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FREQUENCY DOUBLING TELEGRAPH SYSTEM

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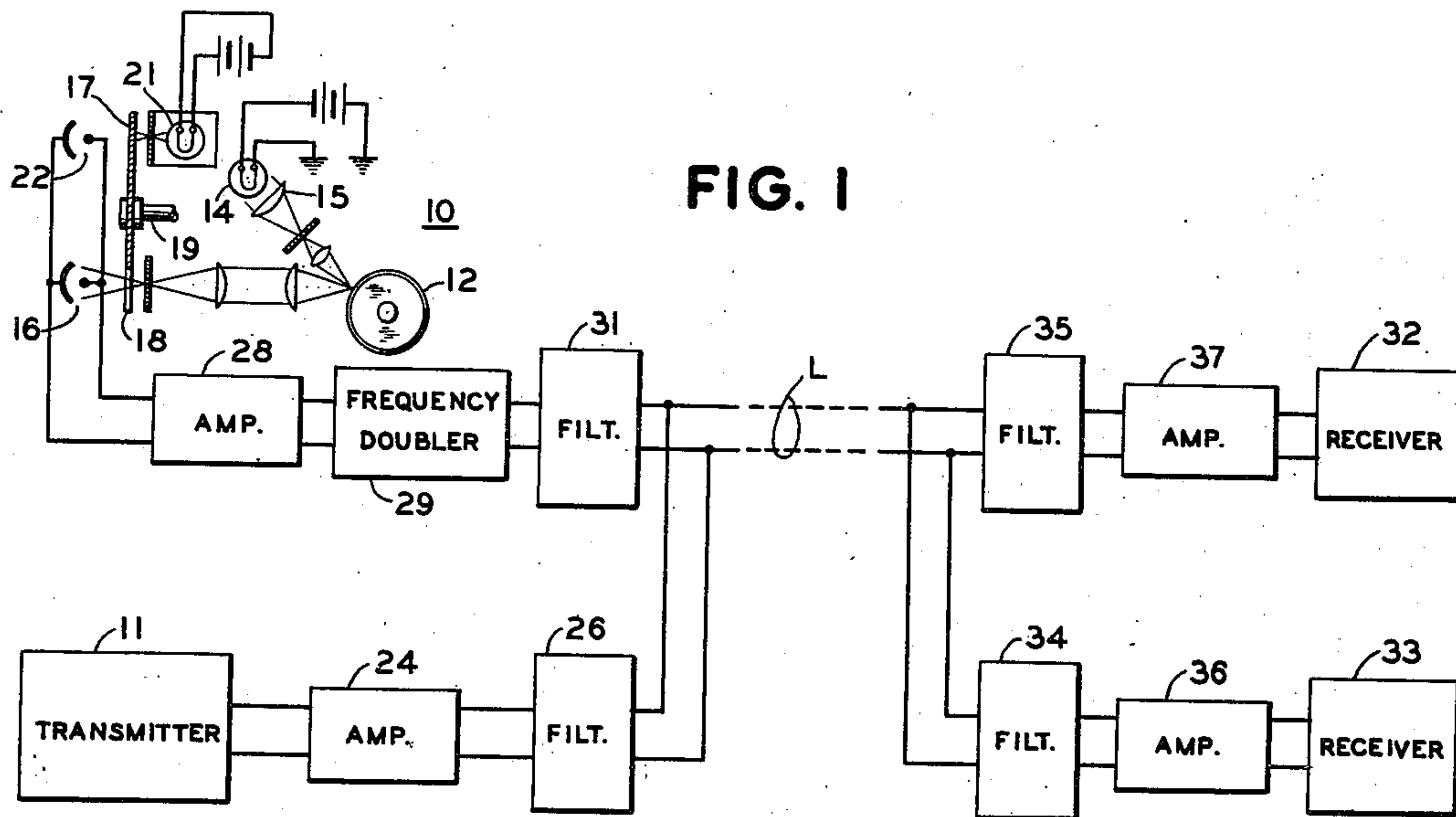


FIG. 1

FIG. 3

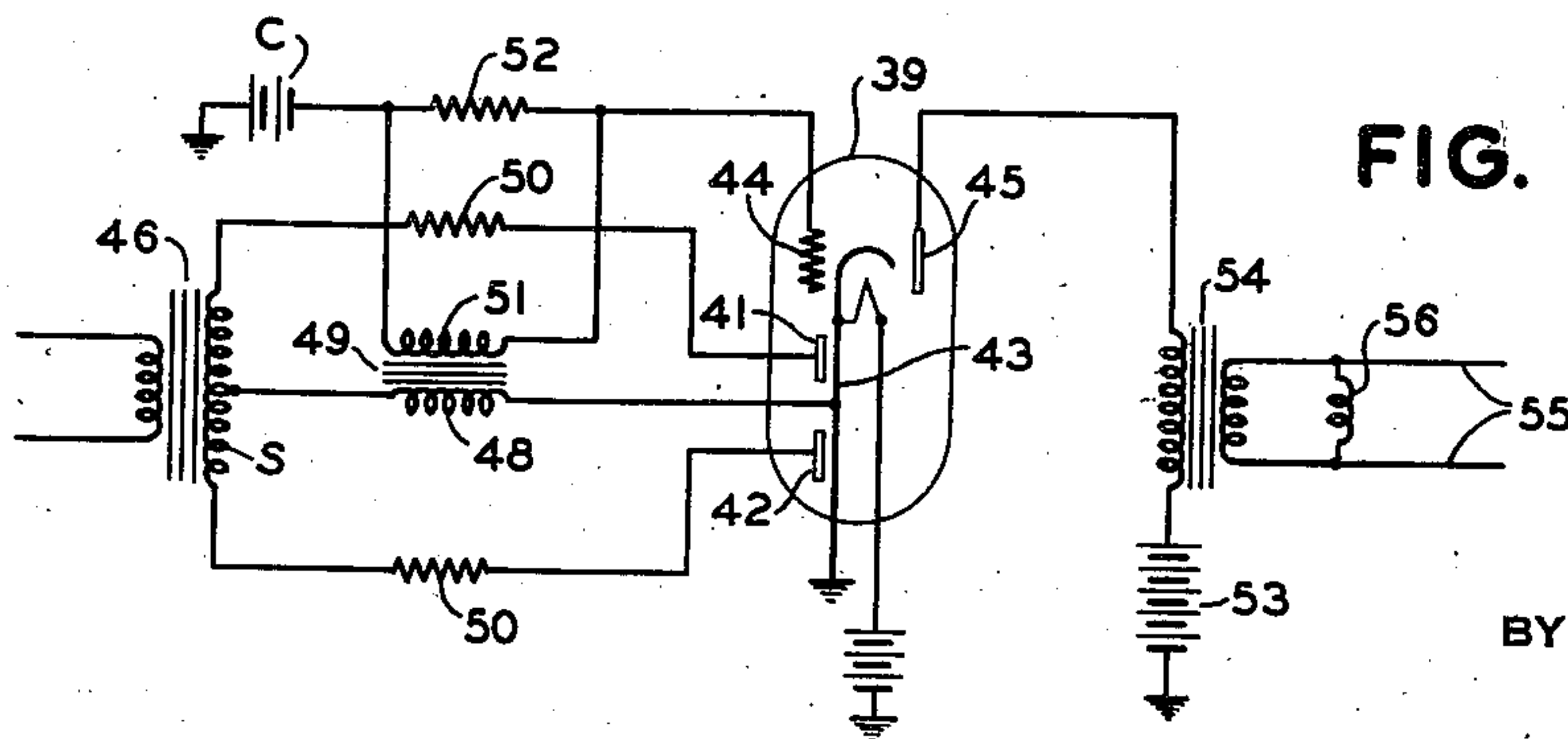
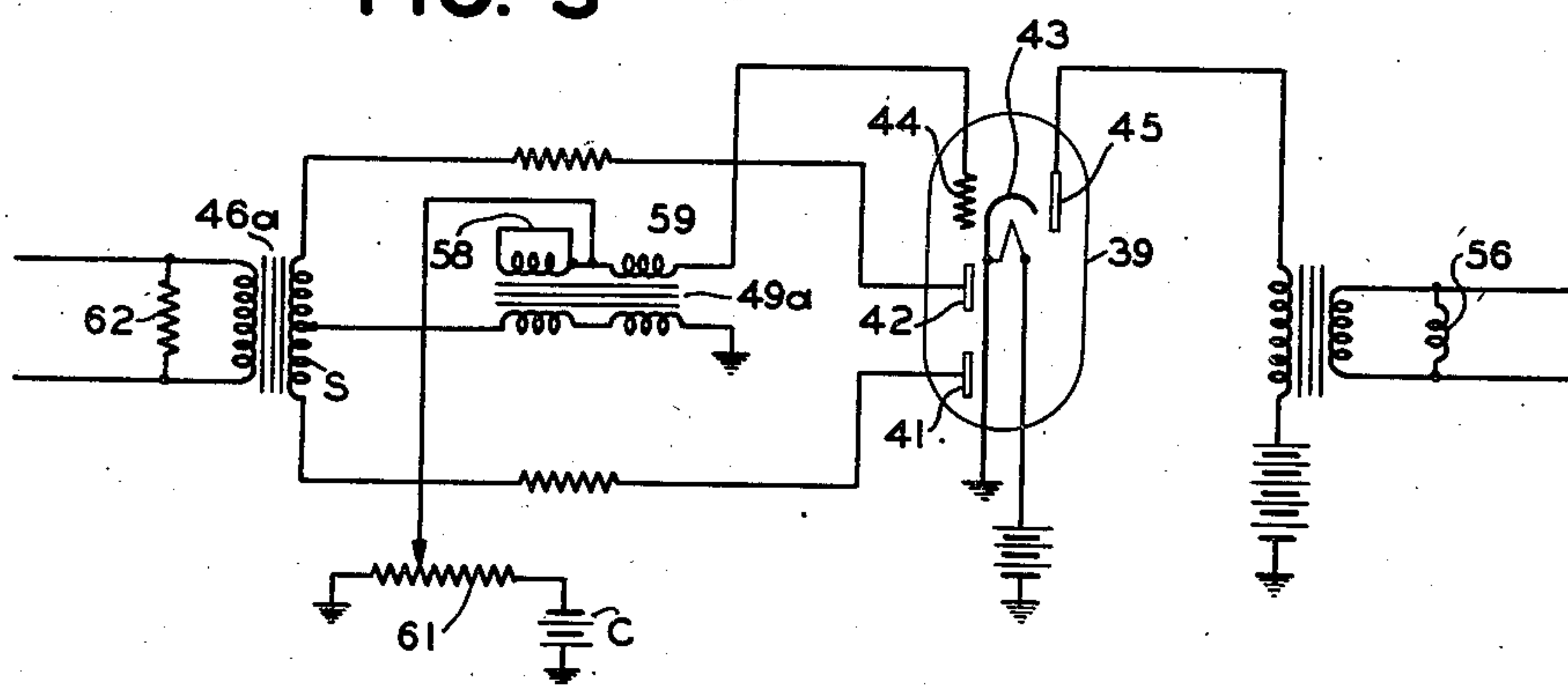


FIG. 2

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FREQUENCY DOUBLING TELEGRAPH
SYSTEM

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9 Claims. (Cl. 178—5)

The present invention relates to carrier current systems and more particularly to a novel system for the transmission of pictures, messages or other subject matter.

Facsimile telegraph transmitters of the type in general use at present produce a carrier current modulated in accordance with the light or other characteristics of elemental areas of a picture or object and the present invention provides a novel arrangement for simultaneous transmission of the output of a number of substantially identical transmitters over a single communication channel or circuit.

The primary object of the present invention, therefore, is to provide a novel system enabling transmission from two or more substantially identical transmitters over a single communication channel or carrier channel thereby reducing the number of different kinds of transmitting equipment which must be kept available for multiplex operation.

Another object of the present invention is to provide means for increasing the frequency of the output from a facsimile or other type of telegraphic transmitter.

A further object of the present invention is to provide a novel unitary arrangement for doubling the frequency and amplifying an alternating voltage or current, and more particularly, doubling the carrier frequency of a high speed signalling circuit without distortion of the signals.

A still further object of the present invention is to provide a transmission circuit embodying means for doubling the frequency of the carrier current and assuring that the signal attains its maximum or steady state amplitude during the first cycle of the carrier frequency and is reduced to zero within one cycle.

The foregoing and more specific objects will appear in the following complete disclosure of the invention in its several aspects.

Referring to the drawing:

Fig. 1 is a diagrammatic presentation of the invention employing two substantially identical transmitters and two substantially identical receivers;

Fig. 2 is a diagrammatic showing of a frequency doubler of this invention; and

Fig. 3 is a diagrammatic showing of a modified frequency doubler.

Referring for the present to Fig. 1 of the drawing, there are shown two facsimile transmitters 10 and 11 which may be of the picture modulated carrier type disclosed in the copending ap-

plication of R. J. Wise, Ser. No. 57,019, filed Dec. 31, 1935. The transmitter 10 is shown in somewhat greater detail for purposes of illustration than the similar or identical transmitter 11 and comprises a subject matter carrying drum 12 which is rotated at a definite speed by any suitable driving motor. Light from a suitable source 14 is concentrated by the lens 15 upon the surface to be scanned and is reflected into the photo-sensitive device 16, the latter, of course, being suitably supported in a housing or the like (not shown) at a proper distance from the outer periphery of a cylinder 12. The light source 14 is preferably of adjustable intensity. The spot of light projected on the surface of the cylinder 12 by the lens 15 is caused to traverse the cylinder in a longitudinal direction as the cylinder rotates by reason of axial movement of the cylinder or if desired, axial movement of the source 14 and the lens 15. Methods of obtaining a scanning movement per se are well known and it is to be understood that any of the known methods of scanning may be employed in either or both of the transmitters 10 and 11.

The light which is incident upon the photo-cell 16 is interrupted by a shutter or light chopper 17 which may be a disc as illustrated having a series of equally spaced openings or notches 18 adjacent its outer edge. The disc 17 is secured upon a rotatable shaft 19 which is suitably driven from a source of mechanical power. The number of holes in the disc 17 and the speed of rotation of the shaft may vary within wide limits depending upon the desired rate of scanning, and other factors. For purposes of illustrating an important feature of the present invention it will be assumed that the disc 17 rotates at such a speed as to produce a carrier frequency of 2500 cycles per second. The output appearing across the terminals of the photo-cell 16 is of such a character as to cause reproduction of a negative record in the usual receiver employed in facsimile systems.

To provide a pickup system capable of furnishing an output suitable for the reproduction of a positive record, a second adjustable intensity light source 21 is provided to illuminate the photo-cell 22, the latter being connected in parallel with the photo-cell 16. The source 21 is so positioned that when the picture modulated beam from the source 14 is incident on the cell 16 through an opening 18 in the chopper, the unmodulated beam from the source 21 is cut off.

In operation of the scanner and pickup sys-

tem just described solely by way of example, the light from the source 14 is projected upon the background or lightest area of positive subject matter on the drum 12 and with the chopper 17 rotating, the intensity of the beam from the source 12 is regulated so that the combined output of the two cells is substantially constant. As the beam from the source 14 traverses the subject matter on the peripheral surface of the drum 12, the reproduced record will show dark portions when the darkest portion of the transmitted subject matter is scanned and proportional gradations of the different light values of the original.

The transmitter 11 may be identical with transmitter 10 just described or of any other suitable type, and it also is adjusted to produce a carrier frequency of 2500 cycles per second. The modulated 2500 cycle output of the transmitter 11 is amplified if necessary in the preamplifier unit 24 and passes through a filter 26 which may be of the low pass type designed to sharply attenuate frequencies above about 3800 cycles per second. The output from the filter is fed to the communication channel L indicated by dotted lines in Fig. 1 of the drawing. It will be understood that the channel L while it is shown for purposes of illustration as a transmission circuit, may be one channel among others of a carrier multiplex communication link or it may be a radio channel or a so-called "wired radio" channel. In the event that the channel L must be restricted to a definite band width, it may be preferable to design the filter 26 as a band pass filter which will pass 2500 cycles plus and minus the subject matter modulating frequency.

The modulated 2500 cycle output from the transmitter 10 is amplified in a preamplifier 28 similar to the preamplifier 24 and from there it passes to the frequency doubling device indicated by reference character 29. This frequency doubler device is preferably as illustrated in Figs. 2 and 3 of the drawing. However, it may be of any type known to the prior art. The output of the frequency doubler 29 is passed through a filter 31 to the communication channel L. The filter 31 may be a high pass filter designed to sharply attenuate frequencies below approximately 4000 cycles per second. If, as previously stated, the channel L is one channel of a carrier multiplex system, the filter 31 may be a band pass filter designed to pass 5000 cycles plus and minus the picture modulating frequency in the given example.

Separate outputs from the substantially identical transmitters 10 and 11, which are conveyed in a non-interfering manner by the communication channel L, operate a pair of receivers or recorders 32 and 33 of any desired type. This result is accomplished by means of filters 34 and 35 which correspond in design and function to the transmitter filters 26 and 31 respectively. Receiving amplifiers 36 and 37 may be provided to raise the level of the incoming signals if desired.

The operation of the several parts of the system disclosed in Fig. 1 will be obvious from the foregoing. In accordance with the present invention if a communication channel L is available which is capable of transmitting a given carrier frequency, a transmitter producing a carrier frequency of half the channel frequency may be employed successfully to transmit signals to a remote receiver or recorder. It will be understood that frequency doubling devices 29 may be cascaded to quadruple or multiply the frequency to

bring it to a frequency approximating the frequency which the channel L is designed to transmit.

Referring to Fig. 2 of the drawing, which illustrates a novel form of frequency doubler in accordance with the invention, reference character 39 indicates a special type of vacuum tube embodying a full wave rectifier and a triode amplifier. One advantage gained by employing the double function tube is that the frequency doubler of this invention can be adjusted to cause no change in energy level when interposed between an alternating current source and a working circuit. The rectifying portion of the tube comprises two plates or anodes 41 and 42 positioned adjacent the cathode 43. The amplifying elements of the tube 39 comprise a control grid 44 interposed between the cathode 43 and a separate anode 45. A commercially available tube suitable for use in the frequency doubler arrangement to be described is known as "Type 85". The incoming signals to the frequency doubling device which may be the modulated output of a facsimile transmitter such as the transmitter 10, are applied to the anodes 41 and 42 of the rectifying section of the tube 39 through an isolating transformer 46. The secondary S of the transformer 46 is tapped at its electrical center and is connected to the cathode 43 of the tube 39 through the primary 48 of a transformer 49. Resistors 50 may be included in each branch between the transformer secondary and the rectifying anodes of the tube to improve operation. The secondary 51 of the transformer 49 is bridged across a relatively high resistance 52 which is in series in the grid circuit of the tube 39. A battery C provides the desired negative C bias for the amplifier portion of the tube 39. Anode 45 of the amplifying portion of tube 39 is connected to the source of anode potential 53 through the primary of an output transformer 54, the secondary of which is connected to the output circuit indicated at 55. To suppress surges of relatively low frequencies in the output circuit 55, a shunt across the secondary of the transformer 54 is provided by the inductance 56. This inductance is of low resistance and low impedance to alternating currents of a frequency substantially less than the carrier current frequency.

In operation of the frequency doubling device just described, the frequency to be doubled is applied across the primary of the transformer 46 and appears across the primary 48 of the transformer 49 as a wave of double frequency by virtue of the conventional double wave rectification. The voltage across the secondary 51 is essentially a sine wave of twice the input frequency because of inductance of the windings of transformer 49. The voltage of doubled frequency derived from the transformer 49 is applied to the grid 44 of the amplifying section of the tube 39 and is amplified in the conventional manner to give an output voltage through the transformer 54 of double the frequency of the input voltage.

The foregoing explanation of the circuit operation applies to steady state conditions. Transient operation, such as encountered in communication circuits, is governed almost entirely by the relative circuit constants. In facsimile operation it is desirable that the signal attain maximum or a steady state amplitude during the first cycle of the carrier frequency which is applied to the primary of the transformer 46. It is also important that the signal amplitude be reduced to zero within one cycle of the carrier frequency

after the exciting voltage has been removed. This requires that the system having a frequency characteristic essentially flat over the frequency range encountered; namely, the carrier frequency plus and minus the carrier modulating signal frequency. In accordance with the present invention the desired frequency characteristic is obtained by properly matching impedances throughout the circuit. In the case of transformer 49, this is accomplished by shunting the secondary with the resistance 52. This applies load across the secondary of the transformer without which the rise of value of the carrier signal would be slow. By properly loading the transformer as by the resistance 52, the rise of the carrier frequency voltage can be made very abrupt.

The inductance 56 functions to prevent a low frequency surge after the carrier frequency has been removed. The inductance 56 as stated above, presents a high impedance to the carrier frequency but serves effectively as a shunt for lower frequency alternating currents. Without the shunting impedance 56, the decay of the carrier frequency appearing in the output circuit 55 would be relatively slow and the desired abruptness in decay is obtained by use of the low impedance 56 or its equivalent.

A modified form of frequency doubling arrangement which is substantially similar to that shown by Fig. 2, is disclosed in Fig. 3 of the drawing. This arrangement differs from Fig. 2 in that the secondary transformer 49a is divided and one portion is short-circuited as indicated by reference character 58. The incoming carrier frequency, as before, is applied to the primary of a transformer 46a, the secondary of which is connected to the rectifying anodes 41 and 42 and the cathode 43 of the tube. One portion 59 of the secondary of the frequency doubling transformer 49a is included directly in the grid circuit of the tube 39, the load on the transformer being provided by the short-circuit 58 of the unused portion of the secondary. A potentiometer 61 connected across the grid bias battery C provides an adjustable bias in the grid 44 of the tube. It will be understood that an adjustable C bias may be supplied to the grid of the tube in Fig. 2 by similar arrangement. The primary of the transformer 46a and likewise 46 may, if desired, be shunted by a resistor 62 to match the impedance of the transformer to the impedance of the preceding amplifier or other apparatus.

The arrangement in Fig. 3 is substantially the equivalent of that shown in Fig. 2 and operates in a similar manner. The short-circuited portion of the secondary of the transformer 49a serves to cause an abrupt growth of the carrier frequency voltage when a signal is applied. The low impedance inductance 56 serves as before to cause an abrupt decay of the doubled carrier frequency appearing in the output circuit 55.

It will be seen from the foregoing that the present invention provides a novel and simple arrangement enabling the use of duplicate transmitters working into a single communication link or carrier frequency channel. Also, it will be apparent that the invention provides a novel and effective means for doubling the frequency of an alternating current and more especially the frequency of a relatively high frequency carrier current.

While we have described and explained our invention in detail in connection with illustrative embodiments thereof, it is to be understood that the invention may be embodied in other forms

and, therefore, the invention is not limited except as indicated by the terms and scope of the appended claims.

What is claimed is:

1. In a facsimile system, a plurality of substantially similar transmitters capable of operation to produce picture modulated currents of approximately the same frequency, a communication channel, a frequency changer interposed in the connection of one or more of said transmitters to said channel, a filter for each transmitter connected directly to the communication channel, and receiving equipment connected by branched circuits to said communication channel, each circuit to an individual receiver including a filter.

2. In a facsimile telegraph system, a pair of substantially similar transmitters capable of operation to produce picture modulated carrier currents of approximately the same frequency, a transmission channel, a frequency doubler and a filter interposed in the connection of one of said transmitters to said transmission channel, a filter interposed in the connection of the other of said transmitters to said communication channel and a pair of receivers connected to said communication channel through filters having characteristics approximating those of the transmitter filters.

3. A frequency doubler for alternating currents comprising means for rectifying the positive and negative half cycles of the alternating current, means comprising a transformer for converting the rectified current to alternating current and means for loading said converting transformer to cause the frequency doubled alternating current to reach maximum amplitude within approximately one cycle.

4. A frequency doubler for alternating currents comprising a full wave rectifying device and amplifier, means including the rectifying device for obtaining full wave rectification of applied alternating current of a given frequency, means including a transformer for converting the pulsating current of double frequency so produced to an alternating current, a resistance in parallel with the secondary of said transformer and a connection from said resistance to the control electrode of the amplifier, and an output connection from the anode of said amplifier.

5. A frequency doubler for alternating currents comprising a combined full wave rectifier and amplifier tube, means including the rectifier portion of said tube for obtaining full wave rectification of applied alternating current of a given frequency, means including a transformer for converting the pulsating current of double frequency so produced to an alternating current, a resistance in parallel with the secondary of said transformer, a connection from said resistance to the control electrode of the amplifier portion of said tube and an output connection from the anode of the amplifying section of said tube.

6. Telegraphic transmitting apparatus comprising a transmitter capable of operation to produce signal modulated carrier currents of a given frequency, a communication channel, a frequency doubler interposed between said transmitter and said communication channel for doubling the frequency of the carrier current produced by said transmitter, and means comprising a reactor of relatively low impedance connected across the output of said frequency doubling device to cause the frequency doubled carrier current to cease within approximately one cycle when signal mod-

ulated current is removed from the frequency doubler.

5 7. Telegraphic transmitting apparatus comprising a transmitter capable of operation to produce signal modulated carrier current, a frequency doubling device having its input circuit connected to said transmitter and its output circuit connected to a communication channel, said frequency doubling device comprising means
10 in the input and output connections thereof causing it to have a rapid growth and decay of frequency doubled carrier current when the carrier frequency from the transmitter is applied and removed at the input terminals thereof.

15 8. A frequency doubling device including a vacuum tube having a cathode, a pair of rectifying anodes associated with said cathode, an independent anode and a control grid associated with said cathode and independent anode, means for
20 producing full wave rectification of an applied alternating current comprising a transformer having its secondary terminals connected to said rectifying anodes, a connection from the electrical center of said transformer secondary to said
25 cathode including the primary of a coupling transformer, the secondary of said coupling

transformer being connected in shunt to a resistance, a connection from one terminal of said resistance to said control electrode, a connection from said independent anode to the primary of an output transformer, and an impedance of low resistance and inductive reactance connected in shunt to the secondary of said output transformer, said resistance and said impedance serving to cause rapid growth and rapid decay respectively as alternating current of a given frequency
10 is applied to or removed from the primary of said input transformer.

9. Frequency doubling apparatus comprising a combined rectifying and amplifying vacuum tube, means utilizing the rectifying section of said tube
15 to produce full wave rectification of an alternating current, means to convert the resulting pulsations to alternating current of double the original frequency, means to apply said frequency doubled alternating current to the amplifying
20 section of said vacuum tube, and an output connection from said amplifying section to a utilization circuit.

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