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Bordewick

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(54) **NASAL CANNULA WITH INFLATABLE PLENUM CHAMBER**

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(52) **U.S. Cl.** **128/207.18**; 128/206.11
(58) **Field of Search** ..... 128/200.24, 200.26, 128/204.11, 204.12, 206.11, 206.18, 206.21, 207.13, 207.18, 912, 203.22, 203.18, DIG. 26; 604/94.01; 606/199, 204.45

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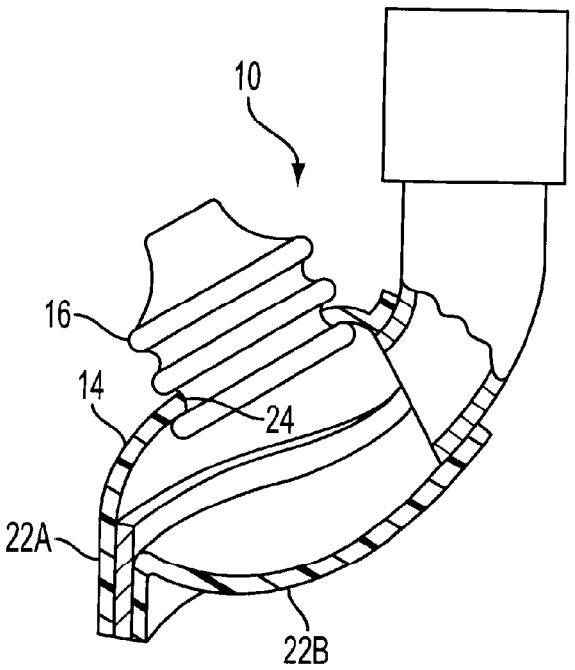
(57) **ABSTRACT**

A nasal cannula for delivering a breathing gas includes a rigid support adapted for placement at least partly beneath the nose of a user, an inflatable plenum chamber mounted on the rigid support, and a pair of nares elements mounted on the inflatable plenum chamber for insertion into the nostrils of the user. The inflatable plenum chamber includes a flexible membrane mounted on the rigid support. The flexible membrane can be preformed to define laterally spaced humps for mounting individual nares element and can further be pleated. Alternatively, a pair of inflatable plenum chambers can be separately mounted on the rigid support.

19 Claims, 3 Drawing Sheets



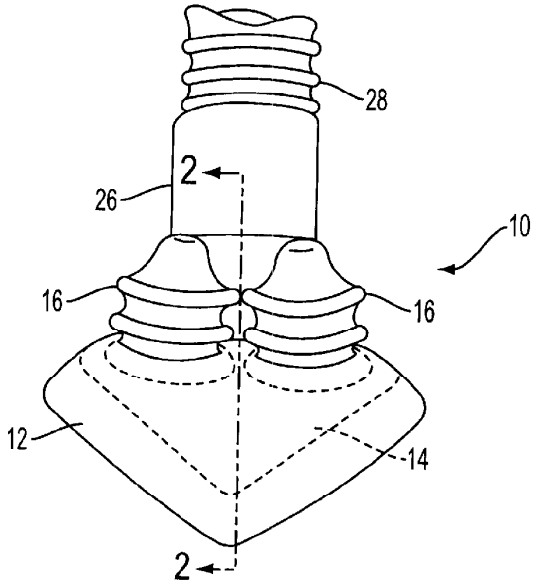


FIG. 1

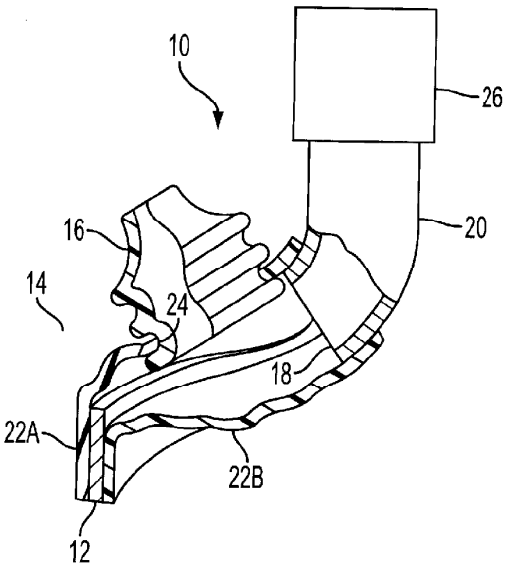


FIG. 2

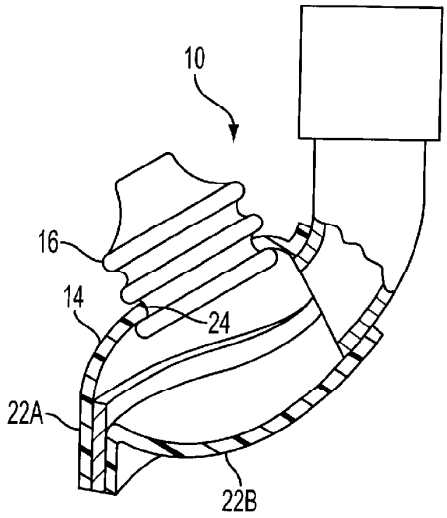


FIG. 3

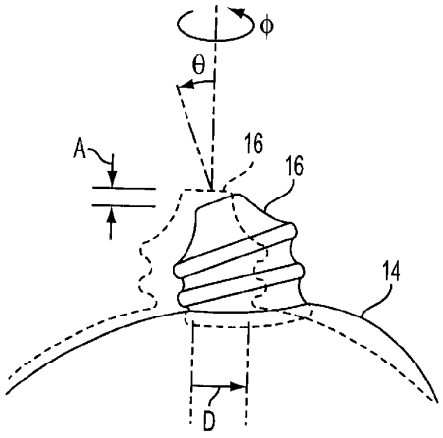


FIG. 4

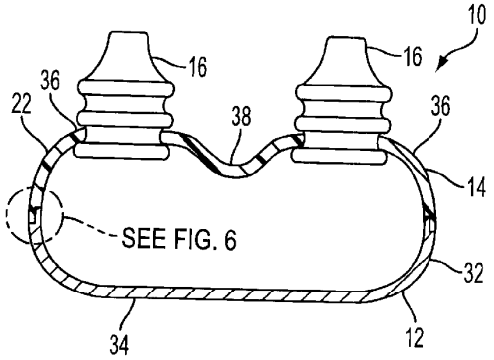


FIG. 5

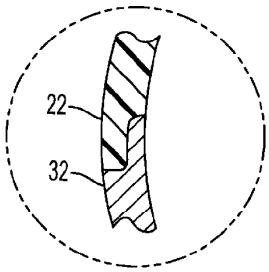


FIG. 6

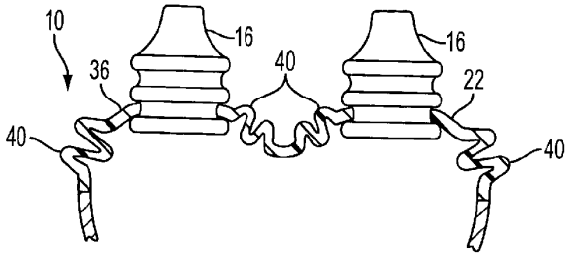


FIG. 7

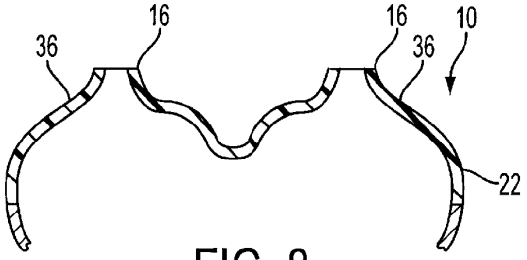


FIG. 8

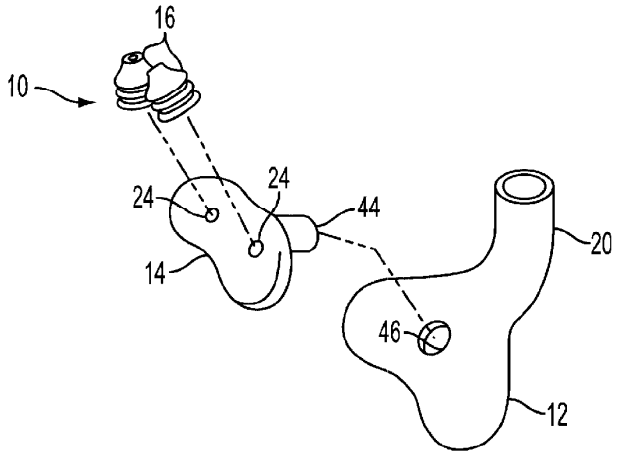


FIG. 9

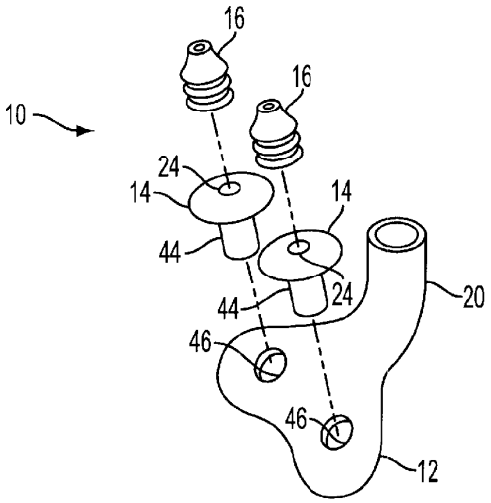


FIG. 10

NASAL CANNULA WITH INFLATABLE PLENUM CHAMBER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to the field of respiratory therapy and, more particularly, to an apparatus and method for delivering a breathing gas to a patient.

2. Description of the Background Art

Continuous positive airway pressure (CPAP) therapy has been shown to be an effective treatment for obstructive sleep apnea, a condition in which the patient's airway passage is repeatedly blocked during a period of sleep resulting in interruption of the flow of air to the patient's lungs and causing the patient to awaken. CPAP therapy involves delivering a breathing gas at a constant gas pressure through the nasal passages to prevent negative pressure conditions within the upper air passageway which can lead to obstruction, thereby allowing continuous air flow through the upper air passageway. The gas is typically administered by placing a mask over the nose of the patient by means of a strap or harness or other headgear and providing a source of positive low pressure air connected to the mask.

Conventional nasal masks, exemplified by U.S. Pat. No. 4,655,213 to Rapoport et al., include a shell that contacts the face of the patient around the nose to form a seal. This type of mask is sometimes considered uncomfortable because of the contact pressure needed to obtain an adequate seal, and are often noisy due to air leaks. In many cases, use of a conventional mask represents a formidable obstacle to patient acceptance of CPAP therapy.

An alternative approach which has gained widespread acceptance, exemplified by U.S. Pat. No. 4,782,832 to Trimble et al., involves use of a nasal cannula having a pair of nares elements or inserts configured for insertion into the respective nostrils of a patient. The nares elements are mounted on a rigid plenum chamber extending from a gas inlet tube connected with a source of breathing gas and include passages formed therethrough in communication with openings in the plenum chamber. The outer wall of each nares element is generally frustoconically shaped so as to sealingly engage the nares-defining surface of the nose. Adjustability of the nares elements is provided by rotatably mounting the elements to the plenum chamber and mounting the elements in slots permitting selective lateral positioning of the elements with respect to each other. The nares elements can be provided with flexible corrugated sections to achieve greater degrees of flexibility and adjustability. The nares elements are also formed of a relatively soft, deformable, shape-retaining synthetic resin material permitting manual deformation and alteration of the effective shape and position of the elements.

A variation of the aforementioned nasal cannula, disclosed in U.S. Pat. No. 5,269,296 to Landis, includes nares elements with inflatable cuffs that engage the interior walls of the nose defining the nares in order to hold the cannula in place within the nares. The cuffs can be inflated by means of apertures formed in the side walls of the nares elements or, alternatively, by tubes delivering gas from a separate source of gas. The nasal cannula is held in place by an inflatable harness composed of hoses made of soft inflatable plastic which inflate upon application of air pressure to the hoses. While such an inflatable harness is potentially softer than a conventional harness, the increased bulk associated therewith can contribute to patient discomfort and the lack of rigidity can make it difficult to properly position and maintain the device in a desired position without frequent readjustment.

While the aforementioned nasal cannulae are an improvement over prior nasal masks, there continues to be a need for an improved nasal cannula that offers greater adjustability and comfort for the patient without added complexity.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention to provide a nasal cannula which overcomes the disadvantages of prior nasal masks and cannulae.

A first aspect of the present invention is generally characterized in a nasal cannula for delivering a breathing gas including a rigid support adapted for placement at least partly beneath the nose of a user, an inflatable plenum chamber mounted on the rigid support, and a pair of nares elements mounted on the inflatable plenum chamber for insertion into the nostrils of the user. The inflatable plenum chamber preferably includes at least one flexible membrane mounted on the rigid support. The flexible membrane can be preformed to define laterally spaced humps for mounting individual nares element and can further be pleated.

The nares elements can be mounted on a single inflatable plenum chamber or on separate inflatable plenum chambers. The nares elements can further be provided separately and attached to the inflatable plenum chamber or formed integrally as part of the plenum chamber. The inflatable plenum chamber can be fixed to the rigid support or detachably connected to the rigid support.

Another aspect of the present invention is generally characterized in a method of delivering a breathing gas using a nasal cannula including at least one inflatable plenum chamber mounted on a rigid support and a pair of nares elements mounted on the at least one inflatable plenum chamber. The method includes the steps of securing the nasal cannula to the head of the user, positioning the nasal cannula such that the nares elements are disposed within the nostrils of the user and the at least one inflatable plenum chamber is disposed between the nares elements and the rigid support, and delivering a breathing gas to the user via the inflatable plenum chamber and the nares elements.

The above and other features and advantages of the present invention will be further understood from the following description of the preferred embodiments thereof, taken in conjunction with the accompanying drawings in which like reference numerals are used to denote like parts.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a front view of a nasal cannula according to the present invention.

FIG. **2** shows a side view of the nasal cannula of FIG. **1**, partly in section, with its plenum chamber deflated.

FIG. **3** shows a side view of the nasal cannula of FIG. **1**, partly in section, with its plenum chamber inflated.

FIG. **4** shows how a nares element mounted on an inflatable plenum chamber can move with several degrees of freedom.

FIG. **5** shows a fragmentary front view, partly in section, of another embodiment of a nasal cannula according to the present invention.

FIG. **6** shows an enlarged fragmentary view, in section, of the interface between inflatable and rigid plenum portions of the nasal cannula of FIG. **5**.

FIG. **7** shows a fragmentary front view, partly in section, of yet another embodiment of a nasal cannula according to the present invention.

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