May 23, 1939. F. R. HOUSE 2,159,481

SOUND LOCATOR RECEIVER

Original Filed July 19, 1934 2 Sheets-Sheet 1

Fig. 1.

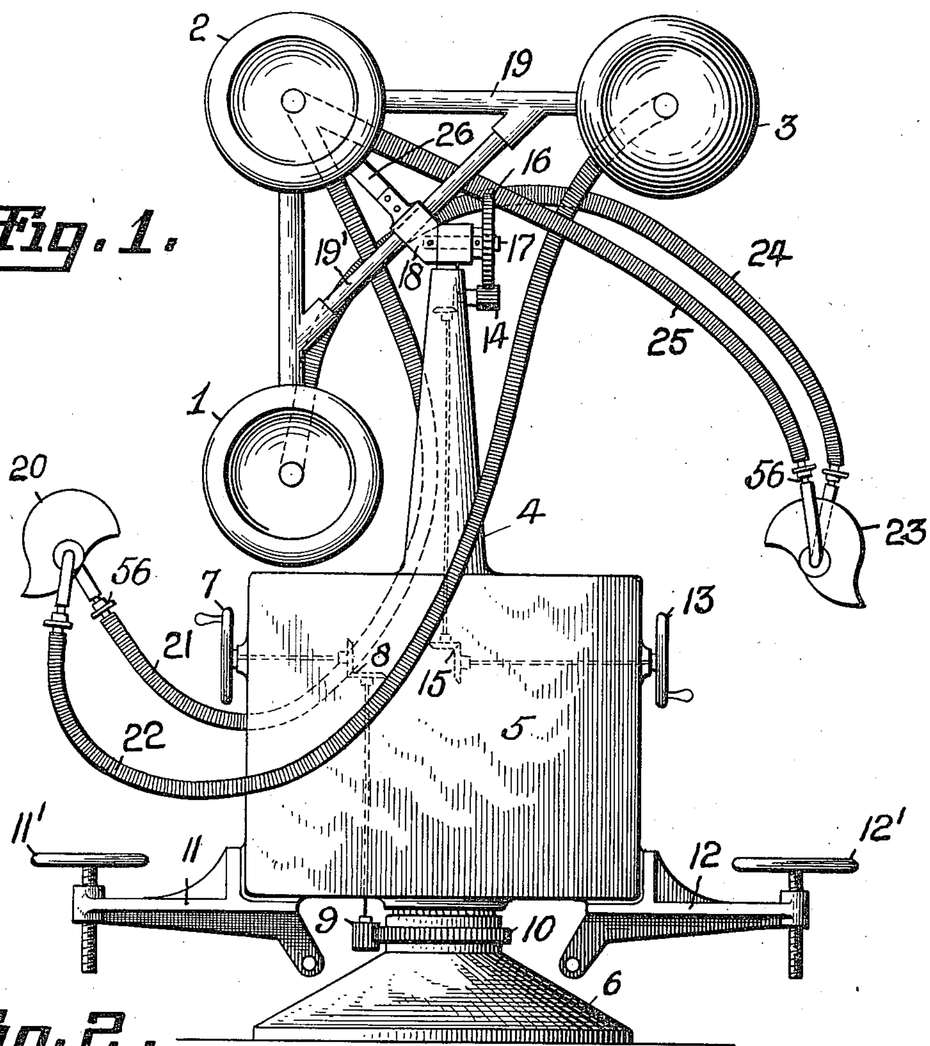


Fig. 2.

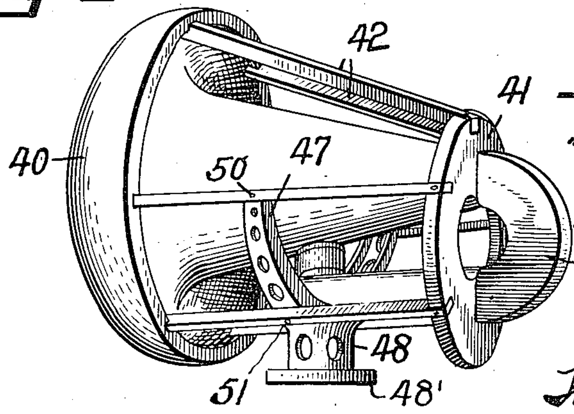
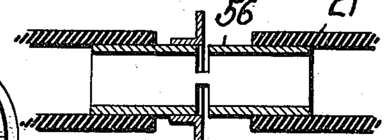


Fig. 3.



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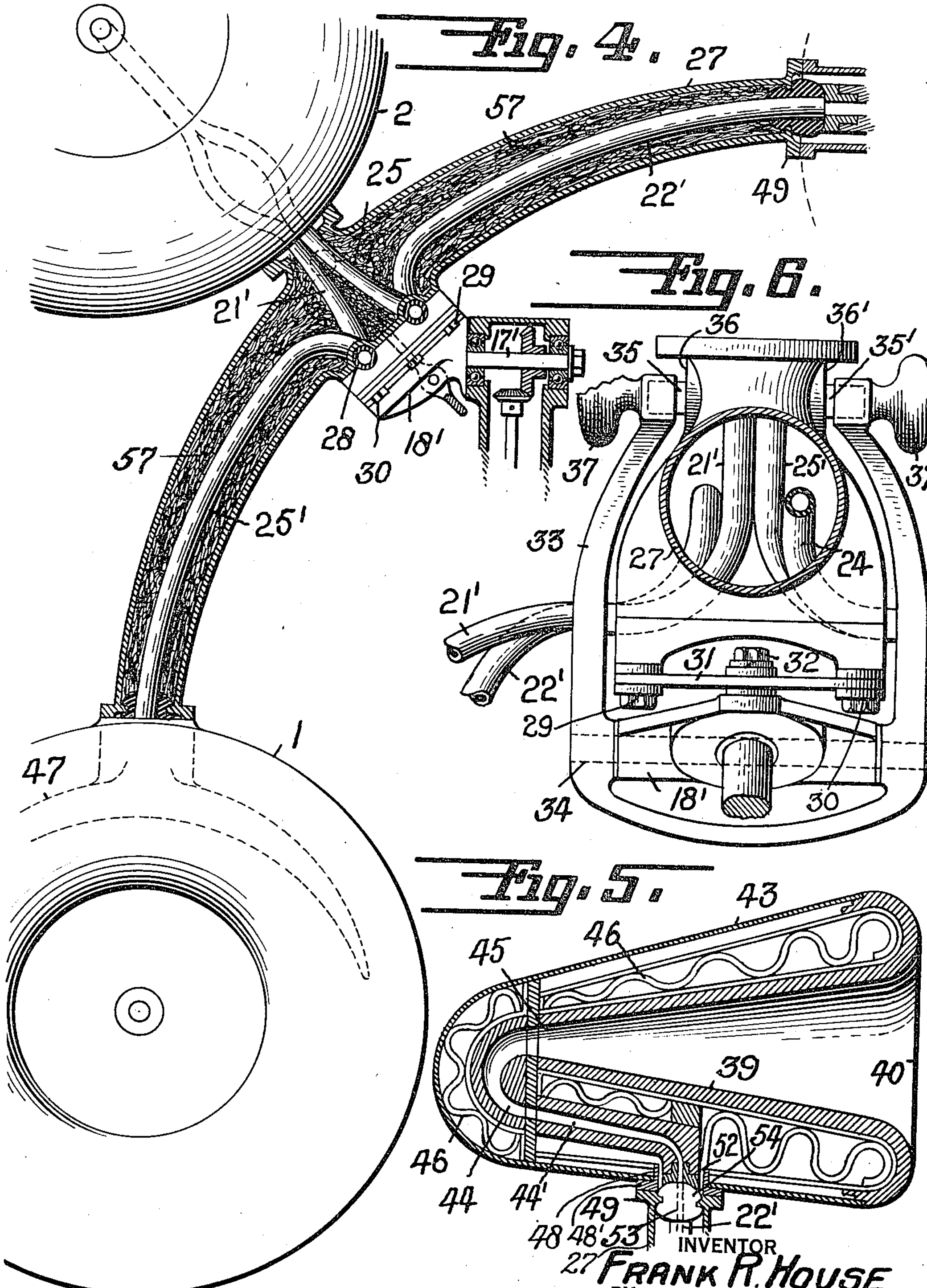

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UNITED STATES PATENT OFFICE

2,159,481

SOUND LOCATOR RECEIVER

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Original application July 19, 1934, Serial No. 735,989. Divided and this application February 28, 1936, Serial No. 66,158

17 Claims. (Cl. 181—26)

This invention relates to apparatus for locat- ng aircraft or other moving targets at night by neans of sound. More particularly, it pertains o the construction of the sound receiving devices r horns, the main object of the invention being o improve the construction of such horns, where- y a smaller, lighter and more efficient unit is rovided and greater efficiency secured.

According to the practice prior to my inven- ion, four large horns constructed throughout on he exponential principle were employed on the heory that great range is secured through great mplification. Each of such horns was on the rder of 3 feet in diameter at the mouth and feet in length, with a sound track length of bout 18 feet. The four horns, as mounted, oc- upied about 12 feet square. This construction s based upon the theory that increased range is btained by large amplification. By careful re- earch, however, I have found that range is not nproved by amplification alone and, in fact, is ometimes reduced thereby, especially if straight ne amplification is used, for which the expo- ential type of horn was designed. The range f a sound locator depends primarily on the con- rast between the ambient or general background oise and that which an airplane adds to it. Am- lification increases the sound level of both the mbient and the airplane sound, but the contrast emains substantially the same. Large straight ne amplification seems to the ear actually to ncrease the low tones of the background at a reater ratio than the higher tones of the aircraft oise, so that less contrast is obtained and the perator is confused on comparing what he hears hrough his head piece and by his ears without id and may be led to believe he hears an air- lane when none is there.

My invention is therefore aimed primarily to educe the ambient noise. Such noise may be lassified as due to two main causes: (1) the oise generated at a distance and carried to the eceiver by sound waves, and (2) the sound gen- rated within or at the receiver itself, either hrough the mechanical vibration of the receiver r due to wind. One object of my invention is to void over-emphasizing the ambient low tones by onstructing the horns with non-linear amplifica- ion characteristics such that the timbre of the mplified background noise sounds essentially he same to the ear as the direct sound.

Another object of my invention is to secure reater efficiency and range by carefully insulat- ng the sound track structure from the support self so that no noise from the movements of the support and operation of the corrector enters the sound track. I also form the receiver itself with a stream-lined exterior and rounded mouth so that wind blowing past the edges of the receiver will not cause turbulence, which sets up a whistle or rumble. I also may employ a filter between the receiver and the head pieces to filter out the general sound level of the remote background noises, thus accentuating the contrast with the noise from an aircraft.

By employing these principles, the size of the horns may be greatly reduced and the exponential construction is largely abandoned. Instead I use a more or less conical construction of the main horns with a short sound track length (about 10 feet). With this construction, the higher notes are amplified at a somewhat greater ratio than the lower notes, so that the timbre of the amplified sound to the ear remains undistorted. I have also eliminated one of the four horns of the prior construction, thus securing a lighter machine without sacrificing efficiency. In addition, I prefer to give the horn mounting a resilient mounting in order to aid in scanning.

This application is a division of my prior application Serial No. 735,989, filed July 19, 1934, for System of locating aircraft at night.

Referring to the drawings, illustrating several forms my invention may assume,

Fig. 1 is an elevation of one form of sound locator.

Fig. 2 is a perspective view of the preferred form of sound locator horn before the final covering of sound absorbing material has been applied thereto.

Fig. 3 is a sectional detail of one of the sound filters preferably employed in the sound track between the horn and receiving helmet or ear pieces.

Fig. 4 is a front view, partly in section, of a slightly modified form of sound locator.

Fig. 5 is a vertical section of the complete horn shown partially assembled in Fig. 2.

Fig. 6 is a detail of the mounting shown in Fig. 4.

According to my invention, the sound locator comprises a suitable arrangement of listening or sound collecting horns 1, 2 and 3 mounted for both turning in azimuth and tilting in elevation. By employing only three instead of four horns, a saving in weight is effected and additional space secured near the base of the instrument. The horns are shown as mounted on a pedestal 4 on a box-like housing 5 which contains the sound lag correction and other apparatus forming no part of the present invention. The entire box is preferably rotatably mounted on a pedestal 6 and is shown as rotated from the azimuth handwheel 7 through gearing 8 and pinion 9, which meshes with a large gear 10 fixed to the pedestal 6. The rotation of the handwheel therefore rotates the horns in azimuth and carries the observers or listeners seated on extensions 11 and 12 with the horns. The elevation control is shown as effected through a handwheel 13 which is shown as turning a pinion 14 through gearing 15. Said pinion rotates a gear 16 mounted on cross shaft 17 at the top of the pedestal and to which is secured at the opposite end a bracket 18 carrying the framework 19 which supports the three horns.

The three horns are shown as mounted in the form of a right triangle on the framework 19, with the center or common horn 2 vertically in line with and above the horn 1 and horizontally in line with the horn 3. Preferably, the vertical and horizontal axes of rotation of the horns bisect the legs of the triangle, so that each horn is the same distance from its axis of rotation. This maintains both horns at the same distance from the source of sound, which is important where the two horns are used to compare the intensity of sound received. The azimuth observer on seat 11' has his receiver or helmet 20 connected through tubing 21 and 22 to the horns 2 and 3, respectively, while the elevation observer at 12' has his helmet 23 connected through tubing 24 and 25 with horns 1 and 2, respectively, so that the horn 2 at the right angle of the triangle acts as a common horn for both listeners.

Preferably the framework 19 has a slightly oscillatory connection to the bracket 18, the same being shown as connected thereto through a leaf spring 26 which connects the apex of the triangle to the bracket. This permits a limited oscillation of the horns in both planes or, in other words, about the axis of the transverse shaft 19' which is rotatably mounted within the bracket 18, thereby increasing the field of hearing and sensitivity of the device. In other words, by giving the horns a vibratory motion in both azimuth and elevation, the keenness of perception of the operators is increased by giving them continuous comparison of the intensity of the sound being received. While no attempt is made to illustrate the comparative length of the sound tracks 21, 22, 24 and 25, it will be understood that in both Figs. 1 and 4 the sound tracks are preferably of substantially the same length.

In Fig. 4 a slightly modified form of mounting is shown, but the horns are again mounted in the shape of a right triangle with the common horn at the right angle or apex of the triangle. In this case the triangular framework 19 is replaced by a hollow curved arm 27 which supports at its two ends the horns 1 and 3 and, adjacent the center, the central horn 2. In this case the connecting tubes 21' and 25' are carried entirely within the metallic structure of arm 27 between the horns and points of emergence 28 near the axis of rotation of the cross shaft 17', which carries the bracket 18'. Preferably, also, sound absorbing material 57 is placed within the arm 27 around the tubes 21' and 24'.

The framework or arm 27 is shown as bolted at spaced points 29 and 30 to a resilient plate 31 which, in turn, is bolted at spaced points 32 to the bracket 18'. Therefore the horn structure is free to oscillate in both azimuth and elevation through a limited angle for the same purpose as effected by the spring 26 in Fig. 1. If desired, the structure may be locked to prevent this oscillation by means of a U-shaped bracket 33 pivoted on shaft 34 and having friction faces 35 and 35' adapted to bear against flattened surfaces 36 and 36' on the horn structure. When in the position shown in Fig. 6, no oscillation can occur and in case oscillation is desired, the handles 37 and 37' are gripped by the operator and the bracket swung downwardly to release the horn framework from locking engagement with the surfaces 35 and 35'.

The preferred form of construction of the horns per se is shown in Figs. 2 and 5. In this construction the horn itself is made smaller than the usual exponential horn and is carefully stream-lined and sound-proofed to avoid transmitting extraneous sounds, such as due to cross winds or to vibrations of the support itself, to the ears of the listeners. Each horn is preferably built up with a conical shaped interior 33, preferably made of wood and having a rolled or bell mouth 40. Adjacent the rear end is placed a supporting ring 41 and light flexible ribs 42 of wood or similar material are connected at front and back between the flaring bell mouth 40 and ring 41. Around the entire structure is placed a smooth covering 43 (see Fig. 5) which encloses completely the inner horn, the outer ribs 42 and the sound track housing 44 connecting the throat 45 of the horn with one of the connecting tubes 22' leading the sound to the listener. Between said cover and horn there is placed a corrugated sound absorbing material 46 or glass wool.

The entire horn is shown as supported on the metallic framework 27 through a U-shaped bracket 47 having a tubular projection 48 and a collar 48' at its base adapted to be secured to a collar 49 on framework 27. The U-shaped arms on said bracket are secured only to central points 50, 51, etc., of adjacent ribs 42 so that whatever vibration is transmitted to the bracket will be damped out before reaching the sound track or horn proper. To this end, it should be noted that the sound track passage, including housing 44 and wooden tube 44', is spaced at all points from the metal bracket. See the annular space 52 between the sound track passage and the part 48. Also, the tube 22' is shown as having the interior thereof connected to the interior of passageway 44' through a hole 53 in soft rubber nipple 54 mounted in the interior of the collar 49. By this means, no vibration reaches the horn or the sound track passages therein.

I am aware that the smaller horns 39 and shorter sound track do not give as true lineal amplification nor as great amplification as usually employed. But this is intentional because, as stated hereinbefore, I find that by amplifying the higher notes more than the lower, the ear is better able to distinguish the aircraft noises from the ambient noise, and by reducing the latter, especially that portion originating in or at the locator itself, good range is obtained without the great size and weight of prior receivers. The conical shape of the forward portion of the horn is preferred as it does not taper down as rapidly as a true exponential horn and therefore the size of the mouth may be made smaller without increasing the amount of air friction on the walls.

Preferably, also, I employ sound filters 56 between the horns and the helmets (see Figs. 1 and 3). Such filters are adjusted to filter out sounds of different pitch from the normal pitch of the propeller and engine drone of an aircraft. With such filters the operator is not confused by extraneous noises.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In a sound locator having spaced sound receivers, a frame supporting the same in spaced relation laterally and in elevation, with azimuth and elevation head phones connected to said receivers, of means for mounting said frame for turning in azimuth and elevation, and a resilient metallic plate connection in said means adapted to maintain oscillation of said receivers through a limited angle.

2. In a sound locator having three spaced sound receivers, a frame supporting the same in spaced relation laterally and in elevation, with azimuth and elevation head phones each connected to one receiver and individually connected to the other two, of means for mounting said frame for turning in azimuth and elevation, including a resilient metallic plate connection permitting oscillation of said receivers in both planes.

3. In a sound locator having spaced sound receivers, a frame supporting the same in spaced relation laterally and in elevation, with azimuth and elevation head phones connected to said receivers, of means for mounting said frame for turning in azimuth and elevation, and a resilient metallic spring plate connection in said means supporting the same at an acute angle to the horizontal, whereby limited oscillation is permitted both in azimuth and elevation.

4. In a sound locator having spaced sound receivers, a frame supporting the same in spaced relation laterally and in elevation, with azimuth and elevation head phones connected to said receivers, of means for mounting said frame for turning in azimuth and elevation, a resilient metallic spring leaf connection in said means adapted to maintain oscillation of said receivers through a limited angle, and means for locking out said resilient connection at will.

5. A sound receiving horn for sound locators, comprising an interior conical horn having a flaring mouth, a spaced-outer covering also of generally conical shape and connecting at its lower end to said mouth, a supporting hollow frame for said horn, and a sound track passage leading from the apex of said horn and curved backwardly on itself to a midway point within said frame and which is between the exterior of said inner horn and the covering thereof, said sound track emerging through said outer covering at said midway point.

6. A sound receiving horn for sound locators comprising an interior conical horn, a spaced outer covering, a supporting hollow frame for said horn, a sound track passage leading from the apex of said horn to within said frame and which is between the exterior of said inner horn and the covering thereof, sound track tubing within said frame and connected to said passage, and sound proofing material between said tubing and frame.

7. A sound receiving horn for sound locators comprising an interior conical horn and a spaced outer generally conical covering therefor, a flaring mouth connecting said horn and covering at the open end, and sound proofing material between said horn and covering, the whole being stream-lined to prevent wind noises.

8. In a sound locator having a plurality of spaced horns, and head phones connected thereto, characterized by each horn being stream-lined and sound proofed against extraneous noises, and sound filters in the connections between said phones and horns to exclude noises of a pitch dissimilar to that emitted by the target.

9. In a sound locator, three sound receivers arranged in the form of a right triangle with one leg vertical and the other horizontal at the upper end of the vertical leg, an elevation following ear piece having connections to the receiver at the right angle of the triangle and to the receiver vertically in line therewith, an azimuth following ear piece having connections also to said receiver at the right angle and to the receiver horizontally in line therewith, and means for mounting said receivers for turning about vertical and horizontal axes which bisect the horizontal and vertical legs of the triangle.

10. A sound receiver horn for sound locators comprising an interior substantially conical nonmetallic member, a resilient, non-metallic, ribbed framework surrounding said member, spaced therefrom and supporting said member adjacent the front and back only, and a metal bracket adapted to be secured to the main support and supporting said horn by being connected to mid points of said ribbed frame.

11. A sound receiver horn as claimed in claim 8, having a sound track passage from said member to a sound tube within said outer covering, and sound absorbing material between said bracket and tube.

12. A sound receiving horn for sound locators, comprising an interior conical horn, a spaced outer covering, a supporting frame for said horn, a sound track passage leading from the apex of said horn to within said frame and which is between the exterior of said inner horn and the covering thereof, and sound absorbing means for supporting said horn from the metallic support through said frame.

13. A listening horn for sound locators having a substantially conical hollow main body provided with a substantially conical sound receiving horn therein and a relatively short hollow sound track member extending from the apex of said horn and confined wholly within said main body, whereby said horn has a non-linear amplification characteristic such that the timbre of the amplified sound is distorted toward the higher tones, whereby the apparent distortion toward the lower tones, that otherwise occurs, is avoided.

14. In a sound locator, three spaced sound receivers, a hollow curved arm supporting the same in spaced relation laterally and in elevation, azimuth and elevation head phones, connecting tubes extending between said head phones and said receivers for connecting one receiver to both of said phones and the other receivers respectively to said phones, portions of said tubes being contained within said arm, sound absorbing material surrounding the thusly contained portions of said tubes, and means for mounting said arm for turning in azimuth and elevation.

15. In a sound locator, spaced sound receivers, tubular supporting means for supporting the same in spaced relation laterally and in elevation, azimuth and elevation head phones, connecting tubes extending between said head phones and said receivers, portions of said tubes extending within said tubular supporting means, insulation within said tubuular supporting means and surrounding said enclosed portions of said tubes, and vibration damping material included in the connection between said enclosed portions of said tubes and said receivers.

16. A sound receiving horn for sound locators, comprising an interior substantially conical horn, a spaced outer covering, a supporting bracket for said horn, vibration damping means between said bracket and said horn, and a hollow tapered member providing a sound track passage leading from the apex of said horn to within said bracket, said tapered member extending between the exterior of said interior horn and the covering thereof.

17. A sound receiving horn for sound locators, comprising an interior substantially conical horn, a spaced outer covering, sound insulation between said horn and covering, bracket supporting means extending inwardly through said covering for supporting said horn, vibration damping means included between said bracket supporting means and said horn, and a sound track housing extending from the apex of said horn reversely and along the exterior of said horn within said covering to within said supporting means for connection to a connecting tube.

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