SWITCHING DEVICE IN WAVE GUIDE TRANSMISSION SYSTEM

Filed March 25, 1944 3 Sheets-Sheet 1

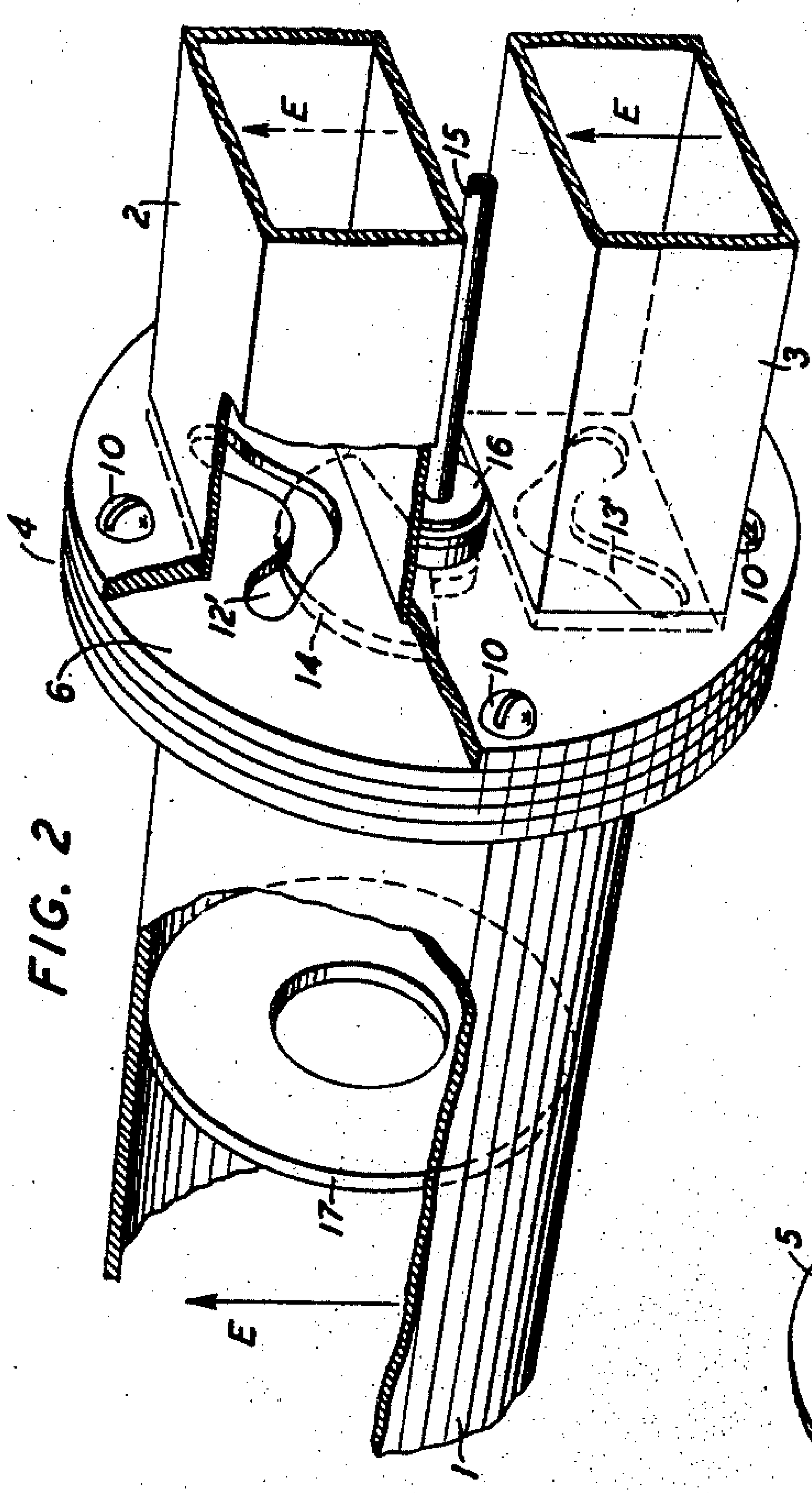

FIG. 2

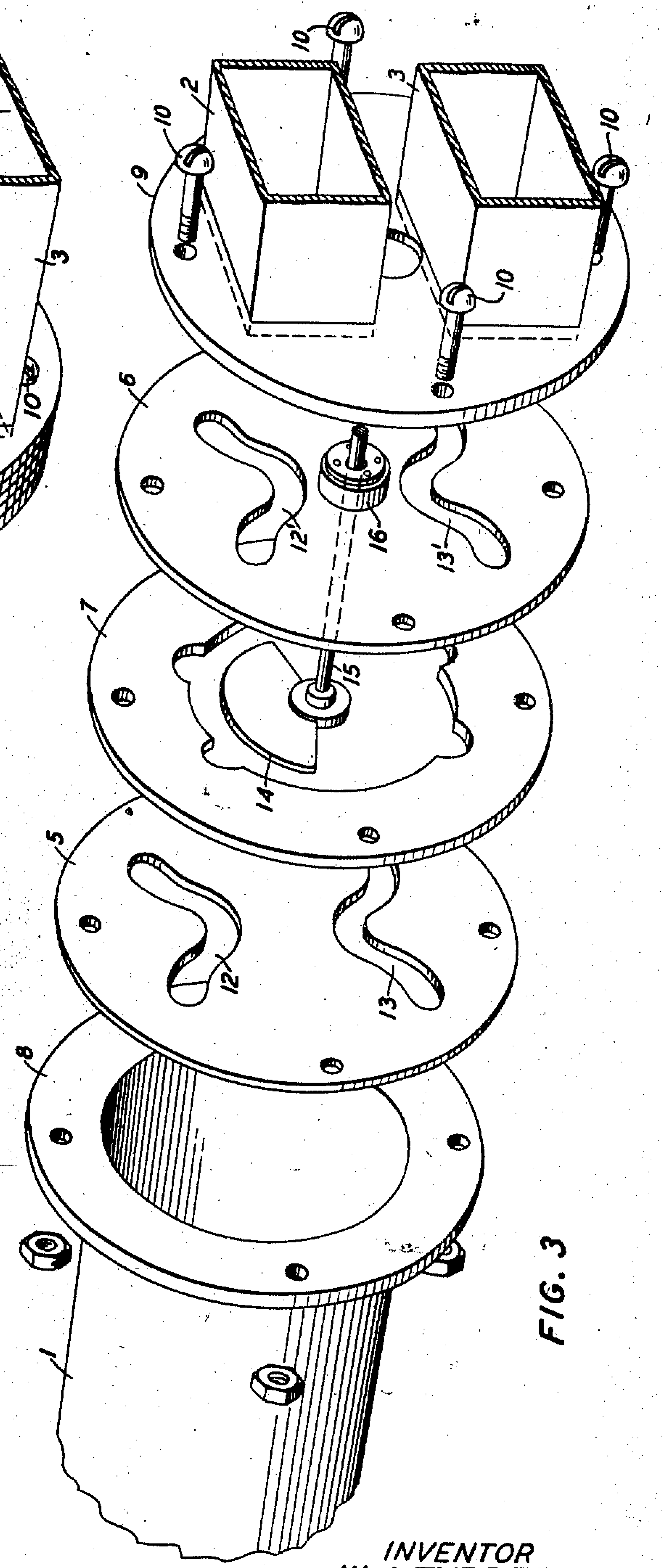

FIG. 3

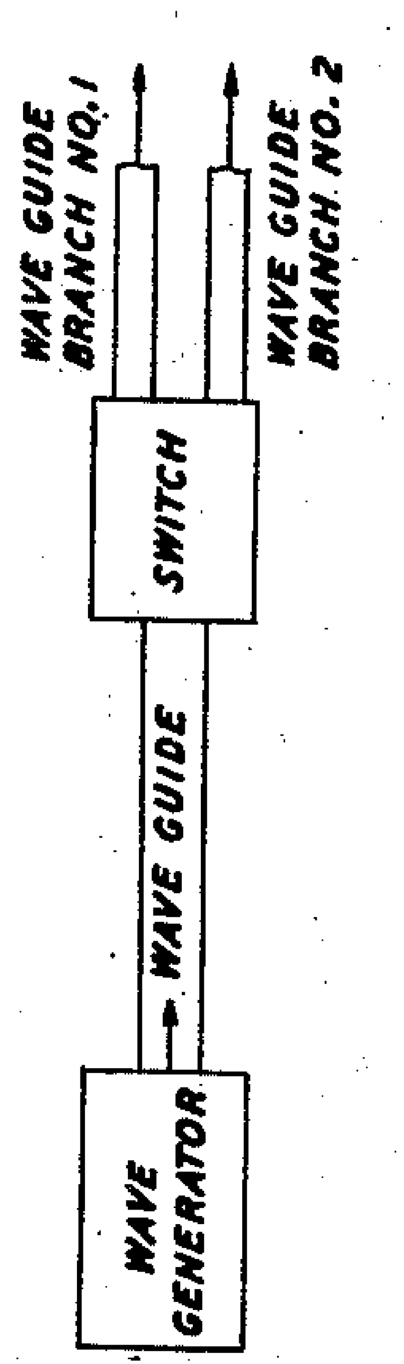

FIG. 1

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FIG. 4

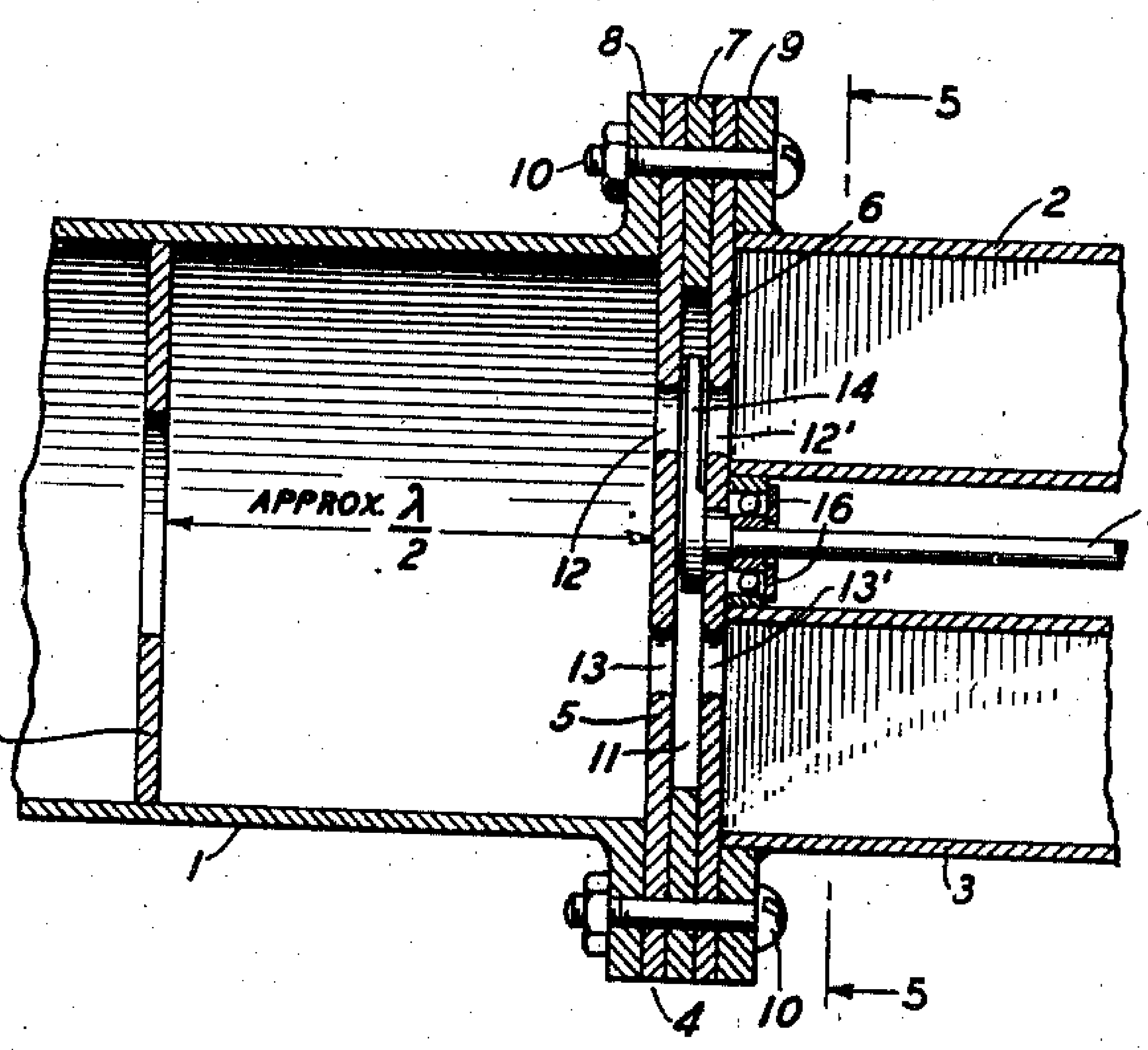

FIG. 5

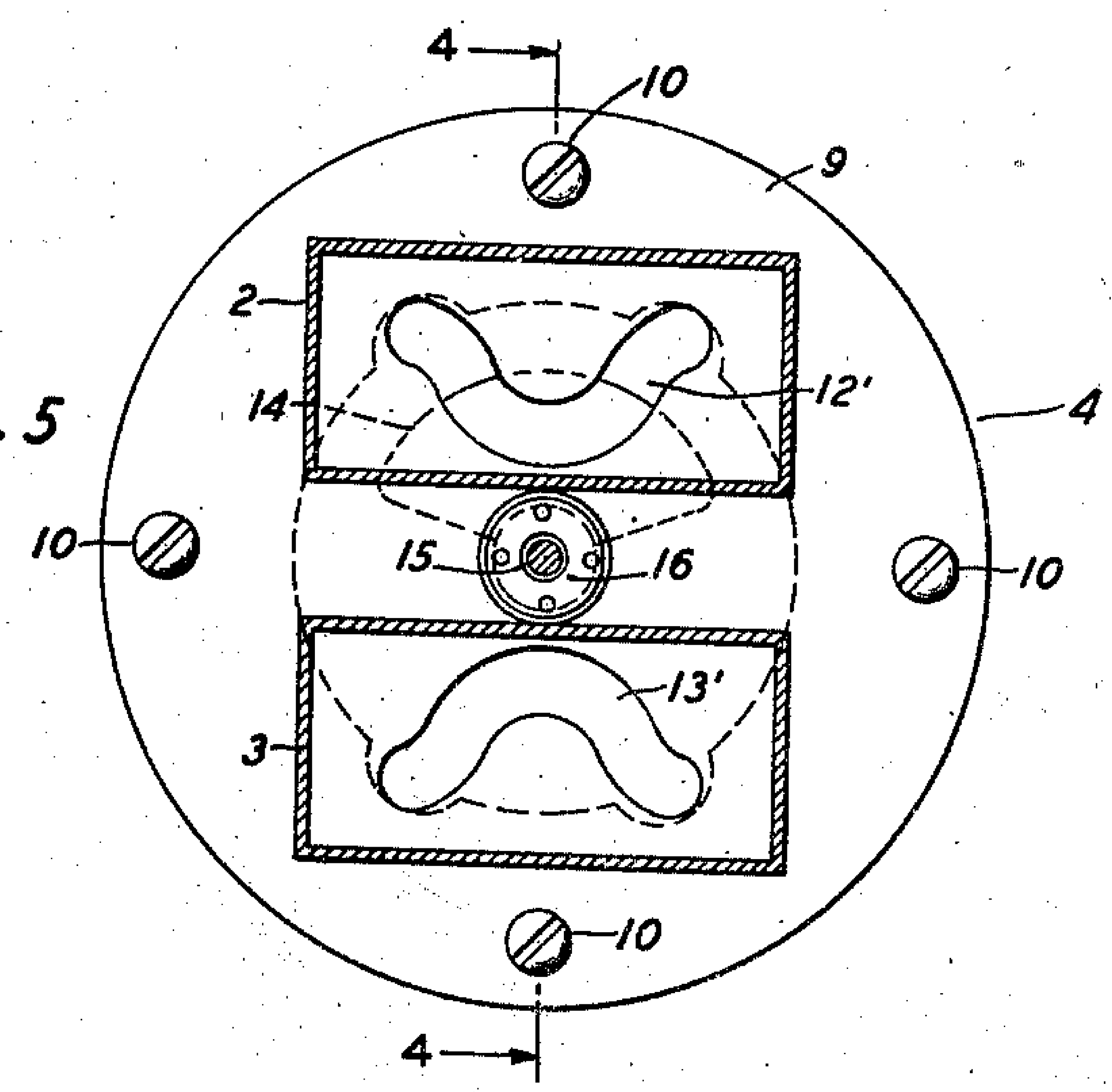

FIG. 6

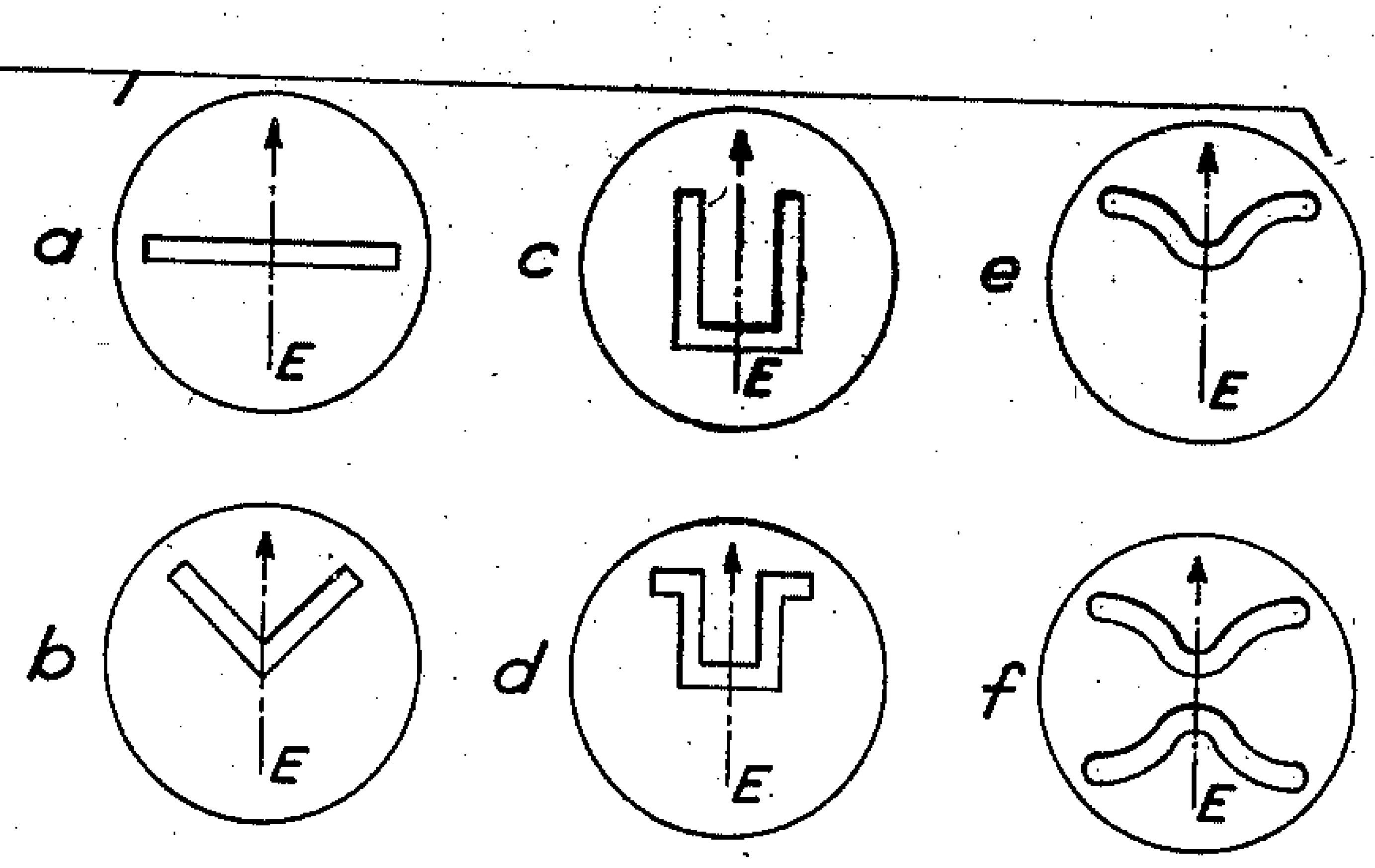

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FIG. 7

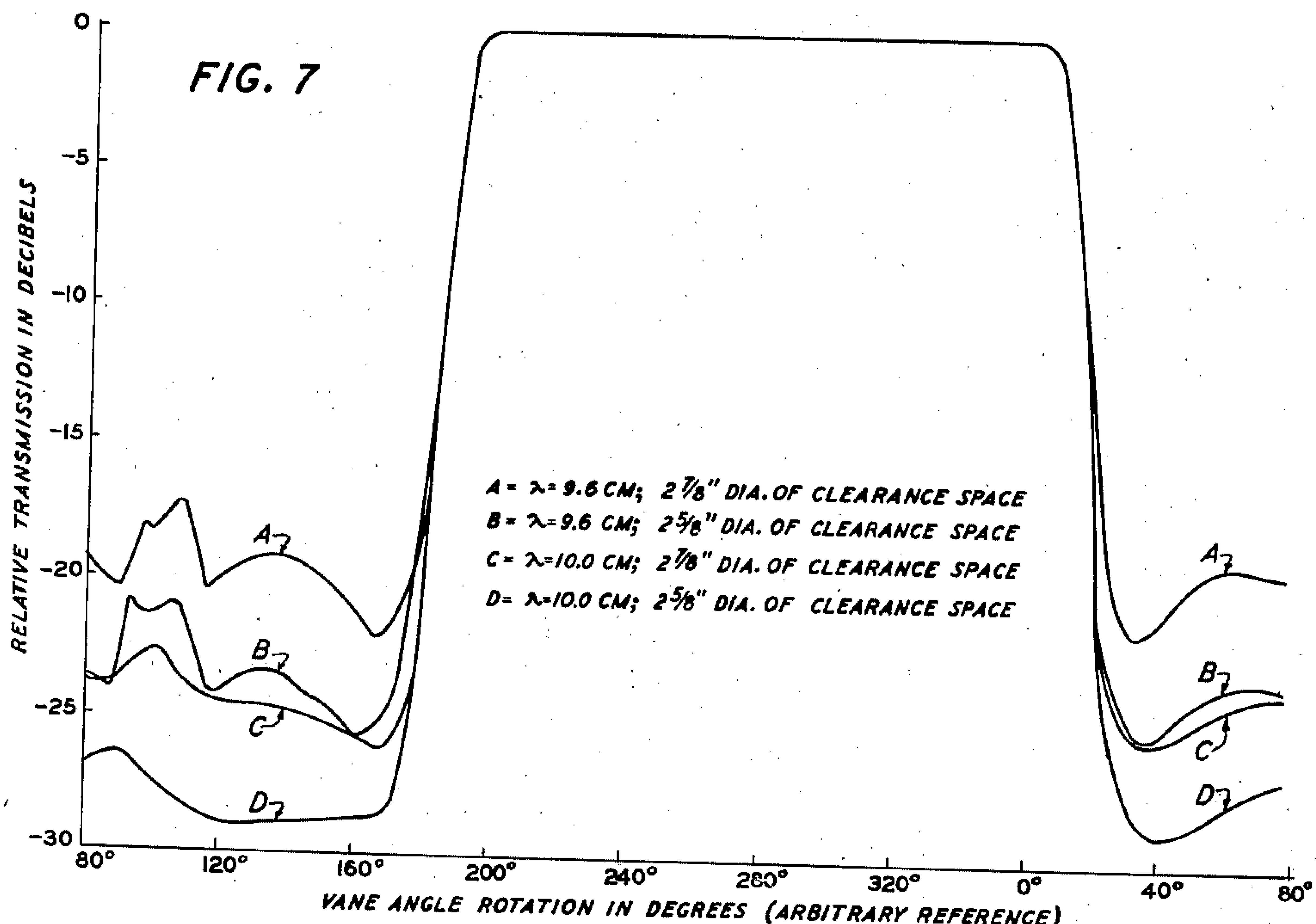
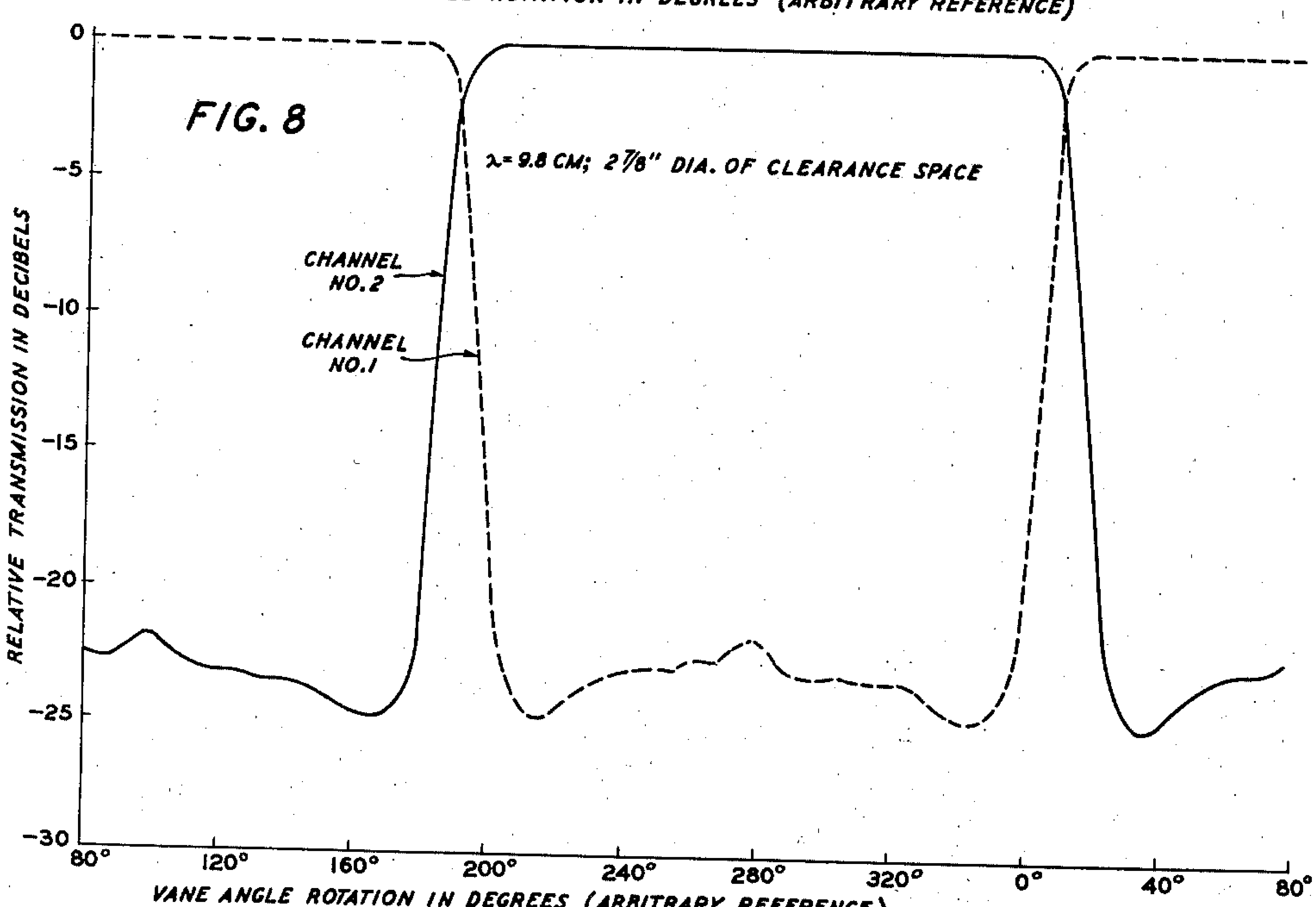


FIG. 8



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SWITCHING DEVICE IN WAVE GUIDE TRANSMISSION SYSTEM

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15 Claims. (Cl. 178—44)

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This invention relates to wave guide transmission systems and particularly to wave switching arrangements for use in such systems.

An object of the invention is to efficiently control wave transmission in a wave guide transmission system.

A more specific object is to switch in an efficient manner the flow of electromagnetic wave power from one wave guide branch to another in a branching wave guide transmission system.

These objects are attained in accordance with the invention by the use of a switching device employing resonant coupling irises and associated mechanical means for detuning the irises, operating in combination as "valves" either to allow or substantially prevent transmission of electromagnetic wave energy of a given frequency through the irises between associated wave guide transmission lines.

In one embodiment of the invention such as switching device is adapted for switching electromagnetic wave energy of a given frequency received over a "main" dielectric wave guide line into either one of two branching dielectric wave guide lines which respectively comprise hollow metal pipes. The switching device includes two metal plates of suitable size each containing two correspondingly situated, oppositely disposed, irises (suitably dimensioned slots) of optimum shape for efficient switching, each proportioned so as to be resonant at the given frequency, the plates being assembled with an inner metal spacer ring and outer metal flanges so as to provide good metallic contact between each plate and the ring and an electrically shielded narrow clearance space between the plates. A sectoral metal vane is adapted for rotation within the clearance space past the two sets of aligned resonant irises in the two plates in turn. The switch assembly is mounted between adjacent ends of the main guide and the two branch guides with one of its plates affixed to the periphery and extending completely across the cross-section of the main guide and the other plate affixed to the peripheries and extending completely across the cross-sections of the two branch guides; and the irises in the two plates are positioned so that the interior of the main guide is connected to the interior of one branch guide through one set of aligned irises and to the interior of the other branch guide through the other set of aligned irises. When the vane is rotated so that a portion of it is in a given position between either set of resonant irises and no portion is between the other set of resonant irises, the first set is

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capacitively detuned so as to substantially prevent transmission of electromagnetic wave energy of the given frequency to the associated branch guide from the main guide and the other set is maintained tuned to transmit substantially all of the wave energy of that frequency from the main guide to the other branch guide.

The important advantages of the switching device of the invention may be summarized as follows: (1) It is capable of efficiently switching a relatively large amount of wave power, in the order of 150 to 200 kilowatts or more; (2) its frequency response, i. e., the frequency band width over which the switch functions properly, is relatively broad; (3) it possesses a comparatively sharp cut-off, or "snap action," in other words, provides high switching efficiency; (4) it is very compact and employs a small number of inexpensive elements including a minimum of moving parts which are small and of light weight so that the cost of operation and maintenance is low; (5) its construction is inherently simple, and is not at all critical as to dimensions so that it is amendable to "punch-press" construction methods which reduce the cost of manufacture; and (6) its valve action is such that the blocking of each branch wave guide channel is characteristic of a fixed virtual piston, which makes it particularly suitable for use in an antenna lobe switching system, for example, such as disclosed in the copending patent application of A. C. Beck, Serial No. 455,322 filed August 19, 1942, which issued as Patent No. 2,409,183 on October 15, 1946.

The various features and advantages of the switching arrangement of the invention will be better understood from the following detailed description when read in conjunction with the accompanying drawings, in which:

Fig. 1 shows diagrammatically how the switching device of the invention would be applied for switching wave power in a wave guide transmission system;

Fig. 2 shows a perspective assembly view of a portion of a dielectric wave guide transmission system embodying a switching arrangement in accordance with the invention;

Fig. 3 shows a perspective exploded view of the arrangement of Fig. 2 illustrating the component parts of the switch and associated wave guide elements more clearly;

Figs. 4 and 5 respectively show a longitudinal sectional view along the line **5—5** and a cross-sectional view along the line **4—4**, of the switch and wave guide assembly of Fig. 2, illustrating certain construction details more clearly;

Figs. 6a to 6f show progressive steps in the development of a preferred resonant iris arrangement for the switching device of the invention, such as illustrated in Figs. 2 to 5; and

Figs. 7 and 8 show curves indicating qualitatively the performance of typical switching devices in accordance with the invention.

As a preliminary to the detailed description of one embodiment of the invention, it is believed that the following general discussion of resonant irises may be helpful to provide an understanding of the operation of the switching device. The discussion will be limited to resonant iris action in connection with the dominant wave propagated in dielectric wave guides, although it is to be understood that the considerations may be extended to include other wave types by making appropriate changes in the constructions.

If a dielectric wave guide is interrupted by a metal plate or partition extending across its cross-section, and which makes good metallic contact with the periphery of the guide, all of the propagated wave power incident upon the plate will be reflected. If the wave guide is represented as a transmission line, the plate may be represented as an electrical short-circuit across the line. Now, if an aperture is made in such a plate, reflection of all of the incident power will be prevented, and some will be transmitted through the aperture. If the aperture comprises a slot having its long dimension parallel to the electric vector of the dominant propagated wave, and extending completely across the wave guide, the slotted plate across the guide may be considered as the equivalent of an inductance in shunt with a transmission line; whereas if the slot extends completely across the guide in a direction perpendicular to the lines of electric force of the propagated dominant wave, the effect will be similar to that produced by a capacitance in shunt with a transmission line. In either case, the amount of power transmitted through the slot will depend markedly upon the width of the slot, and will be small for a narrow slot.

If a rectangular slot is cut in the plate so as not to extend completely to the periphery of the wave guide in either direction, the resultant effect is similar to that produced by an inductance and a capacitance respectively connected in shunt with an equivalent transmission line at the same points. These two shunt elements may be, in general, combined as a shunt reactance the sign of which is dependent on which of the two original shunt elements predominates, i. e., which is lower in impedance.

One case of especial importance in connection with the present invention is that one in which the proportions of the slot are such that the shunt reactance of the capacitance equals the shunt reactance of the inductance. In this case, parallel resonance results and the equivalent impedance of the combination, that is to say, of the slotted plate, is purely resistive at a given frequency comprising only the resistance incidental to the two original, predominantly reactive shunt elements. The magnitude of this shunt resistance will depend upon the width of the slot and also upon the thickness of the plate in which the slot is cut. By a proper choice of the width and thickness, the resistance will be sufficiently high so that there will be no appreciable effect at the frequency at which the parallel resonance occurs. In other words, although the slot is a very considerable geometrical discontinuity, it is in reality essentially transparent for the waves. Although the slotted plate displays parallel resonance only for a given frequency, by a proper choice of the slot width the impedance may be made so high as not to interfere appreciably with the transmission of wave power over a band of frequencies. It will be noted that, as the slot is narrowed, the limit is an infinitely narrow slot one-half wavelength long, having its long dimension perpendicular to the lines of electric intensity.

A parallel tuned slot, to be referred to hereinafter as a resonant iris, may be considered as a means for compressing wave power of the resonant frequency into a small cross-section without materially interferring with the power flow. In the switching devices of the present invention, the resonant irises are used for this purpose and a "valve" action is provided by causing the wave power of the resonant frequency, in its highly compressed condition, to be intercepted by a small suitably shaped metal vane.

In the above discussion, reference was made to the thickness of the metal slotted plates. It is to be understood that their thicknesses are very small compared with the wavelength of the wave energy to be controlled. If a given slot in a plate of given thickness is resonant, then as the plate is made thicker, the inductance L of the slot will decrease exactly in proportion to the increase in its capacitance C, so that the product LC remains substantially constant; thus, for relatively thin plates, the resonant frequency is independent of the plate thickness. This fact greatly simplifies the obtaining of appropriate iris dimensions for a particular application involving thick plates, inasmuch as the preliminary work may be carried out with very thin plates.

Although the resonant frequency is independent of the plate thickness, the frequency response of the slotted plate does depend upon thickness. By "frequency response" is here meant the transmission of wave power through the iris as a function of frequency. As the plate is thickened, the frequency response is made sharper.

The type of valve used in the arrangement of the present invention, therefore, may be regarded as a resonant iris the aperture of which can be at least partially blocked by a metal vane. At this point, it is desirable to point out that the valve action may be regarded as taking place by either of two mechanisms. The power flow proceeds substantially without disturbance across a narrow clearance space or gap between two resonant irises, and the metal vane may be regarded as a means for interrupting this power flow geometrically. Alternatively, the action of such a vane may be considered as a means for capacitively detuning a resonant iris to substantially shift its resonant wavelength, so that at the operating wavelength the iris appears as a low shunt reactance. From the former point of view, the effect of a metal vane on a resonant iris will depend upon how much "shadow" it casts upon the iris, that is, upon how large a portion of the slot it overlaps when viewed from a point behind the vane on a line perpendicular to the planes of the slot and vane. From the electrical circuit point of view, the effectiveness of the vane depends upon how much additional capacitance is effectively introduced by it into the iris. Inasmuch as the capacitance is effectively concentrated near the center of the slot, this latter viewpoint explains why a vane which appears to block only partially may be so effective. It also explains why the clearance between the vane and the iris plates in the embodiment of the invention to be described later in connection with the drawings must be kept small. The electrical circuit point of view is the more exact, the geometrical interruption or "shadow" concept having been introduced merely to give a clearer qualitative understanding of the valve action.

As stated previously, the simplest form of resonant iris is a straight slot a half wavelength long. The slot, however, may be distorted into a great variety of shapes each of which by proper proportioning may be made resonant at the desired frequency. Some of these shapes may be preferable for enhancing the cut-off or "snap action" of the valve comprising the resonant iris and associated detuning vane, i. e., for increasing the blocking effect due to a small movement of the vane. In particular, if the slot is so designed so as to include two portions which are approximately radial relative to the axis of rotation of the vane, the leading edge of a sectoral vane will have a most pronounced effect in blocking the flow of power. Figs. 6*a* to 6*f* show progressive steps in the distortion of a simple resonant iris to provide respectively greater improvement in the snap action of such valve, the orientation of the electric intensity of the electromagnetic wave transmission being indicated by the vector E in each case. Fig. 6*a* shows a plate with a straight rectangular slot (iris) cut in it; Fig. 6*b* the slot bent sharply at the center to provide two straight portions; Fig. 6*c* the slot bent to provide three straight portions; Fig. 6*d* the slot bent to form five straight portions; and Fig. 6*e* a preferred slot derived from the slot of Fig. 6*d* by eliminating all sharp angles. The elimination of the sharp angles is desirable to facilitate the passage of high power or high peak power through the resonant iris without corona discharge in the slot. For the same reason, it is desirable to choose an iris plate thick enough so that an acceptable curvature may also be introduced in the longitudinal dimensions of the iris. The curvilinear length of the resonant irises shown in Figs. 6*a* to 6*e* may not be the same for the same resonant frequency. Fig. 6*f* shows two resonant irises of the type shown in Fig. 6*e* oppositely disposed on the iris plate. A similar construction is used in each iris plate of the embodiment of the invention illustrated in Figs. 2 to 5, in which two such valves as described above are combined to provide a switch.

Figs. 2 to 5 show a detailed embodiment, drawn full scale, of a switching device in accordance with the invention embodying the principles discussed above, applied to a wave guide transmission system of the general type illustrated in Fig. 1 for switching electromagnetic wave energy received over a single "main" wave guide from a suitable wave generator into any one of a plurality of "branch" wave guides, the case of two branch wave guides being chosen for specific illustration. For convenience, the main wave guide line 1 in the system of Figs. 2 to 5 has been shown as comprising a circular metal pipe, and the two branch wave guide lines 2 and 3 as comprising rectangular metal pipes, although the associated switching device in accordance with the invention is adapted for use with any type of tubular conductor for the main and branching lines.

The switching device 4 as shown in Figs. 2 to 5 includes as assembly of two metal iris plates 5 and 6, a relatively thin metal annular spacer ring 7 separating the iris plates and providing good metallic contact with the plates, and two outer flange plates 8 and 9. The assembly of iris plates, spacer ring and flange plates are held tightly together by the bolts 10 so as to form an electrically shielded, cylindrical clearance space 11 between the iris plates and spacer ring, the longitudinal dimension of which is quite small. In each iris plate 5 and 6, there are two correspondingly situated, oppositely disposed resonant irises 12, 13 and 12′, 13′, each comprising a curvilinear slot having its long dimension perpendicular to the vector E representing the direction of the lines of electric intensity of the dominant electromagnetic wave transmitted over the associated main wave guide 2, and proportioned so that it is resonant to the given frequency f of that wave. For the reason given previously, each of these curvilinear slots is preferably shaped so as to include two portions which are radial relative to the longitudinal axis of the main wave guide. The switching device 4 also includes a small sectoral metal vane 14 of a thickness slightly smaller than the longitudinal thickness of the clearance space 11 adapted to be rotated therein past the aligned resonant irises 12, 12′ and 13, 13′ in the two plates in turn, about an axis coaxial with the longitudinal axis of the main wave guide 1, by means of the shaft or axle 15 mounted in bearings 16, and extending into the clearance space 11 through openings in the centers of flange plate 9 and iris plate 6. The dimensions of the clearance space 11 are preferably made such as to provide only sufficient room to allow the vane to rotate freely in it to the desired positions with respect to the resonant irises.

The switch assembly 4 is inserted between adjacent ends of the main wave guide 1 and the branch guides 2 and 3 with the outer face of iris plate 5 affixed with good metallic contact to the periphery of main guide 1 and extending completely across its end cross-section, and with the outer face of the other iris plate 6 affixed with good metallic contact to the peripheries of the two branch guides 2 and 3, and extending completely across the end cross-sections of both branch guides. The irises in the iris plates 5 and 6 are disposed so that the interior of the main wave guide 1 is connected to the interior of one branch guide 2 through one set 12, 12′ of aligned irises and the clearance space 11, and to the interior of the other branch guide 3 through the other set 13, 13′ of aligned irises, and the clearance space 11. The branch guides 2 and 3 may be affixed to the iris plate 6 as shown with the long sides of the cross-sections of the former in parallel with each other and with the plane of the long dimension of the irises in that plate, and the two branch guides 2 and 3 are sufficiently separated near switch 4 to provide room between them for the axle 15, its bearing 16 and the control means (not shown) for driving the axle.

The angle of the sectoral vane 14 is selected so that when it is rotated to a position such that as its leading edge begins effectively to detune one set of aligned irises 12, 12′ or 13, 13′ its lagging edge is just leaving that portion of the clearance space between the other set of aligned irises 13, 13′ or 12, 12′ at which its detuning action effectively ceases.

With the vane 14, the clearance space 11 and the irises 12, 12′ and 13, 13′ properly proportioned, when the vane 14 is rotated to a predetermined position between either set of aligned irises 12, 12′ or 13, 13′, indicated for the former set in Fig. 5, that set of resonant irises is capacitively detuned in the manner described in the previous discussion of the valve action, sufficiently to substantially block transmission of wave energy of the resonant frequency between the associated branch guide and the main wave guide 1, and the other set of irises remains tuned so as to allow transmission, in compressed form, of substantially all of the wave energy of the resonant frequency from the main guide 1 to the other branch wave guide 3. There will be no appreciable dissipation of the wave energy in the clearance space between the set of resonant irises remaining tuned to the operating frequency provided that the longitudinal and transverse dimensions of the clearance space are not excessive.

In the particular embodiment of the invention illustrated in Figs. 2 to 5 in which circular metal pipe is employed for the main wave guide 1 and rectangular metal pipe for the two branch guides 2 and 3, the impedance mismatch over the frequency band of interest, due to the inability of the resonant irises to correct for the offset transition from circular to rectangular pipe wave guide, may be corrected, as indicated in Fig. 2, by the placing of a metal partition 17 with a large circular iris cut in it, across the cross-section of the circular pipe 1 at a point approximately a half guide wavelength away from the resonant irises 12, 13 in the end iris plate 5. Actually, in practice, the circular iris may also be used to correct for any additional reflections due to the transition from the rectangular pipe into a radiating surface of an associated antenna (not shown). If such a circular iris is associated with the switch, the useful transmitted band width is somewhat limited; the position of this band, however, may be varied by changing the size and location of the circular iris.

As brought out in the previous discussion, none of the dimensions of the switch in accordance with the invention is critical. The only dimensions which are important for electrical reasons are (1) the iris layouts in all dimensions; (2) vane in all dimensions; and (3) all longitudinal dimensions; i. e., thicknesses of iris plates, spacer ring, vane, etc., and clearances. Experience has shown that these dimensions will be kept sufficiently accurate for good electrical performance if they are maintained in accordance with moderately accurate mechanical constructions. Also, as mentioned previously, for greatest efficiency all sharp bounding surfaces on the irises and the vane should be rounded off to reduce corona effects.

A number of switch units of the general type illustrated in Figs. 2 to 5 with different dimensions determined by the wavelength of the wave power to be switched, were constructed and tested. The important dimensions of one switch unit and of the associated wave guide lines in the embodiment of the invention as shown in Figs. 2 and 5, which were constructed for use in antenna lobe switching for wavelengths between 9.6 and 10.0 centimeters, were as follows:

Main wave guide	Circular metal pipe of 2⅞ inch inside diameter.
Branching wave guides	Rectangular metal pipe of 1.090 inch x 2.340 inch inside diameter.
Separation between branch wave guides at switch.	.810 inch.
Iris plates	Each 4½ inch diameter x 0.220 inch thickness.
Iris dimensions	Inscribed within rectangle 0.781 inch x 1.604 inch.
Switch clearance space	2½ inch diameter x 0.134 inch longitudinal thickness.
Vane dimensions	Sectoral angle 145°, thickness 0.094 inch.

These switches were experimentally tested with both rectangular guides terminated in their characteristic impedance, and showed good switching performance for the design wavelengths ranging between 9.6 and 10.6 centimeters, and between 9.0 and 9.2 centimeters, respectively. The transmission loss through these switches is very low, being a small fraction of a decibel. All switches were found to be capable of passing in excess of 150 kilowatts peak power if the iris and vane edges are carefully polished and if the vane is rotated at least at a moderately low speed.

Figs. 7 and 8 show curves which indicate qualitatively the performance of some typical switches. Fig. 7 shows the relative transmission in decibels through one channel as a function of vane angle rotation in degrees for two typical wavelengths (9.6 and 10.0 centimeters) and two different clearance space diameters (2⅞ and 2⅝ inches). It is to be noted that 15 to 20 decibels of blocking is sufficient in some of the typical applications, and the simplified mechanical construction illustrated provides that amount of blocking. However, by diminishing the clearance between the vane and the iris plates and increasing the diameter of the vane, almost any desired amount of transmission blocking may be secured. Fig. 8 shows the power division, relative transmission in decibels, in the two branch guides as a function of vane rotation angle in degrees for a wavelength centered in the operating range ($\lambda=9.8$ centimeters) where the diameter of clearance space was 2⅞ inches. The efficiency, i. e., the percentage of the time during which substantially all of the power is flowing into either one or the other channel, is about 93 per cent.

It is apparent that the movement of the vane in a switching device embodying the principles of the invention may be in a straight line or vibratory instead of rotary as described and illustrated, in which case a different shape and size of the clearance space and the vane may be required to obtain the desired switching operations, which might involve the use of switch elements somewhat different from those described above. By suitable control of the vibratory, rotary or other movement of the vane in a switching device of the general type described, any desired time distribution of the flow of the electromagnetic wave energy between the branching wave guides may be obtained. For example, it may be arranged to distribute the flow alternately into the branching guides for desired equal or unequal time intervals, by providing suitable motor driven cam arrangements to maintain a portion of the detuning vane in the proper position between each set of aligned irises in turn for corresponding time intervals. The aligned resonant irises may be located in adjacent portions of the side walls of the main and branching wave guides instead of in end cross-section plates as illustrated, in which case these adjacent side wall portions would be conductively connected together so as to provide the narrow clearance space in which the vane rotates, between them. Other modifications of the arrangements which have been illustrated and described within the spirit and scope of the invention will occur to persons skilled in the art.

What is claimed is:

1. A switch for controlling the transmission of wave energy of a given frequency between wave guide line sections in a wave guide transmission

system comprising coupling means between said wave guide line sections, including at least one resonant coupling iris normally tuned to said given frequency, so as to efficiently transmit wave energy of that frequency between the coupled wave guide sections and means mechanically displaceable transversely to said iris for detuning said resonant iris to reduce the transmission of wave energy of said given frequency between said coupled wave guide sections.

2. In combination in a wave transmission system, a main tubular conductor for transmitting electromagnetic wave energy of given frequency, at least one branch tubular conductor for receiving said wave energy and having at least a portion of one of its conductive boundary walls adjacent to a conductive boundary wall of the main conductor, and coupling means between said main and branch conductors such as to conductively connect together the respective adjacent portions of their boundary walls and to provide a relatively small electrically shielded clearance space between them, said coupling means including in said adjacent portions of the boundary walls of the main conductor and each branch conductor respectively oppositely situated irises disposed so as to connect the interior of the main conductor with the interior of that branch conductor through said clearance space, each of the oppositely situated irises being proportioned so as to be resonant at said given frequency and in the resonant condition allowing the transmission of a substantial amount of the wave energy of said given frequency between the connected main conductor and branch conductor, and mechanical means movable to different positions within said clearance space and in a given position with respect to a pair of the oppositely situated resonant irises operating to detune them sufficiently to prevent transmission of wave energy of said given frequency between the tubular conductors connected thereby.

3. The combination of claim 2, in which said mechanical means comprises a sectoral vane of conductive material adapted for rotation within said clearance space to and away from said given position with respect to a pair of the oppositely situated irises, and each resonant iris in said adjacent boundary portions of said main and branch conductors comprises a narrow slot of suitable dimensions and of a curvilinear shape having two portions which are approximately radial with respect to the axis of rotation of said vane.

4. The combination of claim 2, in which each of said resonant irises in said adjacent boundary portions of said main and branch tubular conductors comprises a narrow slot of suitable dimensions and of a curvature both in the longitudinal and transverse directions such as to enable the passage of high peak electromagnetic wave power when in the resonant condition.

5. In combination in a wave transmission system, a main tubular conductor transmitting electromagnetic wave energy of given frequency, one or more auxiliary tubular conductors for receiving said wave energy and coupling and switching means therebetween comprising one plate of conductive material conductively attached to the output of said main conductor and extending completely across the cross-section thereof, a second plate of conductive material conductively attached to the inputs of and extending completely across the cross-sections of said one or more auxiliary conductors, means conductively connecting the two plates together in such manner as to provide a relatively narrow electrically-shielded clearance space between them, correspondingly situated identical irises in each plate of a number equal to the number of auxiliary conductors, each proportioned so as to be resonant to said given frequency, each set of aligned irises in the two plates being disposed so as to connect the interior of said main conductor to the interior of a different one of said auxiliary conductors through said clearance space, and in the resonant condition being adapted to transmit with little attenuation to the latter auxiliary conductor electromagnetic wave energy of said given frequency from said main conductor, and an element of conductive material in said clearance space adapted to be rotated therein at least partially in and out of alignment between each set of aligned resonant irises in turn, said mechanical means in a predetermined alignment position with respect to a set of aligned irises operating to detune that set only, so as to prevent transmission therethrough of any substantial amount of electromagnetic wave energy of said given frequency to the associated auxiliary conductor.

6. The combination of claim 5, in which each resonant iris in said plates comprises a narrow slot having its long dimension perpendicular to the electric vector representing the direction of the line of electric intensity of the electromagnetic wave energy transmitted over said main tubular conductor, the dimensions of said slot being proportioned to make it resonant at said given frequency, and said conductive element for detuning the resonant irises comprises a thin vane of conductive material and of suitable shape and dimensions rotatable in said clearance space to said predetermined position between each set of aligned irises.

7. The combination of claim 5, in which each of said resonant irises in said plates comprises a narrow slot having its long dimension perpendicular to the lines of electric intensity of the electromagnetic wave energy transmitted over said main conductor, and proportioned so as to be resonant at said given frequency, each of said slots being of curvilinear shape having two portions which are approximately radial with respect to the axis of rotation of said conductive element.

8. In combination in a dielectric wave guide system, a main tubular conductor transmitting electromagnetic wave energy of given frequency, a plurality of other tubular conductors branching out from said main tubular conductor, coupling means between the output of said main conductor and the inputs of said branching conductors comprising two plates of conductive material respectively extending completely across the cross-section of and conductively attached to the peripheries of adjacent ends of said main tubular conductor and said tubular branching conductors, means connecting said plates conductively together so as to form a narrow, electrically shielded clearance space therebetween, each of said plates having a plurality of identical and identically situated irises each resonant to said given frequency, each pair of aligned resonant irises in the two plates being disposed so as to connect the interior of said main tubular conductor with the interior of a different one of the branching tubular conductors through said clearance space, and in the resonant condition being adapted to transmit electromagnetic wave

energy of said given frequency in compressed form to the associated branching conductor from the main conductor, and a thin conductive vane in said clearance space adapted for rotation therein to predetermined positions between the several sets of aligned irises in said plates in turn, said vane when rotated to said predetermined position between one set of aligned irises, and away from said predetermined position between another set, operating to detune the first set sufficiently to prevent substantially any transmission of electromagnetic wave energy to the associated branch conductor from said main conductor, while maintaining each other set of aligned irises in the resonant condition so as to allow transmission therethrough of said energy of given frequency to the associated branching conductor from said main conductor.

9. In combination in a dielectric wave guide transmission system, a main hollow metal pipe transmitting electromagnetic wave energy of given frequency, two branch hollow metal pipes and coupling and switching means between said main and branch pipes comprising two metal plates respectively affixed in conductive relation with and extending completely across the cross-sections of adjacent ends of said main pipe and said two branch pipes, respectively, metal means holding said two plates in conductive relation and forming therebetween an electrically shielded narrow clearance space, two identical oppositely disposed apertures in each plate, respectively aligned with the corresponding apertures in the other plate, and so positioned that each aligned set of apertures connects the interior of said main pipe with the interior of a different one of said branch pipes through said clearance space, each aperture in said plates being proportioned so that it is resonant at said given frequency, a thin sectoral metal vane adapted for rotation within said clearance space about an axis coaxial with the longitudinal axis of said main pipe past the two sets of aligned resonant apertures in turn, said vane and said irises being such that when said vane is rotated to a predetermined position between either set of aligned resonant apertures and away from the other set of aligned resonant apertures, it capacitively detunes said first set sufficiently to prevent transmission of any substantial amount of wave energy of said given frequency therethrough to the associated branch pipe from said main pipe, and maintains said other set of resonant irises tuned to allow transmission therethrough to said other branch pipe of substantially all of the wave energy of said given frequency received over said main pipe.

10. The combination of claim 9, in which the thickness of each of said metal plates is very small compared to the wavelength of said electromagnetic wave energy of given frequency and such as to provide a desired sharpness of the frequency response of said resonant aperture.

11. The combination of claim 9, in which the two resonant apertures in each plate comprise oppositely disposed curvilinear narrow slots, the curvature being such as to provide for each slot two portions directed approximately radially toward the axis of said main pipe.

12. The combination of claim 9, in which said main pipe is of circular cross-section and each of said branch pipes is of rectangular cross-section, and to correct for the impedance mismatch due to the transition from circular to rectangular pipe, a metal partition with a circular orifice of suitable dimension is placed across the cross-section of the circular pipe at a distance of approximately a half wavelength from its end plate.

13. In a wave guide system, two hollow conductor wave guides joined end to end for through transmission of electrically guided waves from the interior of one guide to the interior of the other, a conducting transverse plate located between said guides having a parallel tuned slot dimensioned to provide selective transmission of waves of a given frequency from one guide into the other, and means for capacitively detuning said slot to shift its resonant frequency so as to substantially prevent transmission therethrough of wave energy of said given frequency comprising a metallic vane movable transversely across said slot to a given position.

14. The invention according to claim 13 in which said slot is of curvilinear configuration, shaped to be symmetrical about a given medial line so as to have on each side of said line a portion that extends for a distance in a substantially radial direction with respect to the axis of the guide, and in which said vane in one position covers both of said two portions of said slot and in another position uncovers said two portions.

15. In a wave transmission system, two hollow conductor wave guides disposed end to end, wave coupling means between said guides comprising two plates of conductive material respectively extending across and conductively affixed to a different one of the adjacent ends of the two guides, means connecting said plates conductively together so as to form an electrically shielded clearance space between them, each of said plates having a parallel tuned slot therein suitably dimensioned and located so as to enable selective transmission of electromagnetic wave energy of a given frequency between the interiors of the two wave guides through the two slots and said clearance space, and means to capacitively detune said slots so as to substantially prevent transmission of wave energy of said given frequency between said guides comprising a metallic vane movable across said clearance space to a given position between said slots.

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