Feb. 17, 1953 N. E. LINDENBLAD 2,629,051

ANTENNA

Original Filed Aug. 25, 1945

Fig_1

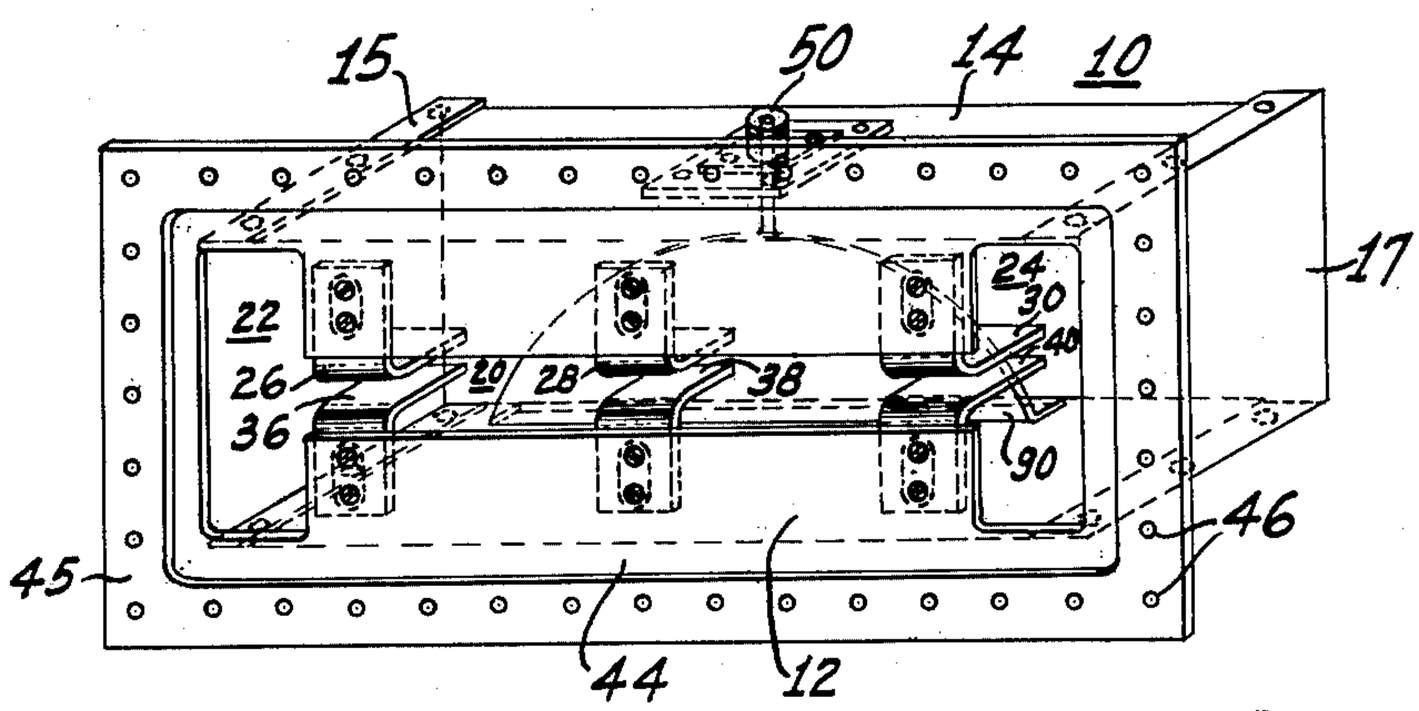


Fig_2

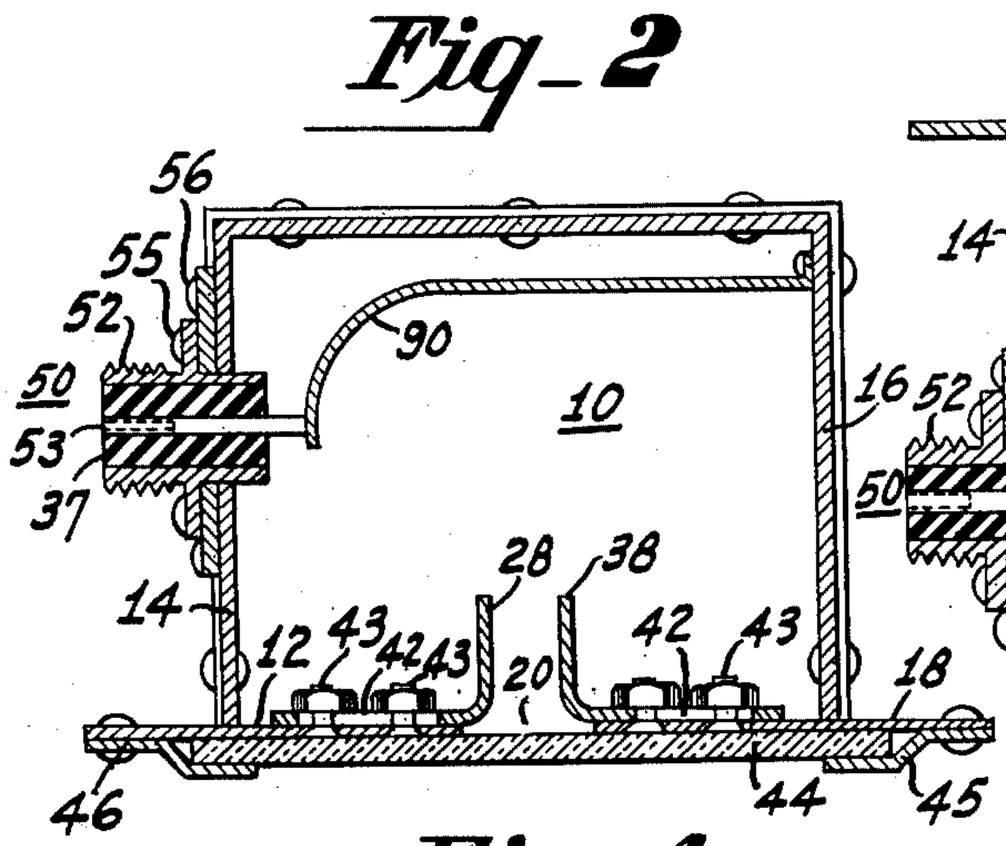


Fig_3

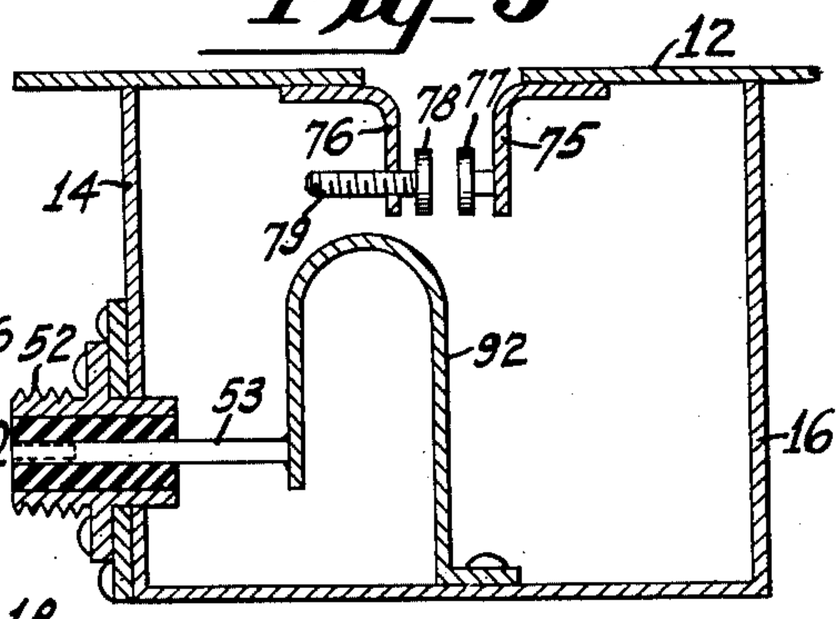
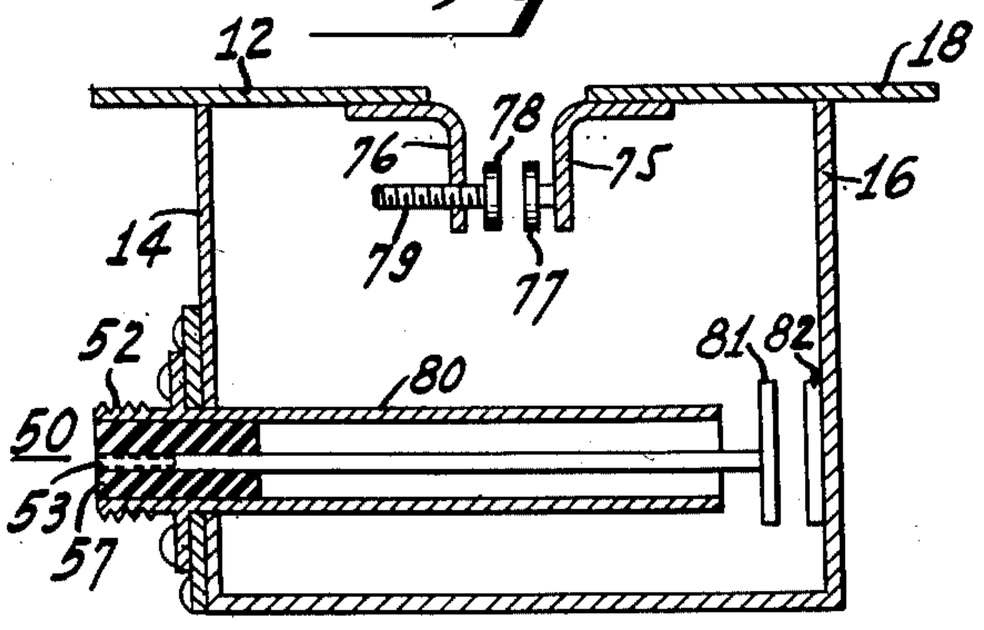


Fig_4



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2,629,051

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Original application August 25, 1945, Serial No. 612,685, now Patent No. 2,573,460, dated October 30, 1951. Divided and this application August 18, 1950, Serial No. 180,108

9 Claims. (Cl. 250—33.63)

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The invention relates to ultra short wave antennas, and more particularly, to cavity resonators having apertures therein such that radiation in a desired pattern of directivity takes place therefrom.

The application is a division of copending U. S. patent application Serial Number 612,685 filed August 25, 1945, now Patent Number 2,573,460 granted October 30, 1951.

An object of the invention is the provision of a broad band ultra short wave antenna which is compact in size.

Another object of the invention is the provision of an antenna which may be used in high speed vehicles such as airplanes without disturbing the aerodynamic properties of the vehicle.

A further object of the invention is the provision of an antenna, as aforesaid, which is mounted flush with the surface of the vehicle.

Still a further object of the invention is the provision of an antenna, as aforesaid, which occupies a minimum amount of space in the skin of the vehicle and also a minimum amount of space within the vehicle.

The foregoing objects and others which may appear from the following detailed description are attained by providing in the exterior surface of an aerodynamic vehicle, such as an airplane, a resonant cavity having one wall set flush with the surface. This wall has an aperture therein of such size and shape as to provide a capacitive reactance component which with the rest of the cavity, which is inductive, will permit tuning to resonance. The radiation pattern and the effective radiation resistance of the antenna is obtained from the currents which spread over the skin from the aperture and may be controlled by varying the size and shape of this aperture connecting the interior of the cavity with the exterior of the vehicle. Generally, said aperture will be in the form of an elongated slot having movable capacity flanges along the edges of the slot whereby the tuning of the system may be adjusted. The casing forming the cavity also serves to prevent currents from spreading over the back surface.

Provisions are made for coupling a transmission line to the cavity whereby the antenna may be connected to appropriate radiant energy transducer means such as a transmitter or receiver.

Throughout this presentation of the invention, it should be clearly understood that the antenna is usable either for the transmission or the reception of radiant energy waves of the operating frequency, though, for the sake of avoiding circumlocution, its operation will be described primarily from the viewpoint of transmission.

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The invention will be described with reference to the accompanying drawing forming a part of the specification and in which:

Fig. 1 is a front view in perspective of an embodiment of the invention;

Fig. 2 illustrates the embodiment shown in Fig. 1 in transverse cross section;

Fig. 3 is a transverse cross-sectional view illustrating a modification of the invention; and

Fig. 4 is a transverse cross-section view of a further modification of the invention.

Referring to Figs. 1 and 2, there is shown an elongated metallic box **10** having a front wall **12** and side walls **14** and **16**. The ends of the box are closed by end walls **15** and **17**. Front wall **12** is arranged to be mounted substantially flush with the conductive exterior surface of a vehicle by means of a circumferential mounting flange **18**. Wall **12** also contains an elongated central slot **20** through which ultra short wave energy escapes from the resonant cavity formed by the box through the continuity of interlinked currents set up in the sheet and is radiated. Slot **20** is provided at its ends with transverse slots **22** and **24** whereby the end portions of slot **20** are electrically freed one from the other. Thereby, the potential distribution along the opposing edges of slot **20** is maintained more nearly uniform. For the purpose of tuning slot **20** to the optimum operating characteristics, opposing pairs of condenser plates **26**, **36**, **28**, **38** and **30**, **40** are uniformly spaced in opposing relationship along the edges of slot **20**. The small cavity within box **10** may be brought into resonance at the operating frequency by adjustment of the capacity loading across slot **20** provided by the condenser plates. Furthermore, the electrical length of the slot may be effectively increased by capacity loading near the ends of the slot. That is, condenser plates **26**, **38** and **30**, **40** parallel the inductance of the slot at each end and by virtue of approaching resonance permits the building up of higher voltage near the ends of the slot. These condenser plates may be conveniently formed as L-shaped brackets or angle plates extending inwardly from slot **20** in opposing pairs. To adjust the capacity effect between members of each pair, the base portions of each L-shaped bracket are provided with elongated slots **42**. Pairs of flat-headed machine screws **43**, **43** are countersunk in the face of wall **12** and pass through each of the slots **42**, **42**. The screws are provided with washers and nuts so that the angle members may

be firmly clamped in position. Preferably after the proper tuning adjustment is attained, solder is flowed in around the nuts and between plate 12 and the angle members to assure a fixed adjustment and a low resistance connection between the angle members and the plate 12 upon which they are mounted.

In order to prevent the entrance of dust, moisture, etc., into the resonant cavity 10, slot 20 is covered with a window 44 of high quality dielectric material. The window may be made of "Lucite" which is the trade name of methyl-methacrylate or of polystyrene. Since these insulating materials are comparatively soft and under some conditions subject to cold flow, it is not desirable that the window be mounted in position by screws or rivets passing through the insulating material itself into the plate 12. Instead, there is provided a bezel member 45 entirely surrounding the window 44. Bezel 45 is preferably permanently attached to flange 18 by means of rivets 46 passing through bezel 45 and flange 18.

One preferred method of energizing the resonant space within the enclosure 10 is shown in Fig. 1. This means of energizing the cavity employs a standard coaxial receptacle 50 mounted on wall 14. Receptacle 50 includes a threaded outer sleeve 52 and an inner jack member 53 adapted to respectively contact the outer sheath and inner conductor of a coaxial transmission line. The outer threaded member 52 is provided with a mounting flange 55 by means of which the receptacle is attached to wall 14. Since wall 14 is made of comparatively thin material, a stiffening plate 56 may be interposed between the mounting flange and side wall 14. The inner jack member 53 of the coaxial receptacle is mounted in coaxial relationship with the interior of threaded sleeve 50 by means of high quality insulating material as indicated by reference numeral 57. Inner conductor 53 of the line fitting 52 is connected to the rounded end of a tapered tongue 90. Tongue 90 has its broad base edge connected to side wall 16 along its entire length. By suitably adjusting the taper of the curved tongue 90 and its curvature, such coupling distribution is obtained between the chamber inside box 10 and the transmission line connected to cable connector 52 so that constant input impedance results over a relatively wide band of frequencies.

Fig. 3 illustrates a further modification of the form of the invention shown in Figs. 1 and 2 wherein the tongue 90 is U-shaped in cross section. The broad base portion of tongue 92 is electrically connected to the rear wall of box 10 opposite the front wall 12. Tongue 92 has the same curving taper described above with reference to Figs. 1 and 2 but it is so bent as to resemble an inverted letter U when viewed from an end of box 10. By varying the taper of the curved tongue 92 and its curvature, similar coupling characteristics are obtained so that substantially constant input impedance obtains over a relatively wide band of frequencies.

Fig. 4 illustrates a modification of the form of the invention previously discussed with reference to Figs. 1 and 2. Similar parts have similar reference characters in all three figures. However, Fig. 4 illustrates a different way of tuning the radiating slot 20. Herein condenser brackets 75 and 76 carry a pair of opposing round plates or discs 77 and 78. Plate 77 is rigidly fixed to bracket 76 while plate 78 is carried on a threaded rod 79 so that by rotating rod 79, the spacing between plates 77 and 78 may be varied. Fig. 4

also illustrates a modified way of coupling the resonant chamber within box 10 to the transmitter. Coaxial line fitting 52 has its inner conductor 53 extending nearly across the width of box 10. At the end of extended conductor 53 is arranged a capacity plate 81 adapted to cooperate with capacity plate 82 connected to wall 16. Extended conductor 53 is surrounded by an outer sleeve member 89 for almost its full length. By suitably adjusting the spacing between plates 81 and 82, the electrical length of extended conductor 53 may be so varied that resonance is approached, thus varying the coupling of the transmission line connected to conductor 52 to the interior of box 10.

While a particular embodiment of the invention has been illustrated, it should be clearly understood that the invention is not limited thereto since many modifications may be made in the several elements employed and in their arrangement without departing from the spirit and scope of the invention.

The invention claimed is:

1. An antenna structure including a conductive walled box having an elongated slot in one wall thereof coupling the interior of said box to surrounding space, said box and said slot having dimensions at which said antenna is tuned to resonance at the operating frequency to produce standing electrostatic and electromagnetic waves in the interior of said box, means to couple a radio frequency energy transducer to said antenna structure, said means comprising a coaxial transmission line having a sheath conductor terminating at a conductive wall of said box and an inner conductor extending into the interior of said box, and a further conductive element connected to said inner conductor at the innermost end thereof, at least a portion of said further conductive element comprising a substantially plane surface of dimensions greater than the cross-sections of said inner conductor arranged in energy transfer relationship to one of the conductive walls of said box.

2. An antenna structure including a conductive walled box having an elongated slot in one wall thereof coupling the interior of said box to surrounding space, means for mounting said box in a conductive surface element with said slot arranged substantially in the plane of said conductive surface element, said box and said slot having dimensions at which said antenna is tuned to resonance at the operating frequency to produce standing electrostatic and electromagnetic waves in the interior of said box, means to couple a radio frequency energy transducer to said antenna structure, said means comprising a coaxial transmission line having a sheath conductor terminating at a conductive wall of said box and an inner conductor extending into the interior of said box, and a flat tapered conductive tongue element connected at the apex thereof to said inner conductor at the innermost end thereof and connected along the base thereof to one of the conductive walls of said box, said flat tapered tongue element having at least a major portion thereof constituting a substantially plane surface.

3. An antenna structure including a conductive walled box having an elongated slot in one wall thereof coupling the interior of said box to surrounding space, means for mounting said box in a conductive surface element with said slot arranged substantially in the plane of said conductive surface element, said box and said slot

having dimensions at which said antenna is tuned to resonance at the operating frequency to produce standing electrostatic and electromagnetic waves in the interior of said box, means to couple a radio frequency energy transducer to said antenna structure, said means comprising a coaxial transmission line having a sheath conductor terminating at a conductive wall of said box and an inner conductor extending into the interior of said box, and a flat triangular shaped conductor connected along the base thereof to one of the conductive walls of said box, a portion of said triangular shaped conductor including the apex thereof being folded back to lie substantially parallel to the base portion, said inner conductor being connected to the triangular shaped conductor at the apex thereof.

4. An antenna structure including a conductive walled box having an elongated slot in one wall thereof coupling the interior of said box to surrounding space, means for mounting said box in a conductive surface element with said slot arranged substantially in the plane of said conductive surface element, said box and said slot having dimensions at which said antenna is tuned to resonance at the operating frequency to produce standing electrostatic and electromagnetic waves in the interior of said box, means to couple a radio frequency energy transducer to said antenna structure, said means comprising a coaxial transmission line having a sheath conductor terminating at a conductive wall of said box and an inner conductor extending into the interior of said box, and a flat triangular shaped conductor connected along the base thereof to one of the conductive walls of said box, a portion of said flat triangular shaped conductor including the apex portion being bent out of the plane of the base portion of said conductor, the apex of said flat triangular shaped conductor being connected to said inner conductor of the innermost end thereof.

5. An antenna structure including a conductive walled box having an elongated slot in one wall thereof coupling the interior of said box to surrounding space, means for mounting said box in a conductive surface element with said slot arranged substantially in the plane of said conductive surface element, said box and said slot having dimensions at which said antenna is tuned to resonance at the operating frequency to produce standing electrostatic and electromagnetic waves in the interior of said box, means to couple a radio frequency energy transducer to said antenna structure, said means comprising a coaxial transmission line having a sheath conductor terminating at one conductive wall of said box and an inner conductor extending through said one wall into the interior of said box, and a flat triangular shaped conductor connected along the base thereof to a wall normal to said one wall of said box, a portion of said triangular shaped conductor including the apex thereof being folded back to lie substantially parallel to the base portion, said inner conductor being connected to the triangular shaped conductor at the apex thereof.

6. An antenna structure including a conductive walled box having an elongated slot in one wall thereof coupling the interior of said box to surrounding space, means for mounting said box in a conductive surface element with said slot arranged substantially in the plane of said conductive surface element, said box and said slot having dimensions at which said antenna is tuned to

resonance at the operating frequency to produce standing electrostatic and electromagnetic waves in the interior of said box, means to couple a radio frequency energy transducer to said antenna structure, said means comprising a transmission line receptacle having an inner conductor extending through one of the conductive walls into the interior of said box, a further conductive surface element connected to said inner conductor at the innermost end thereof and having at least a portion of the surface thereof substantially lying in a given plane and arranged in energy transfer relationship to one of the conductive walls of said box, and a tubular conductor element constituting an extension of said transmission line receptacle surrounding said inner conductor for a portion of the length thereof in the interior of said box.

7. An antenna structure including a conductive walled box having an elongated slot in one wall thereof coupling the interior of said box to surrounding space, said box and said slot having dimensions at which said antenna is tuned to resonance at the operating frequency to produce standing electrostatic and electromagnetic waves in the interior of said box, means to couple a radio frequency energy transducer to said antenna structure, said means comprising a coaxial transmission line having a sheath conductor terminating at a conductive wall of said box and an inner conductor extending into the interior of said box, and a further conductive element connected to said inner conductor at the innermost end thereof, said further conductive element comprising a capacitor plate arranged substantially parallel to and closely adjacent one of the conductive walls of said box.

8. An antenna structure including a conductive walled box having an elongated slot in one wall thereof coupling the interior of said box to surrounding space, said box and said slot having dimensions at which said antenna is tuned to resonance at the operating frequency to produce standing electrostatic and electromagnetic waves in the interior of said box, means to couple a radio frequency energy transducer to said antenna structure, said means comprising a coaxial transmission line having a sheath conductor terminating at one conductive wall of said box and an inner conductor extending into the interior of said box, a tubular conductor surrounding said inner conductor for part of the length thereof and having one end connected to said one conductive wall, and a further conductive element connected to said inner conductor at the innermost end thereof, said further conductive element comprising a capacitor plate arranged substantially parallel to and closely adjacent another of the conductive walls of said box.

9. An antenna structure including a conductive walled box having an elongated slot in one wall thereof coupling the interior of said box to surrounding space, means for mounting said box in a conductive surface member with said slot arranged substantially in the plane of said conductive surface, said box and said slot having dimensions at which said antenna is tuned to resonance at the operating frequency to produce standing electrostatic and electromagnetic waves in the interior of said box, means to couple a radio frequency energy transducer to said antenna structure, said means comprising a coaxial transmission line having a sheath conductor terminating at one conductive wall of said box and an inner conductor extending into the interior of said box,

a tubular conductor surrounding said inner conductor for part of the length thereof and having one end connected to said one conductive wall, and a further conductive element connected to said inner conductor at the innermost end thereof, said further conductive element comprising a capacitor plate arranged substantially parallel to and closely adjacent another of the conductive walls of said box.

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