April 19, 1960 F. H. REDER 2,933,646

MOLECULAR BEAM FOCUSING DEVICES

Filed May 6, 1958

FIG. 1

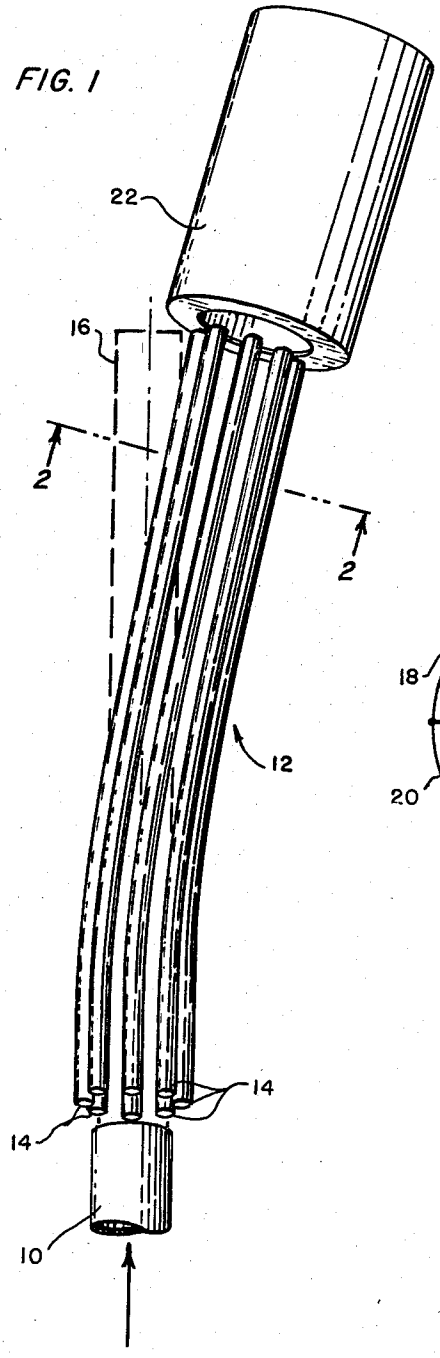
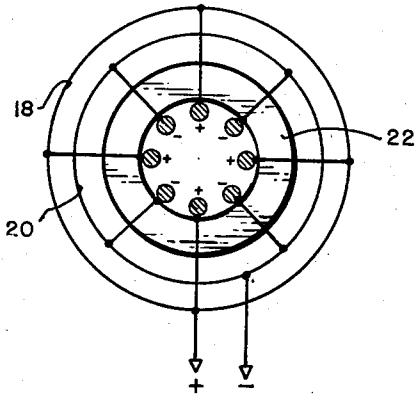


FIG. 2



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MOLECULAR BEAM FOCUSING DEVICES

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3 Claims. (Cl. 315—111)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment of any royalty thereon.

This invention relates to focusers for molecular resonance devices in which oscillations are generated during transitions to lower energy states of molecular particles. One device of this type is known as the Maser.

In the Maser, a stream of ammonia gas is passed through a focuser which separates out the molecules of lower energy state and concentrates those of higher energy state into a beam. This beam is passed into a cavity resonator where, during transitions of the molecules to lower energy states, oscillations of characteristic frequencies, called transition frequencies, are radiated. The resonator is tuned to one of these frequencies, so that the latter is sustained. A more detailed description of the Maser may be found in Physical Review, vol. 99, Aug. 15, 1955.

One type of focuser, known as the Stark focuser, consists of a plurality of straight metal rods, evenly spaced along the circumference of a cylinder. Alternate rods are connected to one terminal of a source of high unidirectional potential, while the intervening rods are connected to the other terminal of said source. A more detailed description of the Stark focuser may be found in Physical Review, vol. 99, Aug. 15, 1955.

A disadvantage of the conventional straight-rod focuser is that molecules effusing close to the axis of the focuser assembly and parallel to said axis are not acted on by the focuser because in the nozzle a slight flow of the gas is created. This flow causes a substantial number of molecules to follow a straight path into the focuser and of these molecules a substantial portion remain in the axial region of the focuser. As a result, these molecules form a useless load since they do not contribute to the power output of the Maser, while they do cause dielectric detuning of the cavity.

In accordance with the present invention, the above effects are reduced by slightly curving the focuser assembly so that the straight projection of axis of the gun through which the molecular stream is ejected just misses the output aperture of the focuser. In this way almost all the molecules are at some point substantially displaced from the axis of the focuser and are subjected to the focusing action.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, in which:

Fig. 1 is a perspective view of a focuser and cavity of a Maser built in accordance with the invention; and

Fig. 2 is a section taken along line 2—2 of Fig. 1.

In Fig. 1, the mouth of the usual gun or effuser **10** effuses a stream of ammonia gas molecules into the focuser **12**. The focuser comprises a plurality of pairs of

rods **14**, in this case four pairs. Ordinarily these rods are straight and are spaced about a cylinder as indicated by the broken line **16**. In the present case, however, these rods are slightly bent so as to form a gradually curved enclosure. As shown in Fig. 2, alternate rods are connected to a lead **18** to which one terminal of a source of unidirectional polarizing potential is connected. The intervening rods are connected to the opposite terminal of said source through a lead **20**.

The amount of curvature is such that the projection of the axis of the gun **10**, as indicated by the dot-dash line, just misses the output aperture of the focuser. Thus, if the gas is effused from the gun along a rectilinear path, said path would extend just outside the space bounded by the focuser at the output end thereof. As a result every part of the gas beam is displaced from the focuser axis at some point and can be more effectively subjected to the action of the focuser.

The molecular beam passes from the focuser into a cavity resonator **22** which functions in the usual manner.

While there has been described what is at present considered a preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention; and it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a Maser system having a gas effusing element and a cavity resonator, a Stark focuser between said gas effusing element and resonator comprising an even number of like rods evenly spaced about a circle and forming an enclosure into which gas particles are effused along a rectilinear path, said rods being curved relative to the axis of said path along a radius common to all the rods to form a curved cylindrical enclosure into which the molecules pass and a direct current voltage source the terminals of which are connected to said rods to impart opposite polarity to adjacent rods.

2. In a Maser, a Stark type focuser structure, means to effuse a stream of gas molecules along a rectilinear path extending into said focuser, at least a portion of the axis of said focuser being inclined along a plane parallel to said axis relative to said path forming a curved inclosure into which the molecules pass and a cavity resonator at the output of said focuser to receive molecules passing out of said focuser.

3. In a Maser as set forth in claim 2, wherein said focuser structure comprises an even number of evenly-spaced curved rods defining the space through which said molecules are directed, the length and degree of curvature of said rods being such that said rectilinear path just falls outside of said space near the output end of said focuser.

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