GAS-SENSING MASK

BACKGROUND OF THE INVENTION

The present invention generally relates to fluid delivery systems, and more particularly to fluid delivery systems that administer oxygen or other suitable gases to a patient.

Each year relatively large numbers of individuals suffer from some type of acute distress which requires treatment at hospitals or by emergency response personnel. Often times, in order to stabilize the individual during the distress period, it is necessary to supplement the individual's oxygen intake to facilitate the breathing of the individual. Once the patient is treated and stabilized, the patient may still require a supplemental oxygen supply. In such cases, it is important to monitor the breathing rate of the individual to ensure continuous respiration and proper oxygen uptake. Hence, if the acute distress reoccurs, which can result in difficulty or a complete cessation of breathing, the hospital clinicians or emergency response personnel can quickly recognize the situation and respond accordingly.

There presently exists several conventional practices for administering oxygen to facilitate breathing of a patient in distress. One practice includes the use of a looped cannula having a pair of stub-like portions which are placed within the nostrils of the patient. Oxygen is introduced to the patient through these stub-like portions. Typical drawbacks of using the cannula include irritation of the nose, which causes swelling and at times severe discomfort, particularly if the person is allergic to the long term presence of the cannula. Another drawback is that the cannula can become easily crimped, thus cutting off the oxygen supply to the patient. Further drawbacks include the relatively easy dislodgment of the cannula from the patient's nostrils.

A variety of oxygen masks have also been used to administer oxygen to the patient. The oxygen masks vary in type and construction depending upon the specific purpose or use of the mask. Conventional oxygen masks include a body, either resilient or rigid, that is sized to seat over the face of the patient. Oxygen is introduced to the patient through an oxygen inlet, and respired gases are vented from the mask interior through appropriately placed ventilation apertures.

Other conventional oxygen administering apparatuses include oxygen tents which substantially completely surround the patient's head. The oxygen tent includes a support structure that supports a resilient membrane (which forms an oxygen chamber) about the patient's head. Oxygen is supplied to the interior of the chamber by appropriately placed fluid conduits. A drawback of the oxygen tent is that a relatively significant portion of the oxygen can escape from the tent. Thus, the total amount of oxygen supplied to the patient is not readily determinable. Furthermore, the creation of a highly flammable environment about the patient's head exposes the patient to risk of injury.

The industry has also developed a number of carbon dioxide indicators which detect the presence of carbon dioxide in a gas mixture. These carbon dioxide detection apparatuses include a chemical compound that changes color in the presence of carbon dioxide. Other devices include pH sensitive dyes suspended in a gel substance, and gas analyzers which typically employ a light source to transmit light through a multi-layered sensor unit and a detector to receive and analyze the color changes of a pH sensitive indicator disposed in one or more of the layers. These devices are commonly used, however, in conjunction with endotrachial tubes to determine whether correct intubation procedures have been effected. Examples of such carbon dioxide indicators are shown and described in U.S. Pat. No. 4,728,499 of Fehder, U.S. Pat. No. 4,994,117 of Fehder, and U.S. Pat. No. 5,375,592 of Kirk et al.

A common drawback of the foregoing conventional oxygen-administering and endotracheal devices is that they generally do not monitor, over a period of time, the breathing or respiration of the patient.

Due to the foregoing and other shortcomings of prior art oxygen administering and gas detecting devices, it is thus an object of the present invention to provide a system for continuously monitoring the respiration of a patient.

It is another object of the invention to provide a relatively lightweight and relatively low cost gas-sensing device suitable for use in hospital and home care environments.

Still another object of the invention is to provide a system and apparatus that continuously detects changes in the respiratory rate of a subject wearing a gas delivery system.

Yet another object of the invention is to provide a system and apparatus that provides a visual indicator of the respiration of the patient.

Still yet another object of the invention is to provide apparatus that detects and displays or indicates the respiratory rate of the subject.

Another object of the invention is to provide a relatively reliable and inexpensive apparatus that monitors the breathing rate of the subject.

Other general and more specific objects of the invention will in part be obvious and will in part appear from the drawings and description which follow.

SUMMARY OF THE INVENTION

The present invention provides for a gas sensing mask and system that senses the presence or absence of a selected respired gas, e.g., carbon dioxide, and that indicates the presence or absence thereof. The term "respired gas" is intended to include any gas inhaled or exhaled by the patient, and particularly includes oxygen and carbon dioxide. The invention attains the foregoing and other objects with a gas sensing mask that includes a non-porous housing that is sized to seat over the nose and mouth of a subject. The mask includes a fluid aperture which communicates with a fluid source and a sensor mounting aperture formed in an intermediate portion of the housing. A gas sensor, which senses one or more selected respired gases, is directly mounted within the sensor mounting aperture. The sensor when mounted within the mounting aperture of the mask is integral with the housing and is preferably disposed in intimate contact therewith.

According to one aspect, the gas sensor includes an indicator element that is integral with the gas sensor, and which visually indicates the presence or absence of the respired gas. According to one practice, the gas sensor includes a calorimetric element that calorimetrically indicates the presence or absence of the gas. The gas sensor thus changes color in the presence of a respired gas, and particularly changes color in the presence of carbon dioxide. According to another practice, the gas sensor includes a gas-sensitive element, e.g., a pH-sensitive electrode or transistor, that forms part of the gas sensor or is coupled to the mask. The gas-sensitive element produces an electrical signal in response to the presence of carbon dioxide. The element is coupled to a control unit that is responsive to the electrical signals produced by the element, and which in turn is coupled to one or more means for indicating the presence