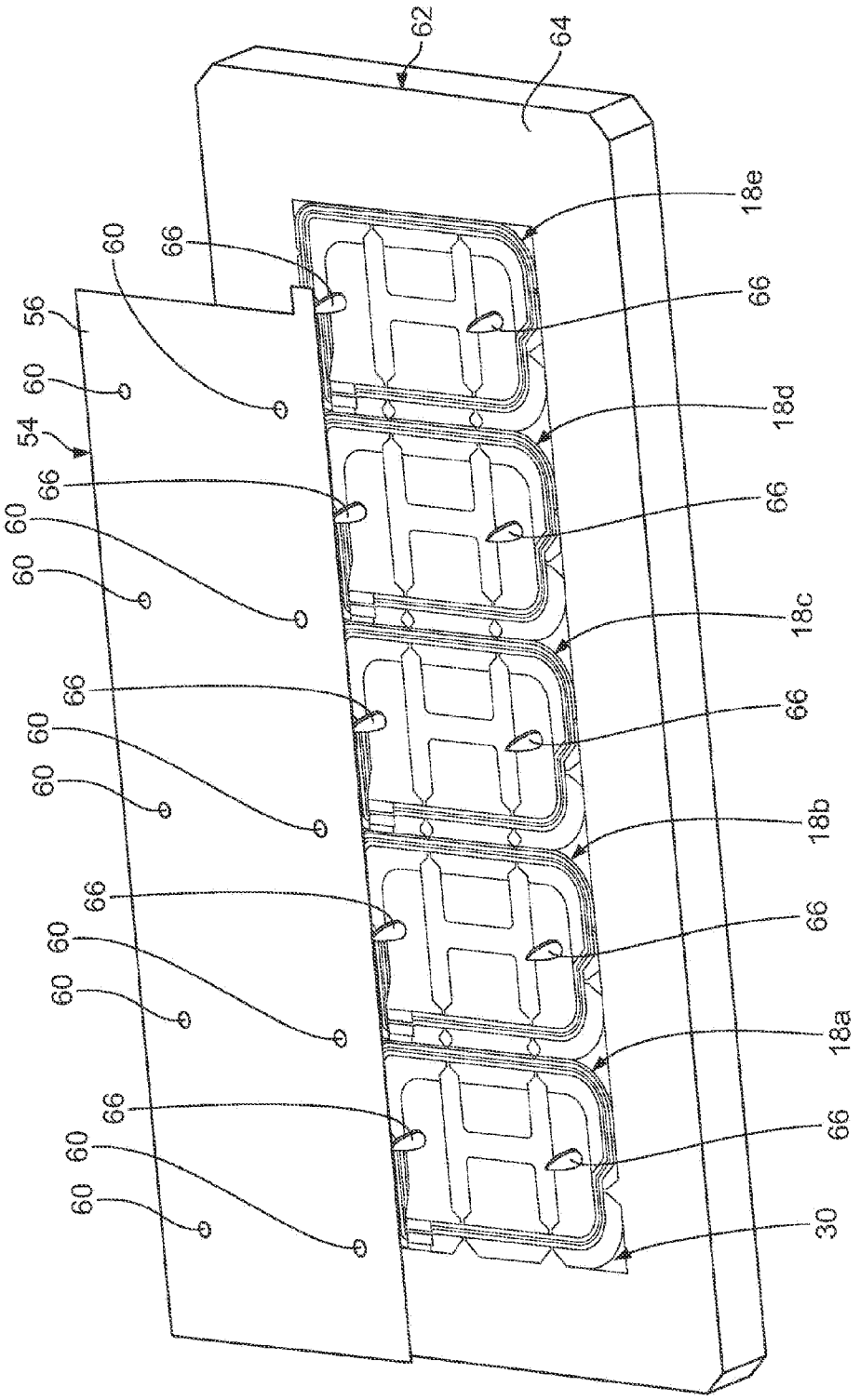

FIG. 14

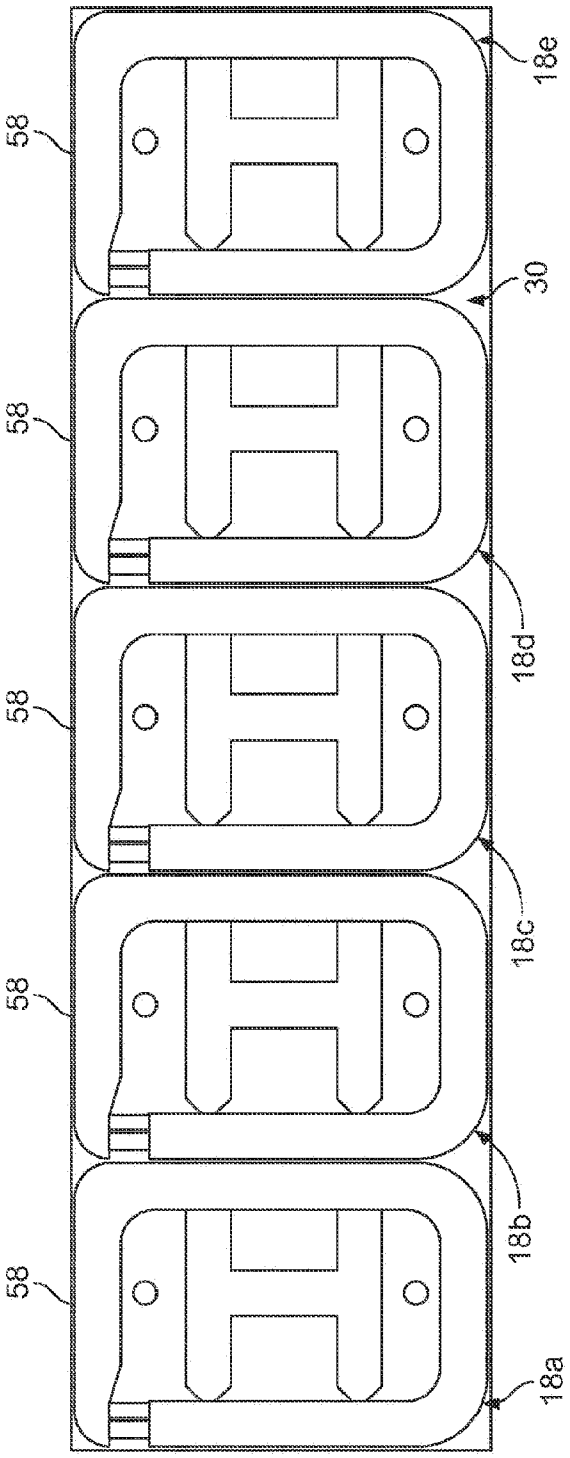

FIG. 15

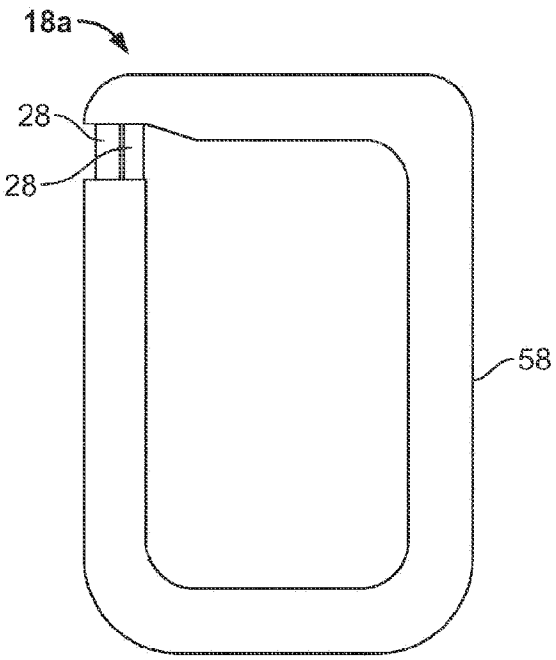

FIG. 16

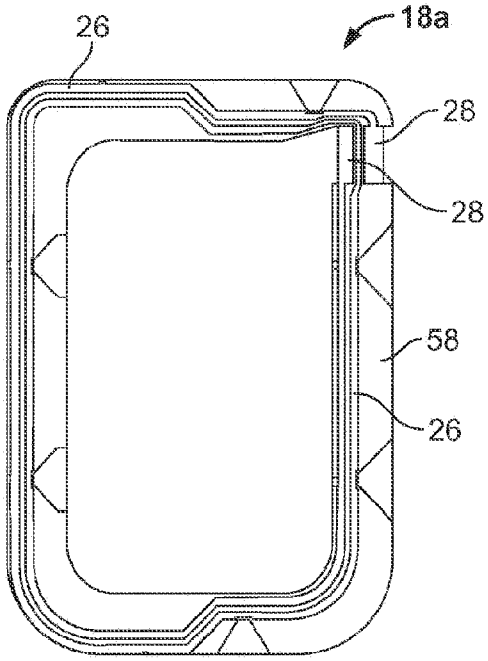

FIG. 17

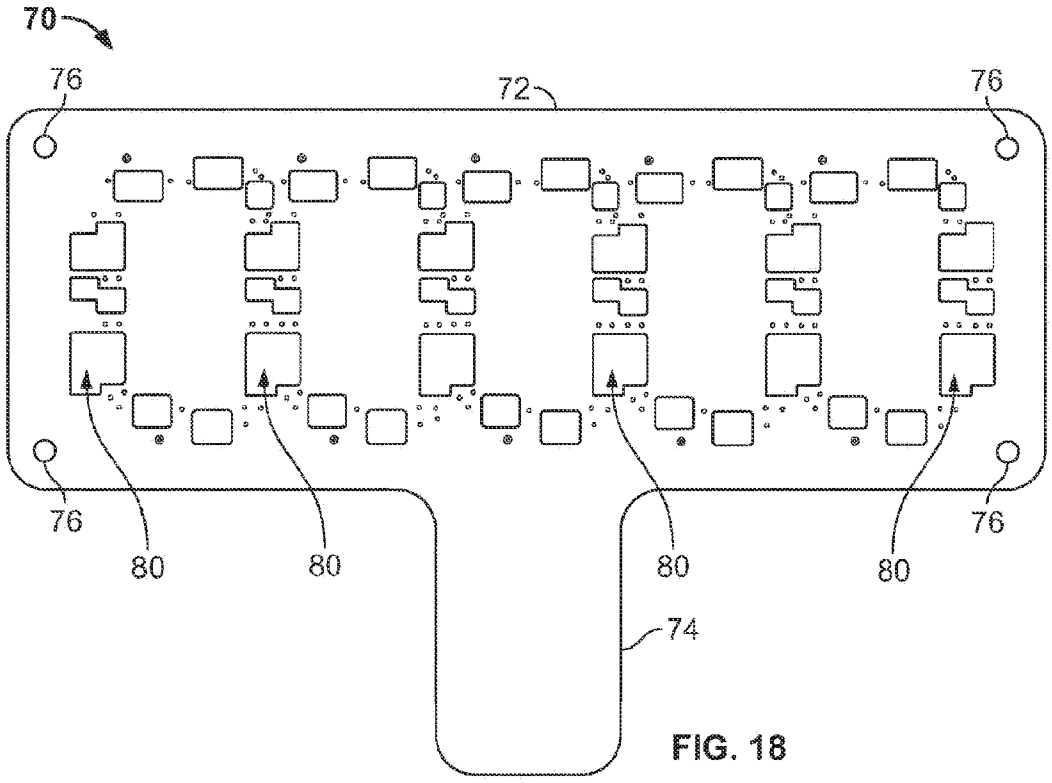

FIG. 18

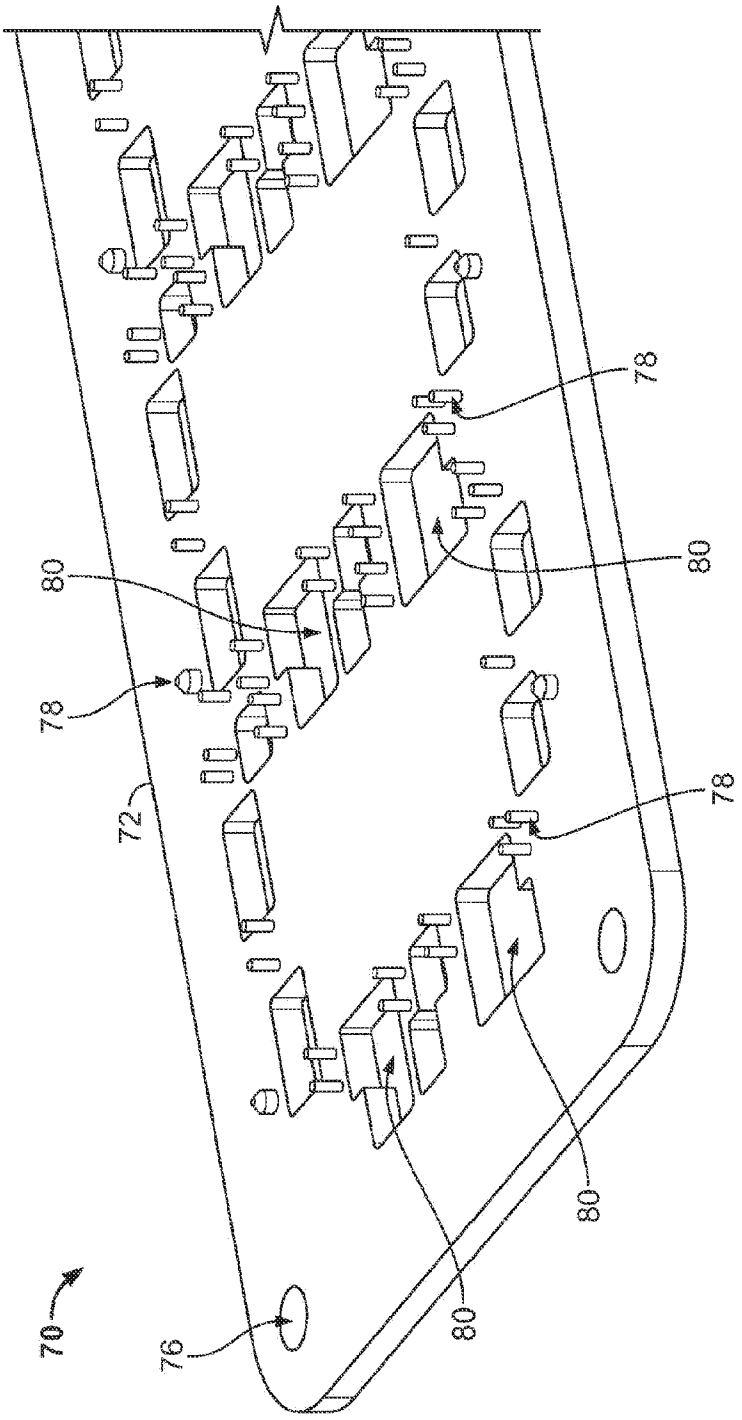

FIG. 19

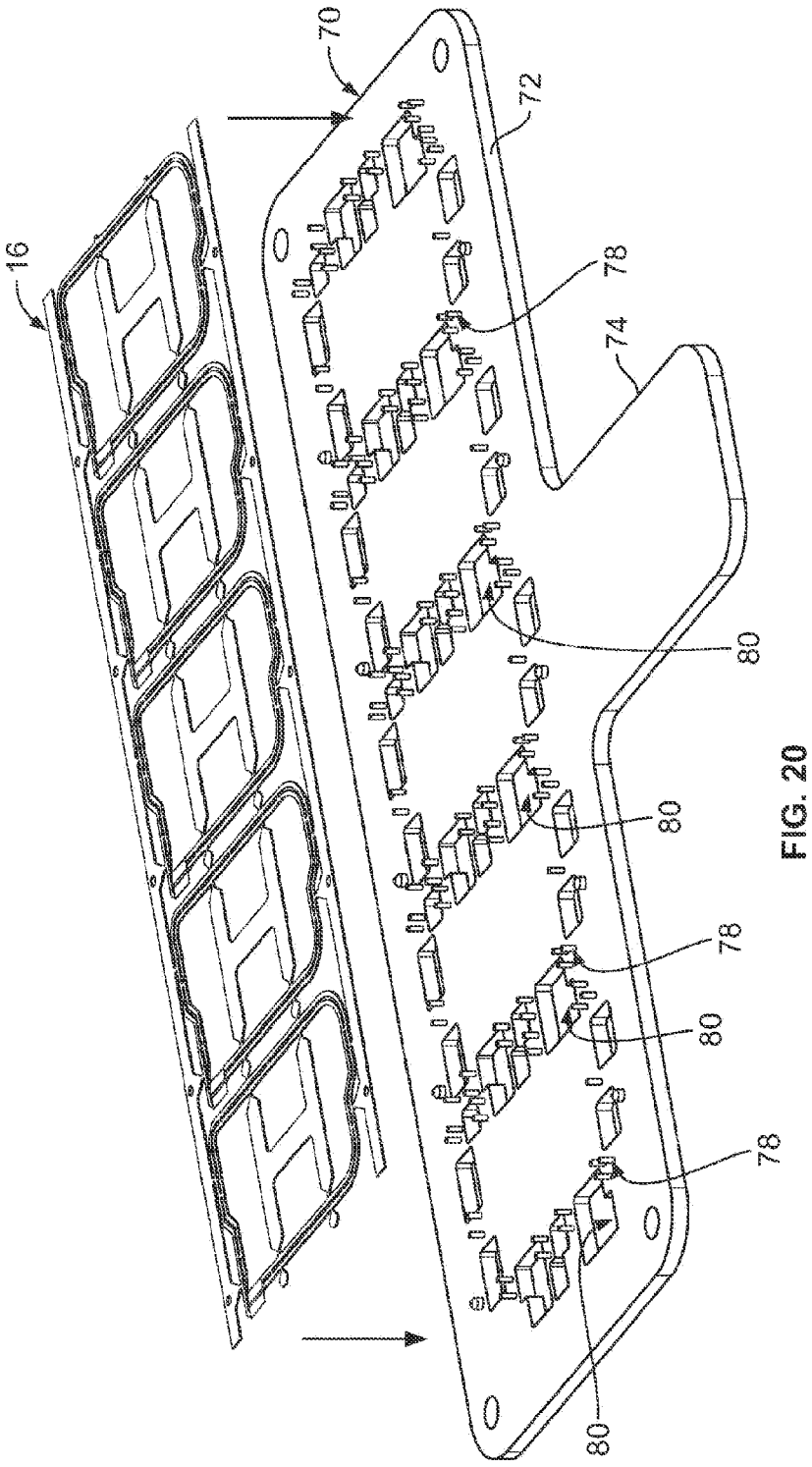

FIG. 20

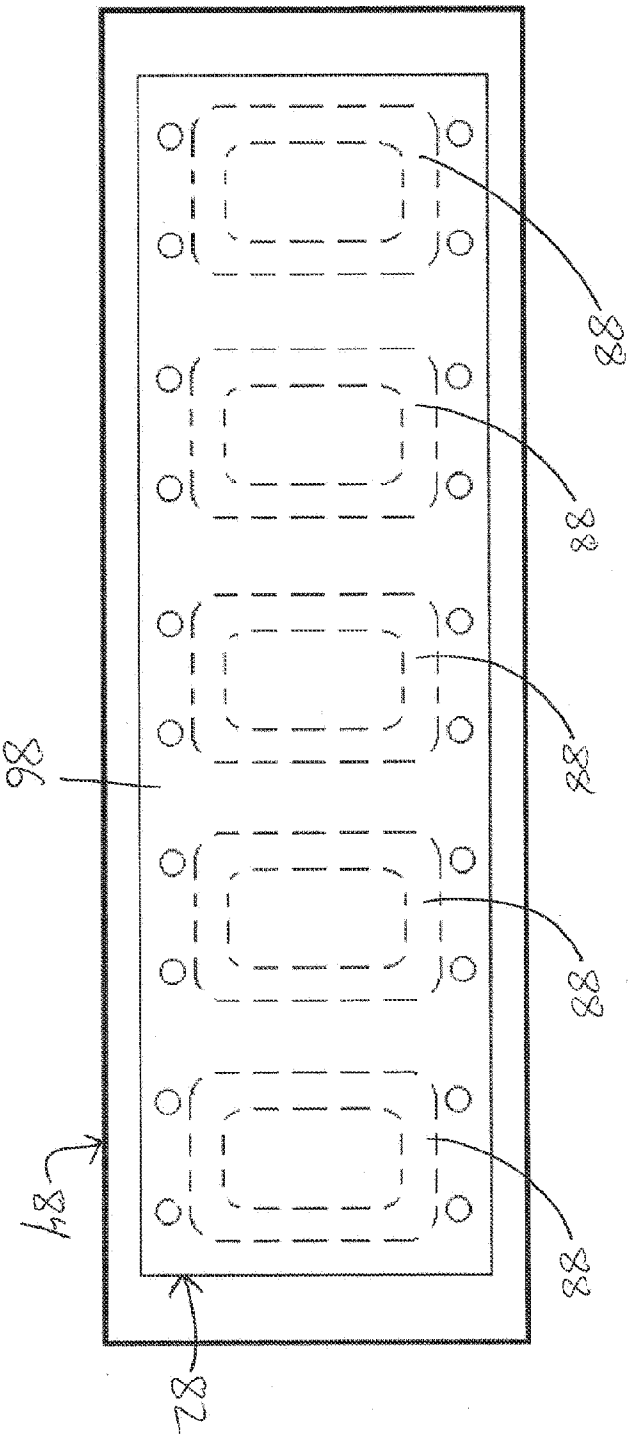

FIG. 21

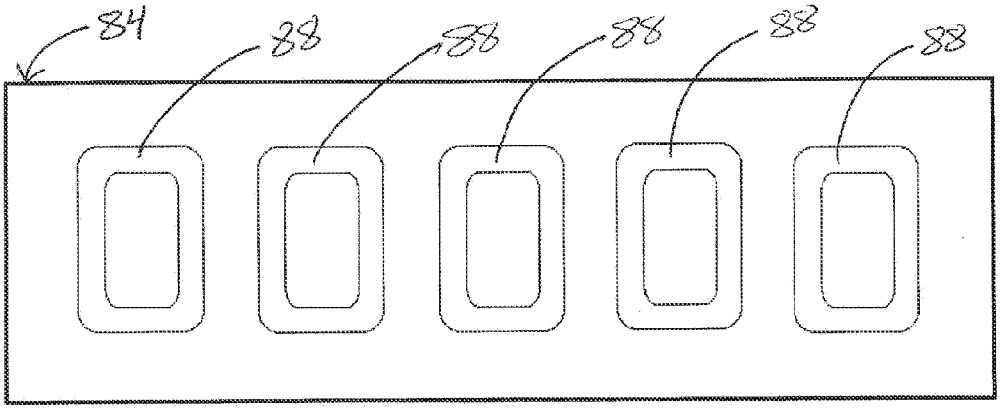

FIG. 22A

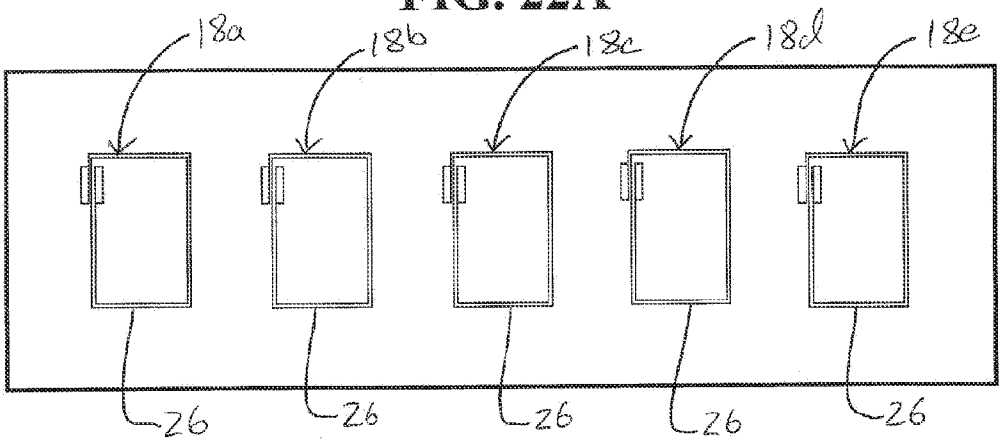

FIG. 22B

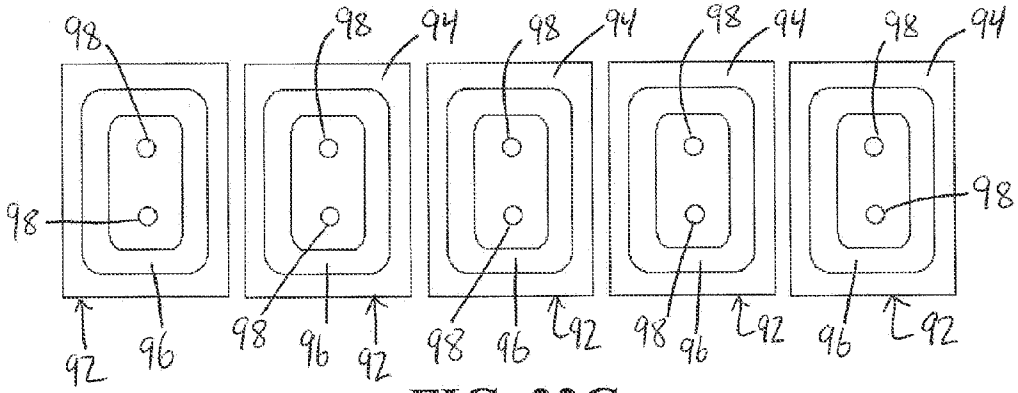

FIG. 22C

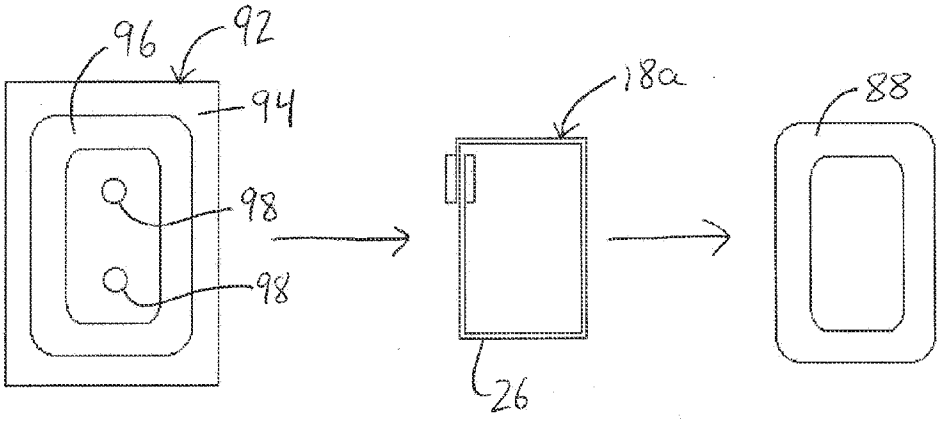

FIG. 23

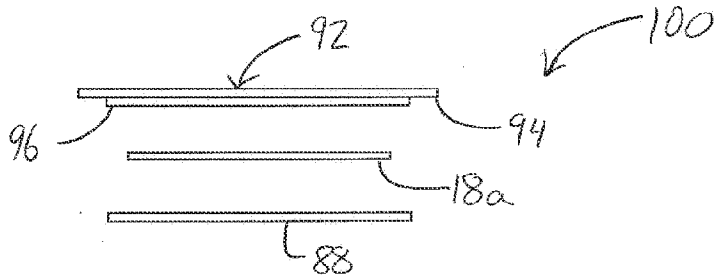

FIG. 24

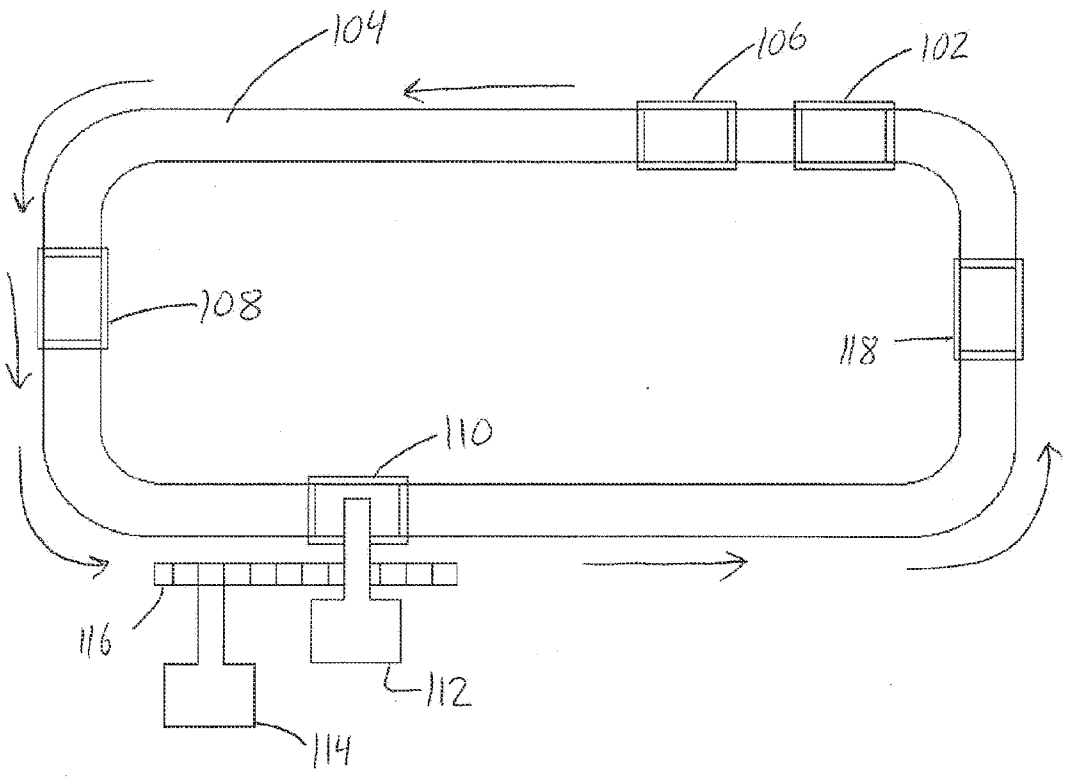

FIG. 25