To move forward with the **provisional application** based on the drafts, I will now structure the content in a format consistent with recent patents in this field. Here's how we'll proceed, aligning with the form, format, and style typically seen in pneumatic device patents:

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### **Provisional Patent Application for Pneumatic Massager**

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**Title**:

**Pneumatic Massager with Rotary Valve Control and Sequential Inflation Method for Therapeutic and Prosthetic Applications**

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**Abstract**:

The present invention includes a pneumatic massager device and a method for controlling the sequential inflation and deflation of air bladders using a rotary valve and stepper motor system. The device consists of multiple air bladders arranged in a cuff that encircles various body parts. Each bladder is controlled via a single pressurized air line. The rotary valve enables precise airflow control, and the user can adjust pressure and flow rate through a central control system. The method involves inflating the bladders in sequence, with user-adjustable settings for pressure and massage patterns, making the system suitable for therapeutic and prosthetic use.

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### **Detailed Description of the Invention**

#### **Field of the Invention**:

This invention relates to pneumatic massagers for therapeutic and prosthetic applications. Specifically, it addresses a device and method for inflating and deflating air bladders using a rotary valve system to regulate airflow, pressure, and sequential operation.

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#### **Background of the Invention**:

Pneumatic massagers are widely used for therapeutic purposes, including promoting circulation, lymphatic drainage, and recovery after physical exertion. Existing massagers often rely on solenoids for valve control, resulting in high noise levels and heat generation, or use complex air tube configurations that add bulk and restrict portability.

Moreover, the lack of fine pressure control and limited flexibility in adjusting massage patterns reduce their effectiveness for certain users, such as those with venous insufficiency, athletes requiring recovery massage, or cancer patients needing lymphatic drainage.

There is a need for a compact, efficient pneumatic massager that can provide controlled, sequential inflation, pressure regulation, and user-adjustable massage patterns. This invention addresses these limitations through a rotary valve system and offers a method for massager operation that is well-suited to both therapeutic and prosthetic applications.

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#### **Summary of the Invention**:

The invention is a **pneumatic massager device** and an associated **method** for sequentially inflating air bladders. The device consists of a **flexible cuff** containing **multiple air bladders** arranged longitudinally along a limb or torso. A **single pressurized air line** feeds all bladders, simplifying the system by eliminating the need for multiple air hoses.

Each air bladder is connected to a **rotary valve** controlled by a **stepper motor**, which adjusts the

intake and exhaust ports to regulate airflow. The rotary valve's unique design includes a hollow rotor, created using 3D printing, and is sealed through acetone lapping to prevent air leaks. The device's wiring is chained from valve to valve using an **I2C bus** for simplified control.

The **method** includes inflating the bladders in sequence, monitoring air pressure through a **central sensor**, and allowing the user to control pressure, flow rate, and massage patterns. These features provide greater flexibility for therapeutic applications such as lymphatic massage and venous insufficiency treatment, as well as prosthetic applications for patients requiring continuous light massage.

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### **Detailed Description of the Device**

1. **Overview of the System**:

- The device consists of a **flexible cuff** (10) designed to fit around various body parts such as limbs or torso. The cuff contains multiple **narrow air bladders** (12) arranged in a stacked configuration to ensure even pressure distribution. Each bladder is connected to a **single air line** (14) for sequential inflation.

2. **Rotary Valve Mechanism**:

- The **rotary valve system** (20) controls the airflow into and out of the air bladders. Each valve has a hollow rotor (22) with a pattern of holes (24) that align with the intake (26) and exhaust (28) ports. The rotor is driven by a **stepper motor** (30) in 90-degree increments, allowing for precise control of airflow.

3. **Chained Wiring**:

- The system uses **four wires** per valve: ground (32), Vcc (34), SCL (36), and SDA (38), which are connected to the **central controller** (40). The wiring is chained from valve to valve, reducing bulk and simplifying the system's structure.

4. **User Control and Pressure Regulation**:

- The **user interface** (42) allows the user to adjust the **pressure**, **flow rate**, and select **massage patterns**. The system includes a **pressure sensor** (44) that monitors the pressure in the air line and adjusts each bladder’s inflation accordingly.

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### **Detailed Description of the Method**

1. **Step 1: Sequential Inflation**:

- The method begins with the **rotary valve system** (50) opening the intake port of the first bladder in the sequence. The **central controller** (52) monitors the pressure using a pressure sensor (54) and inflates the bladder until the desired pressure is reached, at which point the valve closes to seal the bladder.

2. **Step 2: Inflating Subsequent Bladders**:

- Once the first bladder is sealed, the **rotary valve** moves to the next bladder, repeating the inflation process in sequence. This method allows for smooth, user-controlled inflation along the limb or torso.

3. **Step 3: Deflation**:

- After all bladders are inflated, the rotary valve switches to open the exhaust port (60), releasing pressure from the bladders in the reverse sequence of inflation, providing a controlled and therapeutic deflation process.

4. **User Adjustable Control**:

- The method includes **user-adjustable control** (62) over **pressure levels** and **flow rates**, allowing the user to customize the massage for various therapeutic needs. The controller allows for different massage patterns, such as lymphatic or venous insufficiency treatments.

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### **Brief Description of the Drawings**

1. **Figure 1**: A side view of the pneumatic massager cuff showing the placement of air bladders and the rotary valve system.

2. **Figure 2**: An air bladder layout showing the sequential arrangement of the bladders and the integration of the pressurized air line.

3. **Figure 3**: A cross-sectional view of the rotary valve mechanism showing the rotor's alignment with intake and exhaust ports.

4. **Figure 4**: A schematic diagram of the wiring configuration, showing the connection of four wires per valve and the chained setup to the central controller.

5. **Figure 5**: A block diagram of the control system, including the I2C bus, central controller, pressure sensor, and user interface.

6. **Figure 6**: A view illustrating the prosthetic application, showing the massager worn under a compression stocking.

7. **Figure 7**: A flowchart detailing the method of sequential inflation and deflation of the air bladders.

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This format aligns with typical recent patent filings for pneumatic devices and methods. Since provisional applications don't require formal claims, you can file this to secure your priority date. Let me know if you'd like to proceed with filing or if any changes are needed!