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(54) ELASTIC SURFACE WAVE DEVICE

(71) We, TOKYO SHIBAURA ELECTRIC COMPANY LIMITED, a Japanese corporation, of 72 Horikawa-cho, Saikai-ku, Kawasaki-shi, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an elastic surface wave device of which the characteristics are improved by using an elastic surface wave absorber having a particular configuration.

Attempts have conventionally been made to improve the characteristics of an elastic surface wave device by using an elastic surface wave absorber. Such a surface wave device is shown, by way of example, in Fig. 1. In this Figure an interdigital type input transducer 2 and interdigital type output transducer 3 are provided at a predetermined interval on one surface 1 of a piezoelectric substrate. A surface wave propagation path is provided by that surface portion of the substrate which is provided between the transducers 2 and 3. On the extension of the surface wave propagation path, surface wave absorbers 4 and 5 of rectangular configuration are provided one at each end portion of the piezoelectric substrate such that their side edges intersect substantially orthogonal to the surface wave propagation path. The interdigital electrodes 2a and 2b in the input transducer 2 have common connection electrodes 2a–1 and 2b–1, respectively, across a surface wave signal source 6, and the respective common connection electrodes 2a–1 and 2b–1 have a plate-like portion as shown in Fig. 1 except for the overlapped portions of the digit electrodes. As a result, it is possible to prevent unwanted surface waves from being reflected on those digit electrode sections except for the overlapped portions of the digit electrodes. The interdigital electrodes 3a and 3b of the output transducer 3 have common connections 3a–1 and 3b–1, respectively, and are connected to, for example, a load 7.

When a surface wave signal is supplied from a surface wave signal source 6 to the transducer 2 on the conventional surface wave device, a normal surface wave A is transmitted from the input transducer 2 toward the output transducer 3 as shown in Fig. 1 and there are reflected surface waves B to I which reach the output transducer 3 through various paths from the input transducer 2. That is, the reflected surface wave B reaches the output transducer 3 after being reflected on the rear end of the input transducer 2, the surface wave C is reflected several times between the input and output transducers 2 and 3, a surface wave D is incident upon the output transducer after being reflected on the front edge of the absorber 5 which is disposed behind the output transducer 3, a surface wave E is incident upon the output transducer 3 after being reflected on the front edge of the absorber 4 disposed behind the input transducer 2, a surface wave F is incident onto the output transducer 3 after being reflected on the rear edge of the absorber 5 on the output side, a surface wave G is incident onto the output transducer after being reflected on the rear end of the absorber 4 on the input side, a surface wave H is reflected to the output transducer 3 after being reflected on that substrate 1 end at the output side of the substrate 1, and a surface wave I is incident onto the output transducer 3 after being reflected on the substrate 1 end on the input side of the substrate 1.

The reflected wave C can be reduced by adjusting the value of the load 7 and the reflected waves D to I be reduced by properly selecting the material and dimension of the absorbers 4 and 5. The suitable choice of the shape of the end surface of the piezoelectric substrate 1 reduces the extent to which the surface waves are reflected at the respective locations, thereby preventing the degradation of characteristics of the surface wave device. However, the surface wave B can not be reduced by any of the above-mentioned methods and it is difficult to prevent the degradation of characteristics of the surface wave device due to the presence of the reflected wave B.

It is accordingly the object of this invention to provide an elastic surface wave device which can alleviate any influence resulting from surface waves reflected on the ends of transducers in particular.

The above-mentioned object can be attained by partially overlappingly providing a surface wave absorber on that end portion of a piezoelectric substrate which lies on an extension of a surface wave propagation path, the surface wave absorber having end edges inclined the surface wave propagation direction.

In one aspect of this invention there is provided an elastic surface wave device comprising a piezoelectric substrate; interdigital type input and output transducers provided on one surface of the piezoelectric substrate and mutually spaced apart from each other to define a surface wave propagation path therebetween; and a surface wave absorber partially overlappingly provided on that end portion of at least one of the input and output transducers which lies on an extension of the surface wave propagation path, the absorber having end edges which are inclined to the surface wave propagation path.

This invention will be further described by way of example by reference to the accompanying drawings in which:

Fig. 1 is a schematic view showing a conventional elastic surface wave device using a surface wave absorber;

Fig. 2A is a schematic view showing an elastic surface wave device according to one embodiment of this invention;

Fig. 2B is a side view showing the device of Fig. 2A;

Fig. 3 is a signal waveform for explaining the operation of the device of Figs. 2A and 2B;

Fig. 4 is a schematic view showing another embodiment of this invention;

Fig. 5 is a schematic view showing another embodiment of this invention; and

Fig. 6 is a schematic view showing another embodiment of this invention.

In Figs. 2A and 2B a piezoelectric substrate 21 is formed of, for example, lithum tantalate ($LiTaO_3$). An interdigital type input transducer 22 and interdigital type output transducer 23 are provided at a predetermined interval on one surface of the $LiTaO_3$ substrate 21. An elastic surface wave propagation path is provided on the substrate 1 portion between the transducers 22 and 23. The input transducer 22 is constructed of two interdigital electrodes 22a and 22b each having a plurality of digit electrodes. The digit electrodes have their overlapped portions varied in length along a weighting pattern. The pattern is used where, for example, the elastic surface wave device of this invention is employed as a picture intermediate frequency (PIF) stage filter of a color TV receiver. A part of the non-overlapped portions of the digit electrodes in the interdigital electrodes 22a and 22b are shown coated with an electroconductive material so that reflection of any unwanted surface waves can be prevented on the non-overlapped portions of the digit electrodes. Those coated portions of the digit electrodes are used as electrode terminals 22a–1 and 22b–1 of the digital electrodes 22a and 22b. A surface wave absorber 24 is provided overlappingly on those rear edge portions of the electrode terminals 22a–1 and 22b–1 as viewed in the direction of propagation of the surface wave. As the surface wave absorber 24 use may be made of, for example, #4033 ink manufactured by Markem Company of U.S.A. The surface wave absorber 24 covers almost all the rear edge portions of the electrode terminals and is formed in such a V-shape pattern that its opposite edge portions are inclined in the direction of propagation of the surface wave. The output transducer 23 is constructed of a pair of interdigital electrodes 23a, 23b each having a plurality of digit electrodes, and the overlapped portions of the digit electrodes of the interdigital electrodes 23a and 23b are formed to have fixed lengths. Between the output transducer 23 and one end of the piezoelectric substrate 21 a surface wave absorber 25 of rectangular configuration is mounted such that its longitudinal sides intersect substantially normal to the direction of propagation of the surface wave. The surface wave absorber 25 is made of the same material as that of the surface wave absorber 24. The absorber 25 may be partially overlappingly formed on the electrode terminal of the output transducer 23. In operation, when an input signal is applied to the input transducer 22 a main signal output I is received in the output transducer 23 after a slight time t1 as shown in Fig. 3. Further, a slight response II occurs on the output transducer 23 after a slight time t2 due to a wave (corresponding to a reflection wave B in Fig. 1) reflected on the rear edge of the input transducer 22. The slight response II of the output of the output transducer 23 has at a level ratio below 46dB with respect to the main signal output I as will be seen from Fig. 3 and it will be appreciated that the reflected wave is properly damped. A response III occurs due to a reflected wave B arising from a conventional surface wave device and has a level about 8dB higher than the level of the surface wave device of this invention. From the graph of Fig. 3 it will be seen that a great, reflected wave prevention effect will be obtained from the surface wave device of this invention.

In the embodiment shown in Figs. 2A and 2B the surface wave absorber 24 provided with respect to the input transducer 22 has, at its notched end, those portions which are made orthogonal to the direction of propagation of the surface wave. In order to further reduce such reflected wave all end edge portions of the surface wave absorber 24a are formed in a manner to diagonally intersect with respect to the direction of propagation of the surface wave (Fig. 4) and, in addition, a surface wave absorber 25a on the side of an output transducer 23 may have a serrated portion whose tooths diagonally intersect with respect to the direction of propagation of the surface wave (Fig. 4).

In any of the above-mentioned embodiments the non-overlapped portions of the digit electrodes of the input transducer are formed as an integral electroconductive film on which the surface waves absorber 24 is partially overlappingly provided. As shown in Fig. 5, however, the non-overlapped portions of the digit electrodes may be left uncoated and an electrically insulating surface wave absorber 24b be formed on the overlapped portions of the digit electrodes. In the surface wave device shown in Fig. 5 one end edge of the surface wave absorber 24b includes a notch of which the opposite side edges diagonally intersect with respect to the surface wave propagation path, and the other end edge of the surface wave absorber 24b is away from the surface wave propagation path and has a small-toothed section.

In the embodiments as shown in Figs. 2A, 2B, 4 and 5, in order to prevent reflection of surface waves the non-overlapped portions of the digit electrodes of the interdigital electrode constituting the input transducer are either formed as the integral electroconductive film, or left intact so that they are coated with the electrically insulating absorber. As shown in Fig. 6, however, the non-overlapped portions of the digit electrodes may be removed and electroconductive terminals 22a–2 and 22b–2 be formed there. In this case, there is no fear that reflection of surface waves will occur at the non-overlapped portions of the digit electrodes.

Even if the reflection property of the absorber edge is subject to some ageing, since the end edge of the absorber is formed to diagonally cross with respect to the surface wave propagation direction, an excellent surface wave device can be obtained which can prevent reflection of surface waves and thus reduce noises.

WHAT WE CLAIM IS:—

1. An elastic surface wave device comprising a piezoelectric substrate; interdigital type input and output transducers provided on one surface of the piezoelectric substrate and mutually spaced apart from each other to define a surface wave propagation path therebetween; and a surface wave absorber partially overlappingly provided on that end surface portion of at least one of the input and output transducers which lies on an extension of the surface wave propagation path, said absorber having end edges which are inclined to the surface wave propagation path.

2. An elastic surface wave device according to claim 1, in which said input transducer comprises a pair of interdigital electrodes including a plurality of mutually overlapped digit electrodes the overlapped portions of which are weighted and said surface wave absorber is provided on the non-overlapped portions of the digit electrodes and includes opposite side edges which are inclined to the surface wave propagation direction along the weighted pattern.

3. An elastic surface wave device according to claim 1, in which said non-overlapped portions of the digit electrodes are coated with an electroconductive material to provide an integral film formation for each of said interdigital electrodes.

4. An elastic surface wave device according to claim 1, in which said absorber includes a serrated portion.

5. An elastic surface wave device, substantially as hereinbefore described with reference to and as illustrated in Figs. 2A and 2B or Fig. 4 or Fig. 5 or Fig. 6 of the accompanying drawings.

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FIG. 1

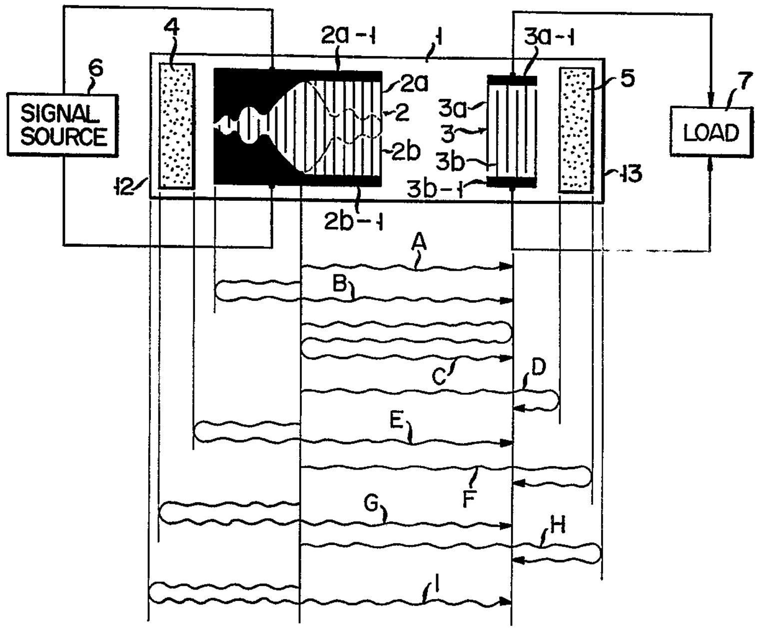

FIG. 2A

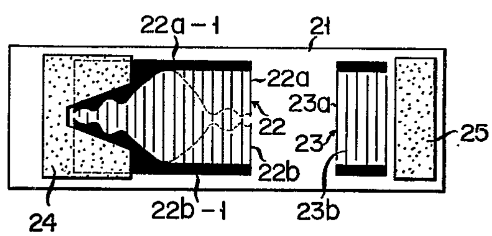

FIG. 2B

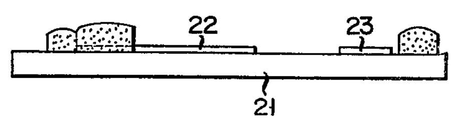

FIG 3

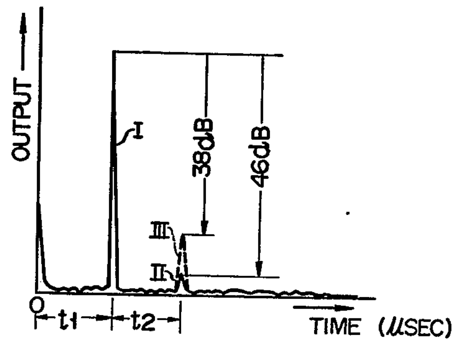

FIG 4

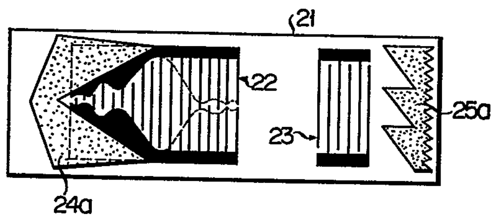

FIG 5

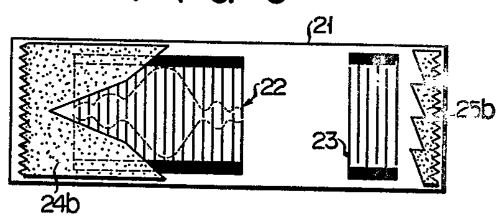

FIG 6