Dec. 29, 1942. G. L. USSELMAN 2,306,850

TRANSMISSION LINE

Filed May 3, 1940

Fig. 1

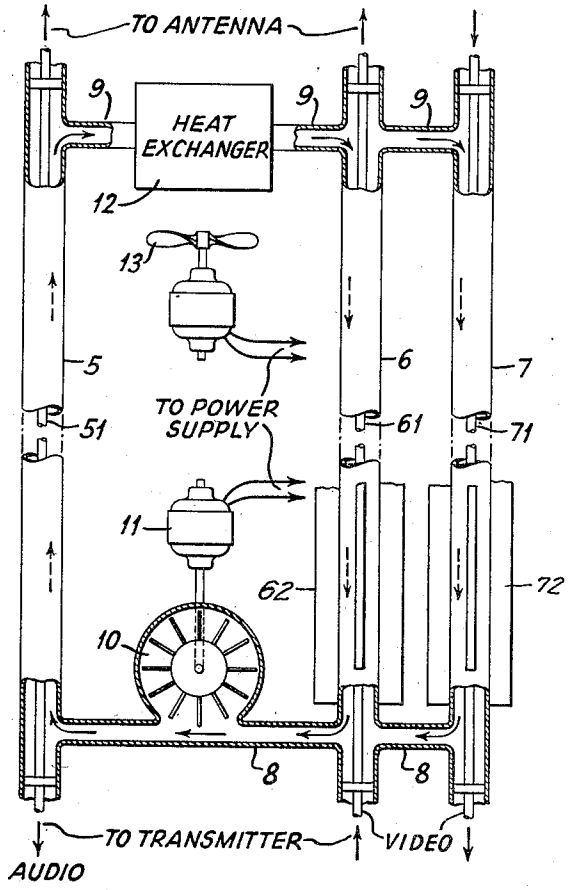
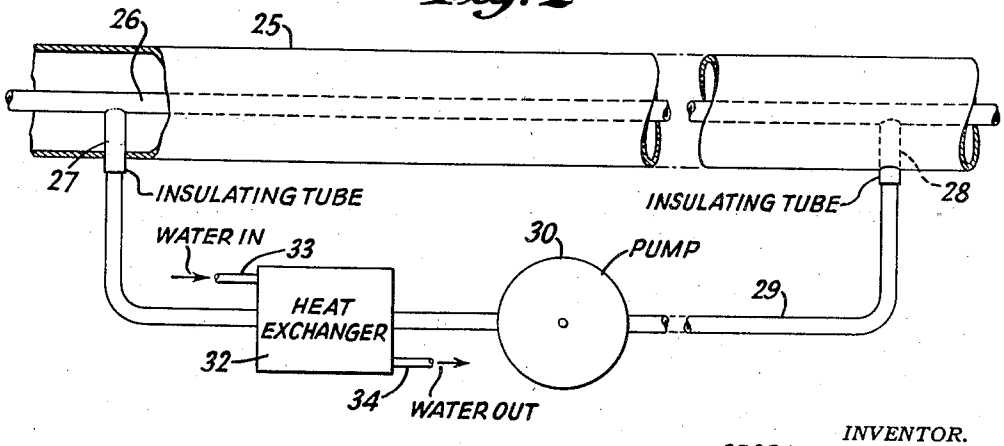


Fig. 2



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TRANSMISSION LINE

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4 Claims. (Cl. 174—15)

The present invention relates to coaxial transmission lines and, more particularly, to a means for cooling high power coaxial transmission lines.

With the recent continuous and substantial increase in power and in operating frequencies the problem of heat dissipation has become very important. Although the power loss per unit length in coaxial transmission lines is comparatively small, the inner conductor of the line cannot rid itself of heat very readily. At any rate, its heat radiating capabilities are very much smaller than those of the outer conductor. Consequently, the inner conductor of the coaxial transmission line when carrying high power tends to become dangerously hot. The heat tends to cause rapid oxidation of the conductor and, in extreme cases, the heat might even melt the solder in the joints in the inner conductor. Oxidation of the adjacent surfaces of the coaxial conductors is undesirable since the oxides of most metals have a higher resistance than the metal itself. Since practically all of the current carried by the coaxial transmission line is carried by the adjacent surfaces, the losses in the line are increased excessively thus further increasing the heat which must be dissipated. Furthermore, due to the heating effect of the inner conductor the atmosphere within the coaxial transmission line is heated and it is well known that hot air ionizes more easily than cooler air. The heated ionized air becomes a poor insulator and thus tends to cause flash-over within the transmission line and consequent breakdown.

The present invention is directed especially toward a means of cooling coaxial transmission lines.

An object of the present invention is to efficiently remove heat from the inner conductor of coaxial transmission lines.

Still a further object of the present invention is to provide a structure for causing circulation of a cooling fluid in the space between the inner and outer conductors of a system of coaxial transmission lines.

In accordance with the present invention I propose to so connect together groups of coaxial transmission lines at different elevations so that a circulation of the fluid contained therewithin, whether air or other gas or fluid, may take place. The lines are so grouped as to heat radiating capabilities and power carried that one group runs hotter than the other. Due to the convection principle a circulation of the contained fluid takes place. Cooling fins may be provided on the cooler lines, if desired, in order to increase their cooling capabilities.

Further objects, features and advantages of the present invention will be understood from the following detailed description which is accompanied by a drawing in which Figure 1 shows an embodiment of the invention while Figure 2 shows a modification of the present invention.

Figure 1 shows a group of three coaxial transmission lines 5, 6 and 7 having inner conductors 51, 61, 71. The lower ends of the transmission lines may be considered as connected to a source of radio frequency energy such as a transmitter while the upper ends may be considered as connected to a load or an antenna. In the showing of Figure 1, one transmission line has been labeled audio transmission line while the other pair have been labeled video transmission line to indicate that the present invention may be adapted to a single-ended or unbalanced transmission line such as may be used for audio signals and, simultaneously, to a push-pull balanced transmission line used for video signals in a television transmitting system. Of course, the present invention is not limited thereto but may be used wherever heavy current at high frequencies is being transmitted. The lower ends of each of the transmission lines are connected together by tubing 8 and the upper ends by tubing 9. In some cases, when the lines are sealed and subject to gas pressures above atmospheric, convection circulation may be naturally produced through the system especially if the unbalanced transmission line is arranged to run warmer than push-pull video transmission lines 6, 7 while the increased area of the pair of outer shell conductors provides a larger radiating area. It is also contemplated as within the scope of the present invention to place radiating fins 62, 72 along lines 6, 7 to increase the heat radiation therefrom. Forced circulation may be provided if desired by a pump 10 which is driven by motor 11. Also, at the upper end of the transmission lines a heat exchanger 12 may be interposed in the cross-connection tube 9 between the single and push-pull lines. However, since, transmission line 5 runs warmer than do lines 6 and 7, sufficient cooling may be obtained with the latter two lines connected in parallel as far as the air circulation is concerned. In operation, the heated air from transmission line 5 passes through the heat exchanger 12 and is cooled. The cool air then passes down through lines 6 and 7, picking up heat from the inner conductors 61, 71 and is then forced through connec-

tions **8** back into transmission line **5**, where it also picks up heat from conductor **51** before again entering heat exchanger **12**.

While I have, in this figure, shown the heat exchanger as being air cooled with the circulation of the outer air through the heat exchanger aided by fan **13**, it is within the scope of my invention to utilize a liquid cooled heat exchanger such as shown in Figure 2 of the drawing.

In Figure 2 I have shown a coaxial transmission line composed of outer conductor **25** and a hollow inner conductor **26**. An insulating transformer oil may be passed through the hollow inner conductor **26**. The oil connections **27** to the inner conductor from outside of the outer conductor **25** must be made of some insulating material such as glass or an artificial rubber which is not affected by the cooling fluid. The cooling fluid is forced to circulate through the system by pump **30** though in some vertical installations thermo syphon circulation may be sufficient. The heat exchanger **32** in this figure is indicated as being of the water cooled type, water being allowed to flow in through an inlet **33** and out to waste at **34**. The cooling fluid and the water are in contact with opposite sides of thin metallic separations. The separations may be arranged in sheet or tube form, as is well known. In some cases, sufficient cooling may be obtained without water cooling merely by substituting a radiator similar to the conventional automobile radiator or heat exchanger **32**. In this case, convection may be relied upon to cause air to flow through the radiator.

While I have shown and particularly described several embodiments of my invention, it is to be distinctly understood that my invention is not limited thereto but that modifications within the scope of my invention may be made.

I claim:

1. In combination, a plurality of substantially parallel transmission lines each having at least an outer shell, means for providing a fluid connection between said lines at each end thereof, some of said lines having a heat radiating capacity exceeding that of the others and one end of said lines being at a higher elevation than the other whereby a circulation of fluid in said lines is caused.

2. In combination, a plurality of substantially parallel coaxial transmission lines, each having an inner conductor and an outer shell, means for providing a fluid connection between the outer shells of said lines at each end thereof, some of said lines having a heat radiating capacity exceeding that of the others and one end of said lines being at a higher elevation than the other whereby a circulation of fluid within said lines is caused.

3. In combination, a plurality of substantially parallel coaxial transmission lines, each having at least an outer shell, means for providing a fluid connection between said lines at each end thereof, said lines having their one ends at a substantially higher elevation than their other ends, at least all of said lines carrying sufficient radio frequency energy to cause excessive heating thereof and the outer shells of the remainder of said lines having a heat radiating capability in excess of that required to cool said remainder whereby convection causes a circulation from end to end of a fluid contained in said lines.

4. In combination, a plurality of substantially parallel coaxial transmission lines, each having an inner conductor and an outer shell, means for providing a fluid connection between said lines at each end thereof, said lines having their one ends at a substantially higher elevation than their other ends, at least some of said lines carrying sufficient radio frequency energy to cause excessive heating of the inner conductors thereof and the outer shells of the remainder of said lines having a heat radiating capability in excess of that required to cool said remainder whereby convection causes a circulation from end to end of a fluid contained in said lines.

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