Sept. 2, 1958 W. F. GABRIEL 2,850,706

MACHINED WAVEGUIDE PIN CHOKE

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FIG. 1

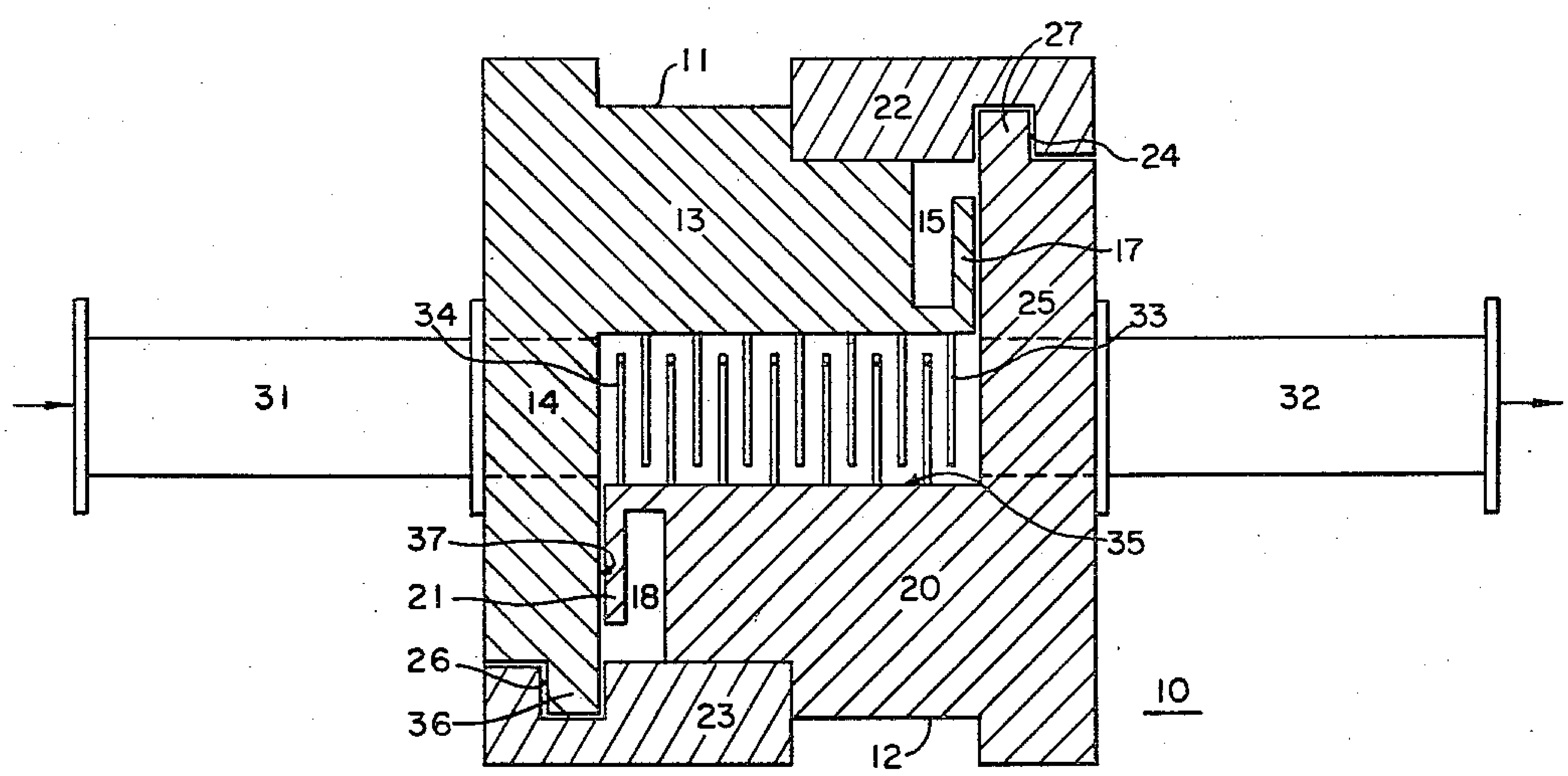


FIG. 2

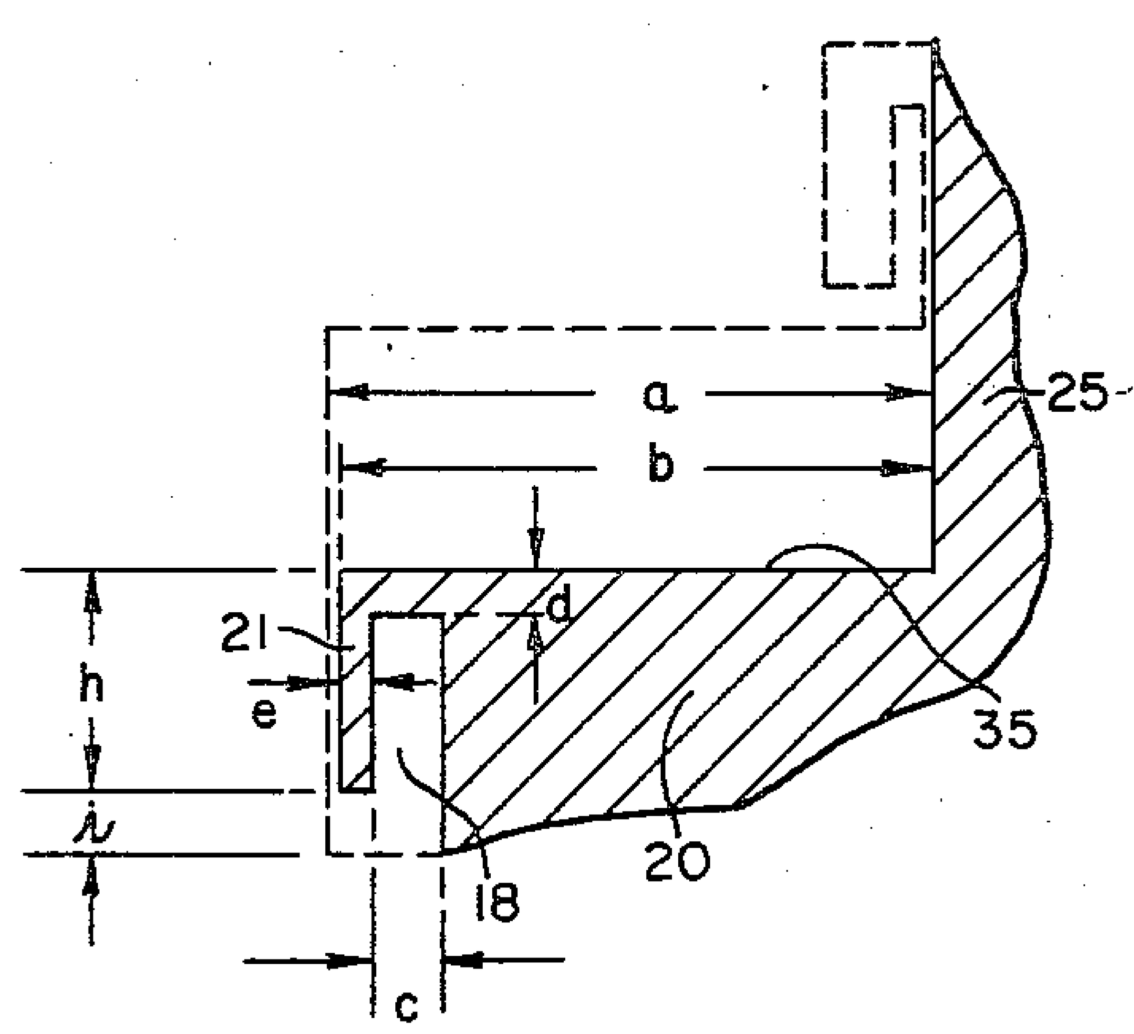
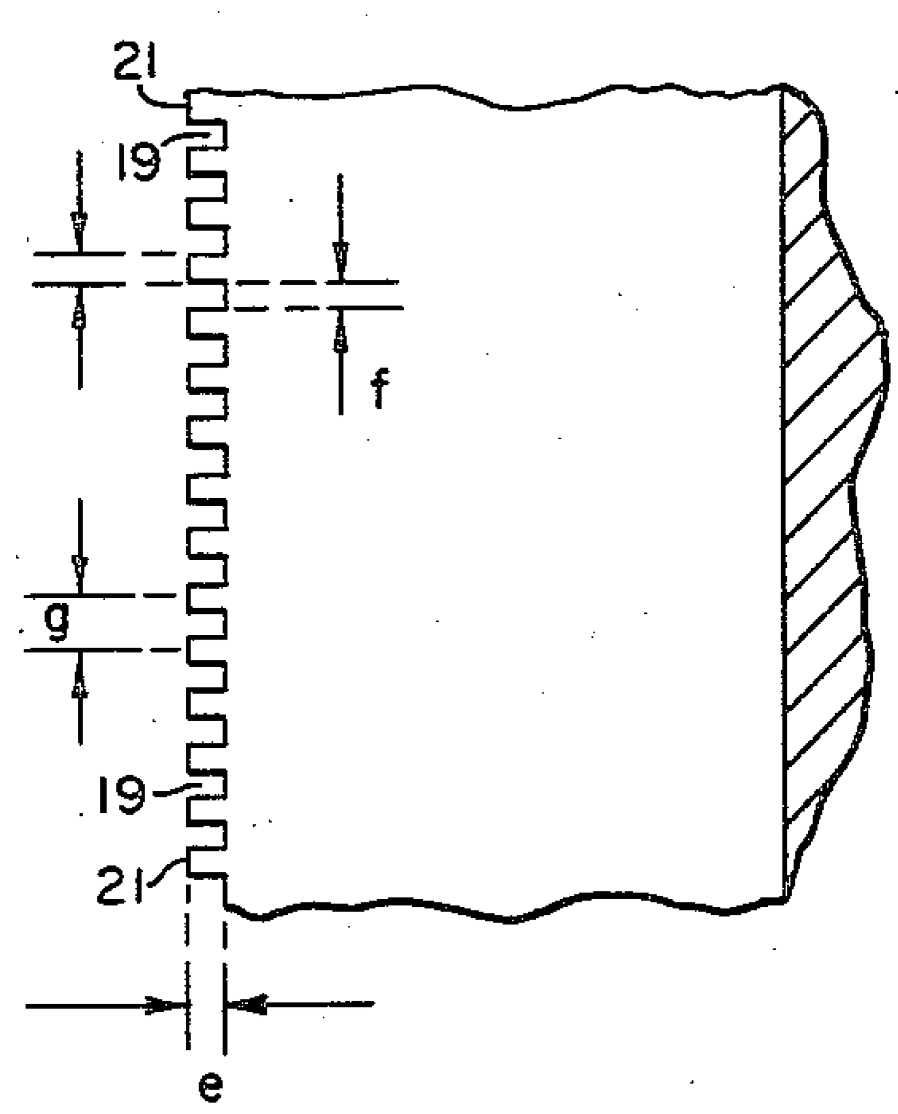


FIG. 3



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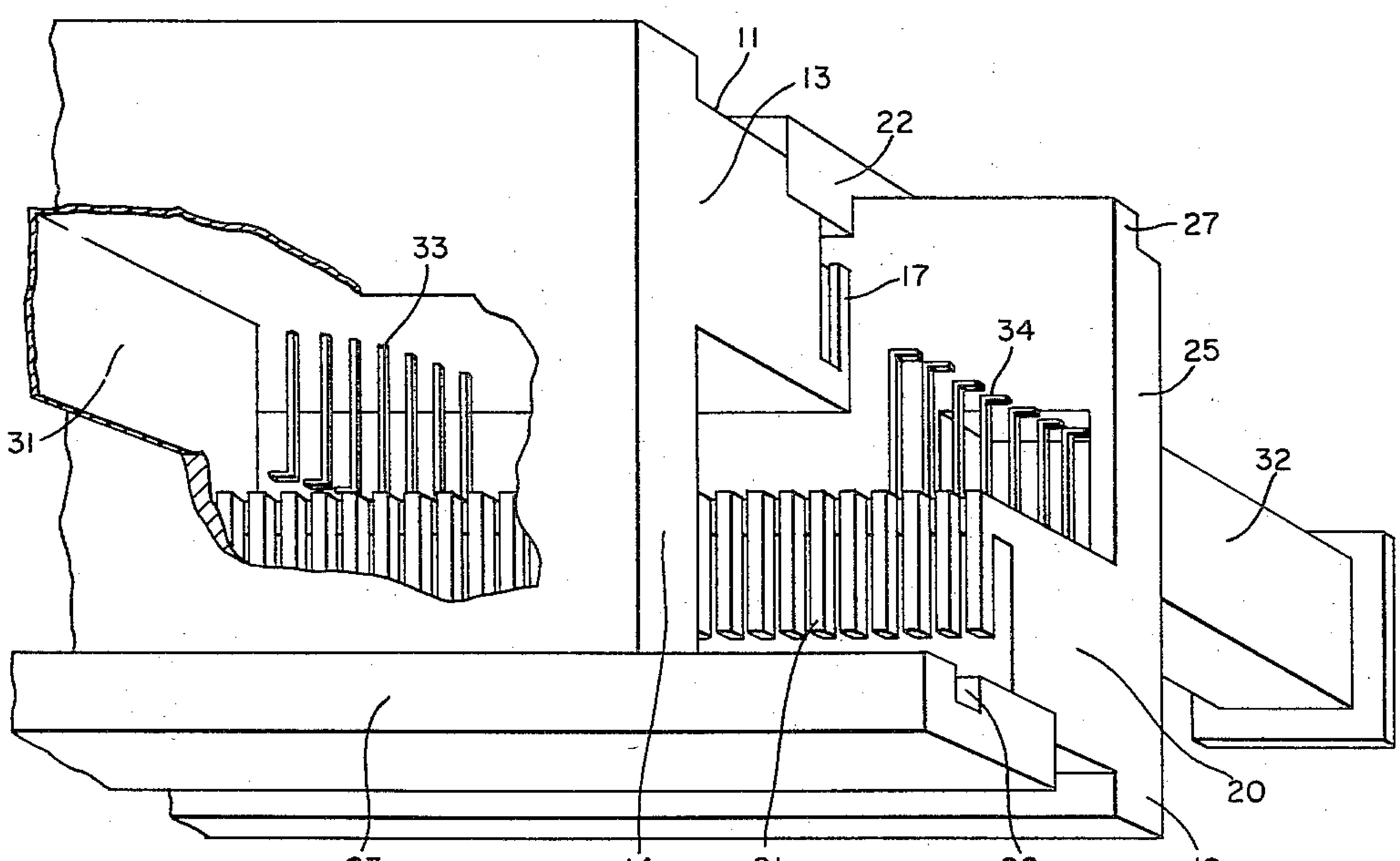

FIG. 4

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MACHINED WAVEGUIDE PIN CHOKE

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3 Claims. (Cl. 333—98)

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

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to waveguides for effecting transfer of high frequency energy between two points.

More specifically, this invention relates to a waveguide made of two complementary sections on which a pin choke has been machined along a longitudinal edge of each section that forms the waveguide.

The waveguide is formed from two identical first and second "L-shaped" complementary sections being machined and placed together so that the two sections have longitudinal relative motion. Each of the sections are machined to form a longitudinal cavity along one edge thereof whose outer lip is transversely slotted along the same edge to form a comb like pin choke structure. The longitudinal cavity and transverse slots form the pin choke along the respective edges of the complementary sections and the pin choke formed on each section is on diagonally opposite edges of the sections and contiguous to the side wall of its complementary section when the sections are assembled to form the waveguide.

The pin choke is machined or fabricated into the same piece of metal which forms the waveguide, thus eliminating the need for cutting, soldering or sweating, and adjusting each individual pin which is formed quickly and accurately in the correct position by machining. The two identical complementary "L-shaped" sections are machined the same and assembled to form the waveguide so that the separate pieces can be moved relative to each other in order to permit waveguide switching and scanning.

It is accordingly an object of the present invention to form by machining, a waveguide comprising a pin choke.

A further object of the present invention is to permit a waveguide to be fabricated from two complementary sections which can be moved relative to one another to permit waveguide switching and scanning.

A still further object of the present invention is to provide a simple, inexpensive waveguide, to increase production and yet make a waveguide which is accurate and more stable than prior known waveguides.

Other and more specific objects of this invention will become apparent upon a careful consideration of the following detailed description when taken together with the accompanying drawings, in which:

Fig. 1 is an end view showing the relative parts assembled;

Fig. 2 is a cutaway of the bottom section showing the pin length and relationship to the top section (shown in dotted line);

Fig. 3 is a sketch showing the relationship of the pins and spaces between the pins; and

Fig. 4 is a pictorial view showing the relationship of the parts moved relative to each other and showing an input and output with adjacent interleaving parallel, effective reflecting finger-like projections on the top and bottom walls.

Referring now to the drawings wherein like reference characters designate like or corresponding parts throughout the several views there is shown a machined waveguide **10** having identical first and second complementary "L-shaped" sections **11** and **12**, respectively. The first complementary "L-shaped" section has a top portion **13** having a thickness greater than ¼ of a wavelength at the operating frequency of the waveguide and a top side portion **14** integral with the top portion positioned at 90° thereto and depending downwardly. Longitudinally of the top portion **13** near the end removed from the top side portion **14** a slot is machined in the top portion to form a cavity **15** having a depth of ¼ wavelength. Transversely of the edge of the top portion **13** and the cavity **15** the lip of the top portion is machined to form slots defined between pins **17** of ¼ wavelength in length at the operating frequency of the waveguide. The combination of the cavity **15** near the end of the top portion and the transverse slots form a pin choke along one edge of the top portion **13**. The second section **12** comprising a bottom portion **20** and a bottom side portion **25** is machined identically to the first section **11** and forms a pin choke along one edge of the bottom portion having a longitudinal slot forming a cavity **18** therein, and transverse slots **19** machined along the lip of the bottom portion to form pins **21**.

Elongated bars **22** and **23** are secured respectively to the top and bottom sections. The bar **22** on the top section has a groove **24** machined therein so that the extended end portion **27** of bottom side **25** extending upwardly from the bottom portion **20** will fit within the groove **24**; and the bar **23** secured to the bottom section has a groove **26** therein so that the extended end portion **36** of the top side **14** of the top section will fit therein. The facing surfaces of the top and bottom sides **14** and **25** are machined to form a waveguide of the desired width when assembled.

The two complementary sections are machined so that when they are assembled, the rectangular waveguide formed is at least ½ wavelength in width. The height should be at least ¼ wavelength to accommodate the interleaving parallel reflecting finger-like projections **33** and **34** extending from the top and bottom portions.

The illustrated waveguide is dimensioned for X-band frequencies only and for other frequencies the appropriate scaling factor must be used. As shown in Figs. 2 and 3, the width (*a*) of the waveguide is .9 in., the total width (*b*) of the bottom portion **20** is .885 in.; the difference between (*a*) and (*b*) being the distance between the pins **21** and the side **14** of the top section. The cavity **18** is .1 inch in width (*c*) machined .05 in. from the left edge of the bottom portion **20** to form an outwardly extending lip. There is a wall thickness (*d*) of .075 inch from the top of the cavity **18** to the waveguide bottom wall **35**. Transverse slots **19** are machined along the lip at the left edge of the portion **20** to form transverse slots .05 inch (*e*) in depth and .04 inch (*f*) wide. The slots define pins that have .09 inch (*g*) between centers. The pins have a length (*h*) of .33 inch from the waveguide bottom wall **35**. This length is ¼ wavelength at the operating frequency. A space (*i*) of .1 inch separates the end of the pins and the elongated bar **23**. The side wall of **14** extending downwardly has a clearance between the pins **21** and the inner wall **37** which is the difference between the waveguide width (*a*) and the width (*b*) of the bottom wall **35**. The top section is machined the same manner as the bottom section and the pin choke has the same relationship to the side wall of the bottom section as the pin choke on the bottom section has with the side wall of the top section.

In general design the waveguide width in inches is dimentioned according to the formula

$$\frac{9225}{\text{Av. frequency}}$$

and the waveguide dimensions are adjusted proportionally. The distance between centers of the pins is preferably $\frac{1}{10}$ of the waveguide width but may vary to be $\frac{1}{15}$ to $\frac{2}{15}$ of the waveguide width. If the pins are machined to be too closely related they will act the same as a solid choke. If they are too far apart they also lose their effectiveness as a pin choke. The width of either the transverse slots or pins can be from $\frac{1}{15}$ to $\frac{1}{30}$ of the waveguide width but should be dimensioned according to the variation of the pin centers so that neither the pin width nor the slot will be less than $\frac{1}{30}$ nor more than $\frac{1}{15}$ of the waveguide width. The pin and slot need not have the same width but in cases of the lower and higher limits between pin centers the pin width and slot width will necessarily be equal. The cavity behind the pins can vary from $\frac{1}{15}$ to $\frac{1}{7}$ of the waveguide width and the clearance between the pins and the adjacent side wall should not have a clearance less than $\frac{1}{100}$ nor greater than $\frac{2}{100}$ the waveguide width. The length of the pins and the depth of the cavity from the outer wall to the bottom of the cavity must be at least ¼ wavelength at the operating frequency of the waveguide.

The above mentioned dimensions are machined into the "L-shaped" metal to form one section of the waveguide and the pin choke related to that section. The two complementary sections of the waveguide can be fabricated from a single elongated "L-shaped" piece of metal then cut into the desired lengths to form the two complementary sections.

Fig. 4 illustrates in perspective a moveable waveguide junction for feeding radio frequency energy from an input guide **31** to output guide **32**. In order to show the essential structure, the parts are displaced beyond the range of operative adjustment. Reflectors **34** are mounted on the bottom guide face to the right of output **32**, and reflectors **33** are mounted on the top guide face to the left of input **31**.

The reflectors confine the wave energy to the portion of the adjustable section between the input and output. As shown in Fig. 1, the two series of reflectors are positioned to clear each other if required by guide movement.

The waves of desired frequencies, which are those of the X-band frequency for the selected embodiment, are directed into the waveguide through input **31**. The waves are reflected in only one direction through the guide since they are blocked by fingers **33** and directed through the waveguide until they reach fingers **34** wherein they are reflected and directed through the outlet **32**. The two complemetary L-shaped sections are movable relative to each other and makes the waveguide useful for radar switches and scanners. In the sections shown the radius of curvature is infinite. Shorter radii may be employed in application of the invention, as in rotary joints. Since the two sections are movable relative to each other there is a discontinuity between the two sections of the waveguide which would result in energy losses. The choke structure of the present invention along diagonal edges of the top and bottom portions prevents such loss. The pins **17** and **21** are ¼ wavelength in length, also the cavities **15** and **18** are effectively ¼ wavelength in depth; therefore, the space between the side walls and the pins constitutes a passageway of ½ wavelength when the waves are reflected back, and the space between the side walls and the pins, and the depth of the cavities constitutes a passage of one wavelength when the energy is reflected back. These passages are equivalent to a shorted half wavelength or full wavelength transmission line where the impedance across the open end is the same as if there were a short circuit at that point. The pin chokes cut down on interferences since the energy in the choke propagates with the same velocity as the energy in the main guide.

Obviously, many modifications and variations of the present invention are possible in the light of the above teaching. It is therefore to be understood, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A waveguide comprising first and second relatively movable identical complementary conductive sections of generally L-shaped cross-section arranged to define corresponding long and short inner wall surfaces on corresponding legs of said L-shaped sections to provide therebetween a rectangular wave transmission path which in the longer dimension is equal to one-half wavelength and in the shorter dimension to one-quarter wavelength at the operating frequency of said waveguide, said corresponding legs of said L-shaped sections which define said corresponding long wall surfaces being positioned with one end thereof adjacent to said wall surfaces of said corresponding legs of said L-shaped section which define said short wall surfaces to provide a spacing between the ends of said corresponding legs which define said long wall surfaces and the wall surfaces of said corresponding legs which define said short wall surfaces, a choke means provided on the end of said corresponding legs which define said long wall surface to provide a low impedance across said spacing, said choke means comprising a rectangular cavity along the end of said corresponding legs at said spacing, said cavity having a depth of one-quarter wavelength and extending outwardly perpendicular to said long wall surface and parallel with the wall of said corresponding legs which define said short wall surface, a series of integral regularly spaced machine-cut pins which in length are equal to one-quarter wavelength of said operating frequency, said pins forming a comb-like pin choke structure with said cavity whereby the length of said pins at said spacing and the depth of said cavity constitutes a path of one-half wavelength and on reflecting back energy, constitutes one wavelength to provide an impedance across the spacing, the same as if there were a short circuit at the spacing, and means for providing relative motion between said sections, said means serving as an end closure for said pin choke structure and to maintain a uniform spacing between said sections.

2. A waveguide comprising first and second relatively movable identical complementary conductive sections of generally L-shaped cross-section arranged to define corresponding long and short inner wall surfaces on corresponding legs of said L-shaped sections to provide therebetween a rectangular wave transmission path which in the longer dimension is equal to one-half wavelength at the operating frequency of said waveguide, said corresponding legs of said L-shaped sections which define said corresponding long wall surfaces being positioned with one end thereof adjacent to said wall surfaces of said corresponding legs of said L-shaped section which define said short wall surfaces to provide a spacing between the ends of said corresponding legs which define said long wall surfaces and the wall surfaces of said corresponding legs which define said short wall surfaces, a choke means provided on the ends of said corresponding legs which define said long wall surfaces to provide a low impedance across said spacing, said choke means comprising a rectangular cavity along said ends of said corresponding legs at said spacing, said cavity having a depth of one-quarter wavelength and extending outwardly perpendicular to said long wall surface and parallel with the wall of said corresponding legs which define said short wall surfaces, a series of integral regularly spaced machine-cut pins which in length are equal to one-quarter wavelength of said operating frequency, said pins forming a comb-like pin choke structure with said cavity and spaced along said cavity at a distance between each pin which is from about $\frac{1}{30}$ to $\frac{1}{15}$ of the longer dimension of said wave transmis-

sion path and at a distance between centers of said pins which is from about 1/15 to 2/15 of the longer dimension of said wave transmission path, whereby the length of said pins at said spacing and the depth of said cavity constitutes a path of one-half wavelength and on reflecting back energy, constitutes one wavelength to provide an impedance across the spacing the same as if there were a short circuit at the spacing, and means for providing relative motion between said sections, said means serving as an end closure for said pin choke structure and to maintain a uniform spacing between said sections.

3. A waveguide as defined in claim 1 having a wave inlet and a wave outlet communicating with the wave-

transmission path and reflecting finger-like means staggered with respect to each other and arranged to deflect wave energy from said wave inlet through said transmission path and from the latter to said wave outlet.

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