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Fender

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[54] **HUMBUCKING PICK-UP ASSEMBLY INCLUDING AN UNMAGNETIZED, DISASSOCIATED COIL**

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[52] **U.S. Cl.** **84/1.15;** 84/1.16

[58] **Field of Search** 84/1.15, 1.16

[56] **References Cited**

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[57] **ABSTRACT**

A pick-up assembly for stringed musical instruments including a pair of pick-up assemblies, only one of which is magnetized. The first and second pick-up assemblies are physically disassociated so that the reactance of the unmagnetized pick-up assembly does not interfere with the magnetized pick-up assembly. The unmagnetized pick-up assembly is lowered further into the body of the instrument than the magnetized pick-up assembly for the same purpose. The outputs of the two pick-up assemblies are summed at the negative input of an operational amplifier which negative input is a virtual ground so that neither coil acts as a load for the other coil.

8 Claims, 3 Drawing Figures

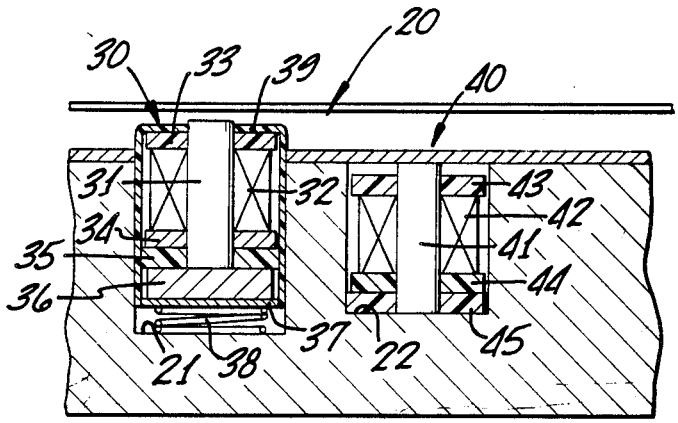


FIG. 1.

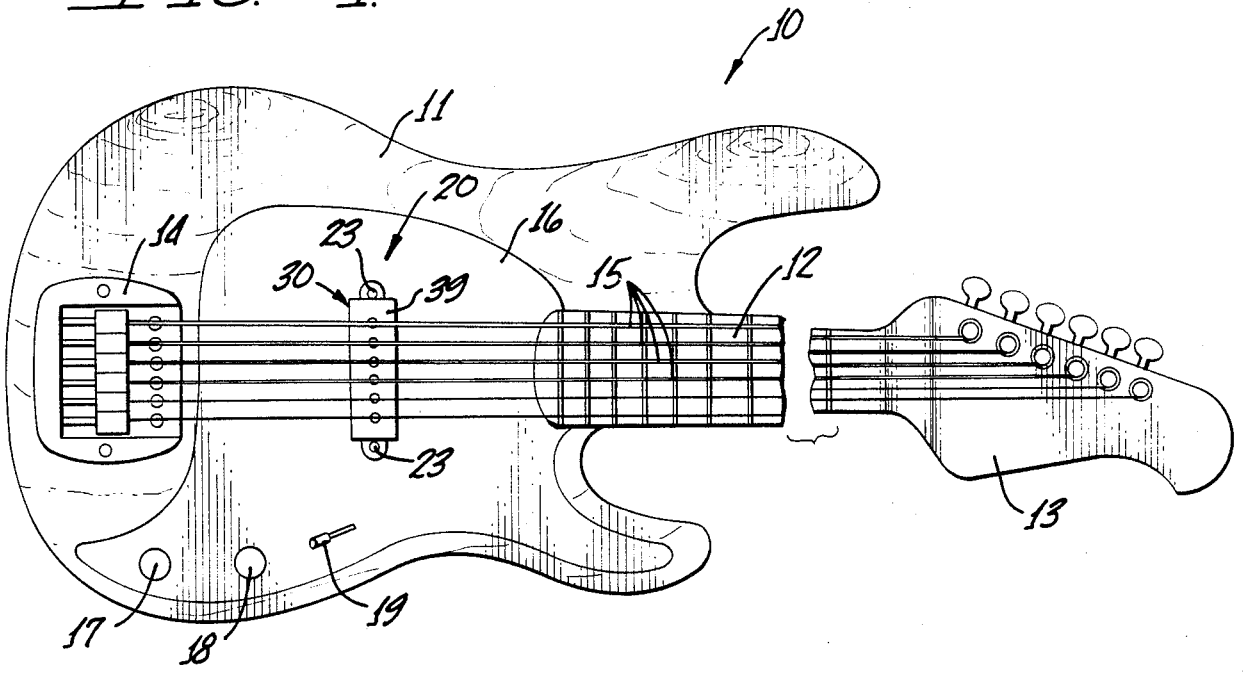


FIG. 2.

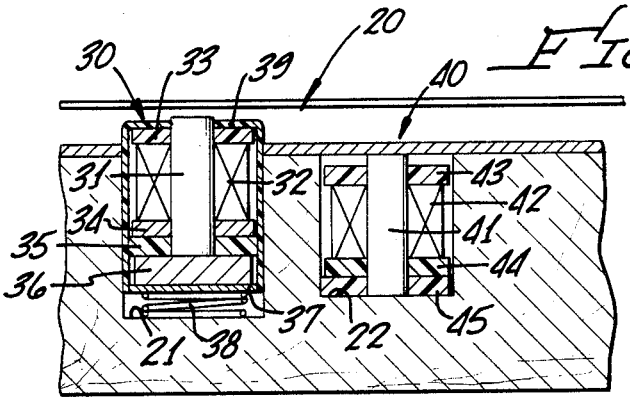
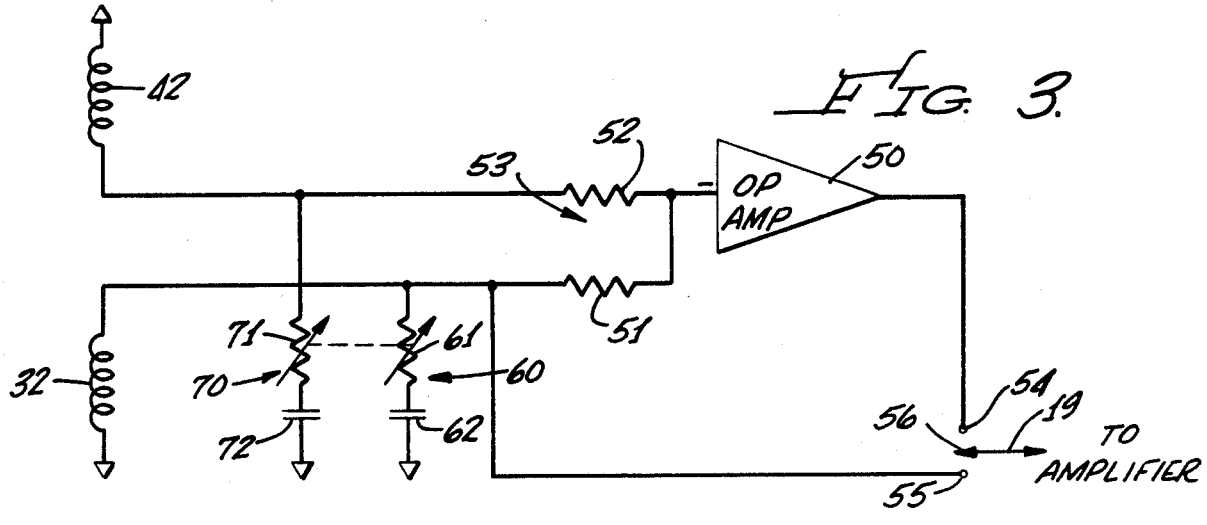


FIG. 3.



HUMBUCKING PICK-UP ASSEMBLY INCLUDING AN UNMAGNETIZED, DISASSOCIATED COIL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a humbucking pick-up assembly for stringed musical instruments and, more particularly, to a pick-up assembly for stringed musical instruments including a magnetized, signal coil and an unmagnetized, disassociated, humbucking coil.

2. Description of the Prior Art

The present invention relates broadly to electrical musical instruments of the stringed type. It is particularly applicable to an electrical guitar or similar musical instrument having a plurality of stretched strings extending across a body and a neck, between the head of the instrument and a bridge assembly connected to the body, in which the strings are caused to vibrate by plucking or picking same.

In order to derive an output from such an electrical guitar or other similar electrical musical instrument, the instrument is conventionally provided with an electromagnetic pick-up comprising a number of magnetic elements (pole pieces) having wound therearound a conductive coil. Typically, one such magnetic element is disposed directly beneath each string of the instrument. The strings are constructed of a magnetizable substance, such as steel, and, therefore, become part of the conductive path for the magnetic lines of flux of the pole pieces. Accordingly, when any of the strings are caused to vibrate, this causes a disturbance in the magnetic field of the associated pole piece. This has the effect of generating a voltage in the conductive coil, which voltage may be suitably amplified and transmitted to a loudspeaker system.

With such an electromagnetic pick-up construction, a number of problems exist. Electric guitars and other similar electrical musical instruments are used in areas having strong magnetic fields from lighting fixtures, motors, transformers, and the like, and these magnetic fields are sensed by the pick-up as an extraneous noise source. In the United States, such source typically has a frequency of 60 Hz, the usual power line frequency. These magnetic fields induce voltages in the coil which are also amplified and transmitted to the loudspeaker system, manifesting themselves in an objectionable hum.

In order to overcome this problem, it is known to provide a pick-up for an electrical musical instrument including a pair of identical pick-up assemblies, each having a plurality of magnetic pole pieces and a coil, the pick-up assemblies being positionable in parallel, spaced, closely adjacent relationship. All of the pole pieces of one of the pick-up assemblies have their north poles adjacent to the strings and their south poles relatively remote from the strings whereas all of the pole pieces of the other pick-up assembly have their south poles adjacent to the strings and their north poles relatively remote from the strings. The coils of the two pick-up assemblies are wound in opposite directions and the two coils are connected either in series or in parallel. Because the direction of current flow in each coil is governed by the magnetic polarity, the direction of current flow in one coil is opposite to that of the other coil for each string. However, since the directions of the windings of the two coils are opposite, the signal induced in each coil as a result of string vibrations is additive and the output signal is the sum of the signals induced in each coil.

On the other hand, signals picked up by the coils from power line sources produce currents in the coils which are independent of the magnetic polarity and, accordingly, such power line sources produce voltages that are in phase. However, since the coils are wound in opposite directions, these in phase signals cancel and the output signal is the difference between the power line signals induced in each coil. This means that any noise from power line sources, which is otherwise manifested as an objectionable hum, is effectively reduced or cancelled. It is for this reason that such an arrangement is typically characterized as a humbucking arrangement.

While the use of pairs of pick-up assemblies in a humbucking arrangement is effective in eliminating extraneous noise, a new problem is created, that being that the sound produced by a humbucking pick-up assembly is not as sharp and as clear as that obtainable from a single pick-up assembly. The reason for this is felt to be that each pick-up assembly of the humbucking pair interferes with the operation of the other pickp-up assembly of the pair. This is because the coil of each pick-up assembly acts as a load for the coil of the other pick-up assembly and the magnetic field of one pick-up assembly interferes with the magnetic field of the other. Thus, it would be desirable to provide a humbucking pick-up assembly having the tone producing qualities of a single coil but this has been unobtainable heretofore.

SUMMARY OF THE INVENTION

According to the present invention, this problem is solved by providing an electrical musical instrument of the stringed type with a humbucking pick-up having the tonal qualities of a single coil pick-up. This is achieved by the combination of a number of effects. First of all, the present pick-up includes a pair of pick-up assemblies, only one of which is magnetized. The first and second pick-up assemblies are physically disassociated so that the reactance of the unmagnetized pick-up assembly does not interfere with the magnetized pick-up assembly. The unmagnetized pick-up assembly is also lowered further into the body of the instrument than the magnetized pick-up assembly to further disassociate the two pick-up assemblies. Finally, rather than simply being connected in series or in parallel, the outputs of the two pick-up assemblies are summed at the negative input of an operational amplifier, which negative input is a virtual ground, so that neither coil acts as a load for the other coil.

Briefly, in a pick-up for an electrical musical instrument of the type including a body, a neck having a head, a bridge assembly connected to the body and a plurality of strings positioned between the head and the bridge assembly, the present invention comprises a first pick-up assembly positioned between the neck and the bridge assembly, the first pick-up assembly including at least one magnetized pole piece and a coil wound therearound, a second pick-up assembly positioned in spaced relationship to the first pick-up assembly, between the neck and the bridge assembly, the second pick-up assembly including at least one unmagnetized pole piece and a coil wound therearound, the pole piece of the second pick-up assembly being spaced from the strings by an amount greater than the spacing between the pole piece of the first pick-up assembly and the strings, and first and second resistors for connecting the coils of the

first and second pick-up assemblies, respectively, to the negative input of an operational amplifier.

OBJECTS, FEATURES AND ADVANTAGES

It is therefore the object of the present invention to solve the problems encountered heretofore in providing a humbucking pick-up for an electrical musical instrument of the stringed type. It is a feature of the present invention to solve these problems by providing a humbucking pick-up for an electrical musical instrument of the stringed type having a sound which is characteristic of the sound from a single coil pick-up. An advantage to be derived is a humbucking pick-up having a far more desirable sound. A further advantage is a humbucking pick-up including a pair of pick-up assemblies wherein the interference of one pick-up assembly to the other is minimal.

Still other objects, features, and attendant advantages of the present invention will become apparent to those skilled in the art from a reading of the following detailed description of the preferred embodiment constructed in accordance therewith, taken in conjunction with the accompanying drawings wherein like numerals designate like or corresponding parts in the several figures and wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top plan view of an electrical musical instrument of the stringed type incorporating a pick-up constructed in accordance with the teachings of the present invention;

FIG. **2** is an enlarged sectional view taken along the cross section of the pickup in FIG. **1**; and

FIG. **3** is an electrical diagram of the pick-up of the instrument of FIG. **1**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and, more particularly, to FIG. **1** thereof, the present invention is illustrated as being incorporated in an electrical guitar, generally designated **10**, including a body **11**, a fretted neck **12**, and a head **13** connected to one end of neck **12**, the other end of neck **12** being connected to body **11**. Tensioned between head **13** of guitar **10** and a body-connected bridge assembly **14** are a plurality of strings **15** which generally lie in a single plane parallel to the face of body **11**. Strings **15** are constructed of a magnetizable substance, such as steel, and are graduated in diameter in a conventional manner.

Positioned on the face of body **11** is a pick guard **16** which is typically made from plastic or other scratch resistant material. Also mounted on the face of body **11** is a volume control **17**, a tone control **18**, and a two-position switch **19**.

In order to derive an output from guitar **10**, it is provided with an electromagnetic pick-up, generally designated **20**, which forms the subject matter of the present invention. Vibrations of strings **15**, as a result of plucking or picking the same, produce an electrical signal in pick-up **20**, which signal may be suitably amplified and transmitted to a loudspeaker system.

Referring now to FIGS. **1–3**, pick-up **20** includes first and second pick-up assemblies **30** and **40** which are positioned in spaced relationship between neck **12** and bridge assembly **14**. It is unimportant as to whether pick-up assembly **30** or pick-up assembly **40** is positioned closer to bridge assembly **14**. Pick-up assemblies **30** and **40** have some features in common, but are generally quite different. Each includes a plurality of identical metallic, unmagnetized elements (pole pieces) **31** and **41**, respectively. The number of pole pieces in each pick-up assembly is preferably identical and preferably the same as the number of strings **15**. However, such is not required and each pick-up assembly **30** and **40** can have any number of pole pieces from one or more.

Pick-up assemblies **30** and **40** are generally constructed and mounted in body **11** in a conventional manner. That is, pick-up assemblies **30** and **40** include upper and lower support plates **33** and **34** and **43** and **44**, respectively, through which pole pieces **31** and **41**, respectively, extend and bottom support plates **35** and **45**, respectively, which extend below lower support plates **34** and **44**, respectively. Coils **32** and **42**, formed from a large number of turns of fine conductive wire, are wound around pole pieces **31** and **41**, respectively. The wire in coils **32** and **42** is insulated, such as with varnish or lacquer, and the entire assemblies comprising the pole pieces, the supporting plates and the coils are preferably dipped in a suitable varnish or lacquer. Coil **32** extends between support plates **33** and **34** and coil **42** extends between support plates **43** and **44**.

As stated previously, the individual pole pieces **31** and **41** are not magnetized, but are made from a magnetizable substance. Only pick-up assembly **30** is magnetized and the magnetic field is preferably produced by positioning a bar magnet **36** in contact with the bases of pole pieces **31**. Preferably, a magnetic keeper **37** also extends along the bottom surface of magnet **36**. It should be particularly noted that pick-up assembly **40** has neither a bar magnet nor a keeper.

Pick-up assemblies **30** and **40** are positioned within channels **21** and **22**, respectively, in body **11**. A spring **38** extends between keeper **37** and the bottom of channel **21** to urge pick-up assembly **30** upwardly. A cap **39** surrounds and contains the structure of pick-up assembly **30**. A plurality of screws **23** extend through cap **39** and hold pick-up assembly **30** within channel **21** and body **11**. Cap **39** extends through pick guard **16**. Accordingly, the manipulation of screws **23** permits the height of pick-up assembly **30** to be adjusted. Pick-up **40**, on the other hand, does not extend through pick guard **16** and is captured within channel **22** in body **11** by pick guard **16**.

As known in the art, movement of strings **15**, as in the strumming or playing of guitar **10**, results in a voltage being induced in coil **32**. As will be described more fully in connection with FIG. **3**, this voltage is transferred to the input circuit of an operational amplifier **50** before being conducted to a suitable loudspeaker system. On the other hand, since pole piece **41** is not magnetized, movement of strings **15** does not induce a voltage therein.

On the other hand, signals picked up by coils **32** and **42** from power line sources are totally independent of magnetic fields so that both coils **32** and **42** produce currents which are proportional to received noise. Coils **32** and **42** may be wound in opposite directions or otherwise connected in an out of phase relationship so that these signals cancel. Thus, in a conventional manner, noise from power line sources, which is otherwise manifested as an objectionable hum, may be effectively reduced or cancelled.

Turning now to FIG. **3**, first ends of coils **32** and **42** are connected to circuit ground. The opposite ends of coils **32** and **42** are connected via resistors **51** and **52**,

respectively, which are parts of a summing circuit **53**, to the negative input of operational amplifier **50**, the output of which is connected to a first terminal **54** of switch **19**, switch **19** having another terminal **55** which is connected directly to coil **32**. Switch **19** has an arm **56** which is connectable either to terminal **54** or **55**.

Operational amplifier **50** is a conventional circuit well known to those skilled in the art. It is significant to note that summing network **53** applies the signals from coils **32** and **42** to the negative input terminal of operational amplifier **50**, which is a virtual ground. By making the junction between resistors **51** and **52** a virtual ground, neither coil **32** nor coil **42** has any significant loading effect on the other. Additional circuitry (not shown) will be associated with operational amplifer **50**, such circuitry being well known to those skilled in the art and not relevant to an understanding of the present invention.

Coils **32** and **42** are each provided with separate tone control circuits **60** and **70**, respectively. While such tone control circuits might not be so simple, for explanation purposes, tone control circuit **60** is shown as including a variable resistor **61** and a capacitor **62** connected in series between coil **32** and circuit ground and tone control circuit **70** is shown as including a variable resistor **71** and a capacitor **72** connected in series between coil **42** and circuit ground. According to the preferred embodiment of the invention, variable resistors **61** and **71** are mechanically interconnected and become the tone control circuit **18** of instrument **10** so that the magnetized coil **32** and the unmagnetized coil **42** may be balanced simultaneously.

Coils **32** and **42** are either wound in opposite directions or, if the coils are wound in the same direction, the opposite ends of the coils are connected to summing circuit **53**. Because coil **42** is unmagnetized, it is not responsive to string vibrations. On the other hand, coil **42** does pick up noise signals because such signals are not dependent on a magnetic polarity. Because of the manner of connecting coils **32** and **42** to summing circuit **53**, as just described, coil **42** is capable of operating in a humbucking arrangement with coil **32**.

In operation, it is seen that by unmagetizing pick-up **40**, laterally displacing and physically lowering pick-up **40** relative to pick-up **30**, and by summing coils **32** and **42** at the negative input of operational amplifier **50**, the effect of pick-up **40** on pick-up **30** is minimized and the sound produced by pick-up **20** is essentially that which would be achieved by coil **32** alone. The physical disassociation of pick-up assemblies **30** and **40** insures that pick-up assembly **40** does not interfere with the magnetic reactance of pick-up **30**. The electrical connection of coils **32** and **42** also minimizes any loading effect of coil **42** on coil **32**.

It is highly desirable that pick-up **20** function if the preamplifier circuit including operational amplifier **50** becomes inoperative, either because of problems associated therewith or because the batteries that run same in guitar **10** go dead. Accordingly, the output of operational amplifier **50** is connected to terminal **54** of switch **19** and coil **32** is connected to terminal **55** of switch **19**. When connected to terminal **54**, operation is as previously described. When connected to terminal **55**, the signal from coil **32** is conducted directly to the amplification system, thereby bypassing summing resistor **51** and maximizing the signal strength conducted to the amplifier. It is obvious that in this latter case, there will be no humbucking.

While the invention has been described with respect to the preferrd physical embodiment constructed in accordance therewith, it will be apparent to those skilled in the art that various modifications and improvements may be made without departing from the scope and spirit of the invention. Accordingly, it is to be understood that the invention is not to be limited by the specific illustrative embodiment, but only by the scope of the appended claims.

I claim:

1. In a pick-up for an electrical musical instrument of the type including a body, a neck having a head, a bridge assembly connected to said body and a plurality of strings positioned between said head and said bridge assembly, the improvement comprising:

a first pick-up assembly positioned between said neck and said bridge assembly, said first pick-up assembly including at least one magnetized pole piece and a coil wound therearound;

a second pick-up assembly positioned in spaced relationship to said first pick-up assembly, between said neck and said bridge assembly, said second pick-up assembly including at least one unmagnetized pole piece and a coil wound therearound wherein said pole piece of said second pick-up assembly is spaced from said strings by an amount greater than the spacing between said pole piece of said first pick-up assembly and said strings; and

summing means for summing the signals from said first and second pick-up assemblies for conducting said signals to amplification means, said signals being combined so as to achieve humbucking.

2. In a pick-up for an electrical musical instrument according to claim **1**, said musical instrument also including a pick guard on the face of said body, facing said strings, the improvement wherein said first pick-up assembly extends through said pick guard into close proximity to said strings and wherein said second pick-up assembly is buried within said body, below said pick guard.

3. In a pick-up for and electrical musical instrument according to claim **2**, the improvement wherein said second pick-up assembly is spaced from said first pick-up assembly by an amount sufficient so that said second pick-up assembly does not interfere with the magnetic reactance of said first pick-up assembly.

4. In a pick-up for an electrical musical instrument according to claim **1**, the improvement wherein said summing means comprises:

an operational amplifier having a negative input terminal which is a virtual ground; and

means for conducting the signals from said first and second pick-up assemblies to said negative input of said operational amplifier.

5. In a pick-up for an electrical musical instrument according to claim **4**, the improvement wherein said conducting means comprises:

first and second resistors connected between said coils of said first and second pick-up assemblies, respectively, and said negative input of said operational amplifier.

6. In a pick-up for an electrical musical instrument according to claim **1**, the improvement wherein said summing means comprises:

an operational amplifier having a negative input terminal which is a virtual ground; and

means for conducting the signals from said first and second pick-up assemblies to said negative input of said operational amplifier.

7. In a pick-up for an electrical musical instrument according to claim **6**, the improvement wherein said conducting means comprises:

first and second resistors connected between said coils of said first and second pick-up assemblies, respectively, and said negative input of said operational amplifier.

8. In a pick-up for an electrical musical instrument according to claim **1**, the improvement further comprising:

a first tone control circuit connected to said coil of said first pick-up assembly, said first tone control circuit having a first variable element; and

a second tone control circuit connected to said coil of said second pick-up assembly, said second tone control having a second variable element;

said first and second variable elements being mechanically interconnected for simultaneous adjustment.

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