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SPECIAL LOW IMPEDANCE OUTPUT CIRCUIT
FOR HIGH CHAIN BRIDGE AMPLIFIER
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Fig. 1

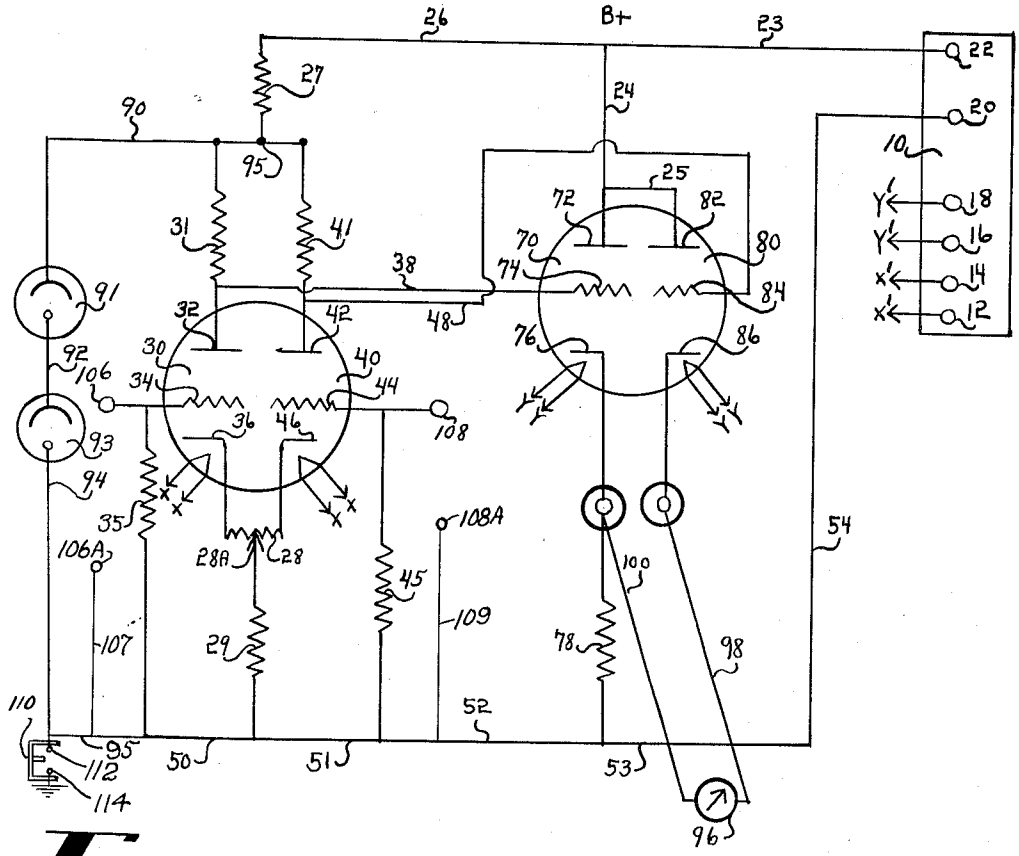


Fig. 1B

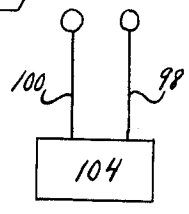
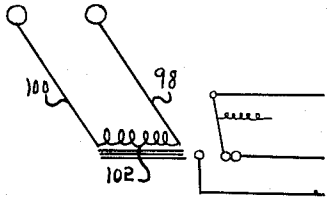


Fig. 1A



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SPECIAL LOW IMPEDANCE OUTPUT CIRCUIT FOR HIGH CHAIN BRIDGE AMPLIFIER

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2 Claims. (Cl. 179—171)

This invention relates to a special low impedance output circuit for a high gain bridge amplifier and the principal object of the invention resides in the provision of a circuit which allows the bridge amplifier to be operated for maximum D. C. gain and allows all of the components to be easily determined for maximum voltage gain. The novel special output circuit takes the output from the high gain amplifier and reduces the impedance to a relatively very low value to drive a relay, a meter, a recorder, or any similar electromechanical device.

Other objects and advantages of the invention will appear hereinafter.

Reference is to be had to the accompanying drawings in which

Fig. 1 is a circuit diagram showing the invention; and

Figs. 1A and 1B are fragmentary showings of different devices operated thereby.

Fig. 1 shows one form of the invention wherein numeral **10** represents a source of electrical energy having terminals **12** and **14** which supply heater voltage to bridge amplifier tubes **30** and **40** through connections X^1—X^1 to heaters X, X. Numerals **16** and **18** are terminals used to supply heater power to the filaments of the output tubes **70** and **80** through connections Y^1—Y^1 to heaters Y, Y. It is preferred that tubes **30** and **40** be of a twin triode or a twin pentode design, and that tubes **70** and **80** be of a twin triode or a twin pentode design.

Source of electrical energy **10** also supplies high voltage at terminal **22** connected by lines **23**, **24**, **25** to the plates **72** and **82** of the output stage; and by lines **23** and **26** to ballast resistor **27** and thence by line **90** to voltage regulator tubes **91** and **93** and thence to the B minus return.

Plate load resistors **31** and **41** of tubes **30** and **40** respectively are connected to the source of regulated high voltage at the point **95** and to the plates **32** and **42** of tubes **30** and **40** respectively. Grids **34** and **44** are connected through grid resistors **35** and **45** respectively to B minus terminal **20** through lines **50**, **51**, **52**, **53** and **54**. Cathodes **36** and **46** are connected to opposite ends of potentiometer **28** whose slider **28A** is connected through resistor **29** to the same B minus return line **51**.

The output of this bridge amplifier is taken from the plates as is the usual practice with bridge amplifiers. However, because of the high impedance of the plate circuit and the desire for a low impedance output, line **38** is connected from plate **32** to grid **74**, and plate **42** is connected by line **48** to grid **84** of the output stage. In order to give this output stage a designation and partially identify its function, it will be referred to as an unbalanced cathode follower bridge output stage, and one cathode **86** does not require any cathode resistor of its own. Cathode **76** of the unbalanced cathode follower bridge output stage is connected through resistor **78** and through lines **53** and **54** to the B minus return at **20**. The magnitude of resistor **78** is determined by the output impedance which is desired.

A meter **96** is connected as by line **98** to the cathode

86 and by line **100** to the cathode **76**. An optional output circuit is shown in Fig. 1A, wherein, a relay coil **102** is connected in place of meter **96**. In Fig. 1B a recorder or any other electro-magnetically driven means **104** is shown with the same connections to the output of the amplifier.

The operation of this circuit is as follows: The heaters X, X of tubes **30** and **40** are operated at a reduced voltage to eliminate gas current effects, reduce contact potential variations and decrease the effects of grid current and grid emission, etc. Bridge amplifier tubes **30** and **40** are operated with extremely high plate load resistors **31** and **41**, being on the order of 2 megohms, thus providing a very high gain amplifier. If pentodes were used for tubes **30** and **40**, high plate load resistors would again be used and both the screen and the plate supplies would be regulated. Voltage regulator tubes **91** and **93** prevent variations in the high voltage supply from affecting the operation of the amplifier. The balanced nature of a bridge amplifier maintains the output voltage between plates **32** and **42** constant despite variations in heater voltage, temperature, humidity, shock, vibration, etc., in so far as this is possible.

Because of slight differences in tubes **30** and **40** even though they are mounted in the same envelope, it is desirable to employ a cathode method of compensating the amplifier to bring its plates to equal potential. If the plate load resistance were used to accomplish this result, the circuit would have been greatly unbalanced under signal conditions and output would not have been as nearly linear.

A common cathode resistor **29** is used to provide degeneration in amplifier tube **30** and the resulting de-generation voltage developed across resistor **29** is impressed as a signal on grid **44** of tube **40**. Thus when a signal voltage of positive polarity is impressed on input **106** to grid **34**, it results in a negative signal being applied to grid **44** through the action of de-generation of resistor **29**. Grid resistors **35** and **45** are preferably equal to help maintain balance, although it was found that leaving resistor **45** at 10 megohms, resistor **35** could be changed from 20 megohms to zero without upsetting the balance of the bridge amplifier, when a 6N7 tube is used for **30** and **40** and its heater voltage is ballast regulated to three volts.

The circuit shown provides for input signals of a positive polarity to be applied to input **106** or negative signals to be applied to input **108**. If a positive signal is applied to grid **34** from input **106**, the current in tube **30** increases, the plate voltage **32** drops, the cathode current through resistor **29** increases, and a resultant rise in voltage across resistor **29** occurs. This causes grid **44** to become relatively more negative with respect to its cathode **46**, and tube **40** conducts less plate current, thus raising the voltage on its plate **42**. Thus the voltage impressed on grid **74** of tube **70** through line **38** drops, and the voltage impressed on grid **84** of tube **80** rises. This results in a decrease in the plate current of tube **70** and an increase in the plate current of tube **80** and therefore in the meter **96** or other device connected between cathodes **86** and **76** the current also increases.

If it is assumed that the bridge amplifier tubes are balanced, it will be seen than an appreciable current passes through both cathode follower tubes **70** and **80** to set up the initial bias for the cathode follower output stage across resistor **78**. This means that an appreciable initial current will flow through meter **96** with no signal. If a positive signal is applied to input **106**, the current through cathode follower tube **70** decreases and the current through cathode tube **80** increases causing the resulting output current through meter **96** to increase in accordance with the increase of signal applied to input

106. Under usual conditions bridge amplifier tubes 30 and 40 are intentionally unbalanced by means of the cathode biasing network so that the initial current through meter 96 is zero or nearly zero, and the circuit then lends itself as a linear amplifier whose output current is approximately directly proportional to the input voltage.

On the other hand, if it is desired to use a relay in the output circuit of the amplifier, the initial current flowing through the relay coil 102 is made just under the drop out current of the relay. Therefore, an increase in signal to input 106 will cause the relay 102 to pull on and will require that the signal be reduced to almost zero in order that the relay may again drop out. If a recorder or similar instrument is used, the initial current may or may not be eliminated. In many cases the initial current will enable the use of a more rugged output device, in that more power will be available to the output if the initial current is an appreciable value. That is, power output depends upon the square of the current; a change of 1 milliampere into 1000 ohm load coil will produce one milliwatt of power variation if the initial current is zero. However, if the initial current is 10 milliamperes and the output increases to 11 milliamperes, the output power will have changed from .100 watt to .121 watt. Thus it will be seen that for the same change of 1 milliampere in output current in one case, there is obtained a power of 1 milliwatt to perform the work of moving a pin or other indicator, whereas in the second case, 21 milliwatts are available from the same 1 milliampere change in current.

The input signal may be impressed between inputs 106 and 108; or it may be impressed from 106 to 106A; or it may be impressed from 108 to 108A. Link 110 may be inserted to ground the B minus return at contact 112 to ground point 114 or the amplifier may be left ungrounded. The numerals 107 and 109 respectively indicate the leads

to the inputs 106A and 108A connecting the same to the B minus terminal 20.

Having thus described my invention and the advantages thereof, I do not wish to be limited to the details herein disclosed otherwise than as set forth in the claims, but what I claim is:

1. The combination with a bridge amplfier circuit of a special low impedance output, said circuit comprising a source of voltage, two cathode follower tubes and two bridge amplifier tubes, the cathode follower tubes being connected by their grids to the plates of the bridge amplifier tubes and the first cathode follower tube only having the cathode thereof connected through a cathode load resistor to the low voltage return of said source of voltage, the cathode of the second cathode follower tube being connected through an electro-mechanically driven device to the cathode of the first cathode follower tube.

2. The combination with a voltage supply, a pair of bridge amplifier tubes, a pair of cathode follower tubes, the grids of the latter being connected separately to the plates of the former, means to adjust the voltage balance at the bridge amplifier plates to a value other than zero, a cathode load resistance for the cathode of one cathode follower tube, the cathode of the other cathode follower tube operating in the absence of a cathode load resistance, of an electro-mechanical device connected to and between the cathodes of the cathode follower tubes, the said cathode load resistance substantially matching the impedance of the device, and input connections to the tubes of the bridge amplifier tubes.

References Cited in the file of this patent

Publication, Vacuum Tube Amplifier, Valley, Jr., and Wallman, Radiation Laboratory Series, 1948 edition, McGraw-Hill Book Co., publisher, p. 481, Figure 11.64.