June 9, 1936. W. S. MARKS, JR 2,043,255

SYSTEM OF SCREEN GRID MODULATION

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FIG. 1.

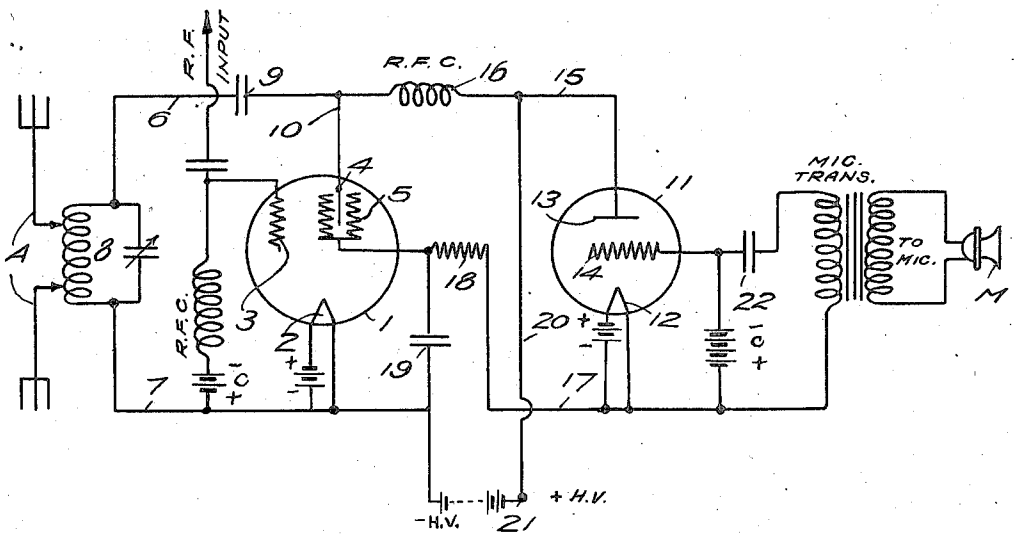
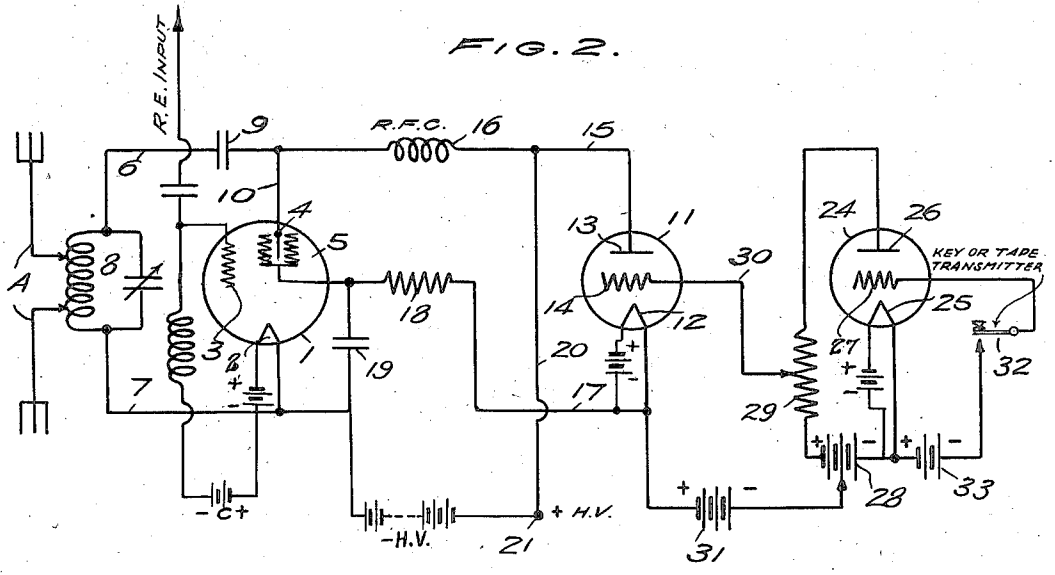


FIG. 2.



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SYSTEM OF SCREEN GRID MODULATION

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4 Claims. (Cl. 179—171)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to a system of screen grid modulation and proposes a circuit arrangement for that purpose, which is adapted for impressing modulating potentials upon the anode screen grid electrode of tubes or electron discharge devices having four electrodes or more.

An object of the invention is to provide a system which may be used either for a telephone or telegraph transmitter; and which adapts itself particularly well to a combination radio telephone and telegraph set without sacrifice of efficiency for either service. Substantially the same apparatus can be used for high speed keying in a telegraph system, as well as for other modulating means such as voice or music in a telephone system. Since according to the present system little or no current is required to be broken by the keying contacts, high speeds with positive action are assured.

An object of the invention is to produce a system simple to install, and which lends itself for ready application to existing radio transmitters which use one or more screen grid tubes, or equivalents, without requiring radical alterations.

Another important object of the invention is economy of operation. In the present system the ratio of power required for modulation to the power to be modulated is very small, being of the order of 1/10 or less. The invention may be used in conjunction with any standard radio frequency oscillating or amplifying system; and it permits relatively high powers to be modulated with very little equipment, and without the necessity of building up large modulating voltages. Other objects will appear as the description proceeds.

Embodiments of the invention are illustrated in the accompanying drawing, in which:

Fig. 1 is a diagrammatic circuit arrangement showing one form of the invention as applied to a telephone transmitter; and

Fig. 2 shows the invention applied to a telegraph transmitter.

Referring to both figures of the drawing, the numeral 1 represents the tube to be modulated, which is shown in the power amplifier stage of a radio frequency transmitter. The tube here shown is a four element tube comprising a filament or cathode 2, control grid 3, plate or anode 4, and anode screen grid 5. The amplifier is conventional, being here shown as consisting of the usual plate-filament circuit 6—7, coupled to a tuned out-put oscillatory circuit 8, feeding into antenna system A. A blocking condenser 9 is inserted in the plate circuit lead 10. The control grid connects with a radio frequency input supply, which needs no detailed description. The anode screen grid 5 is maintained at a positive potential relative to the filament or cathode 2, but preferably of less positive value than that impressed upon the anode 4. It is understood that this tube may or may not be the final stage, as here represented; and only so much of the circuit diagram of the tube is shown as is deemed necessary for an understanding of the operation, since such circuit arrangements are well known in the art. Tube 11 may be termed the modulator tube. This tube, which is placed in series with the screen grid circuit of tube 1, is here shown as a three element tube comprising filament 12, plate 13 and control grid 14, although it is understood that other types of tubes may be substituted. The plate lead 15 of this tube connects through radio frequency choke 16 with plate 4 of tube 1, while the filament lead 17 connects through resistance 18 with anode screen grid 5 of tube 1. A by-pass condenser 19 is placed between the filament lead 17 and the positive side of the filament circuit of tube 1. It will be noted that the plate filament circuit of tube 11 is placed in series with the screen grid of tube 1 rather than with the secondary of a transformer. A lead 20 connects the plate circuit common to the tubes 1 and 11 to the positive electrode of a high voltage source of potential as at 21.

Referring to Fig. 1, the modulator tube 11 is influenced by sound waves from microphone M, the modulated energy being impressed upon control grid 14 of tube 11 in a conventional manner. A negative bias is maintained on grid 14 from the source generally denoted by —C. A blocking condenser is shown at 22.

Referring to the embodiment of the invention shown in Fig. 1, the mode of operation is outlined as follows: Modulation is effected by varying the screen grid potential of tube 1 at the desired frequency. The plate filament resistance of tube 11 changes at the same frequency as that impressed upon the microphone; this in turn changes the screen-grid current of tube 1 at the same frequency. This varying screen grid current flowing through the plate-filament resistance and the series resistance 18, causes a varying potential drop through such resistances, and this results in a varying screen grid potential, the variations of which are the same as the frequency impressed upon the microphone. The plate current of tube 1 is changed at the same frequency as its screen grid potential, which results in the antenna current being modulated at the microphone frequency.

Referring now to Fig. 2, the circuit arrange-

ment is shown as adapted for the work of high speed keying in a telegraph transmitter. This embodiment differs from that shown in Fig. 1, in the respect that another tube **24** is placed ahead of modulator tube **11**. Tube **24** may be designated as the keying tube and is here shown as a conventional three element tube having a filament **25**, plate **26** and control grid **27**. The plate circuit of tube **24** is fed from a regulated or variable high-voltage source **28** through variable resistance **29**, having connection with the grid of tube **11** through lead **30**. A voltage source **31** is inserted between the filament circuit of tube **11** and the battery **28**. In the filament grid circuit of keying tube **24**, instead of a microphone a key **32** is connected, or a tape transmitter may be substituted, if desired. In the circuit just mentioned a source of biasing voltage **33** is also inserted.

The mode of operation of the keying system of Fig. 2 is explained as follows: As in the instance of the embodiment shown in Fig. 1, the tube **11** functions as the modulator tube. Keying is effected by starting and stopping the flow of screen grid current through this tube; that is to say, by opening and closing the screen grid circuit. Tube **24**, hereinbefore designated as the keying tube, functions to alter the grid bias on the modulator tube **11** in such a manner that when the key is open, sufficient negative bias is applied to the grid of tube **11**, so that no screen grid current flows through it; and when the key is closed a sufficiently smaller value of negative bias, or a positive bias, is applied to the grid of tube **11** to cause the proper screen grid current to flow to operate tube **1**.

In practice, it may be explained that when key **32** is open, the grid of tube **24** is free. The voltage of battery **28** is so regulated in respect to tube **24** that under the condition of free grid, plate current flows in said tube **24**. This plate current flowing through resistance **29** puts a negative bias on the grid of tube **11**, according to the adjustment of the variable contact or regulating means of said resistance and change of voltage of battery **31**. Adjustments are so made that when the key **32** is open, the negative bias placed on the grid of tube **11** is sufficient to prevent the screen grid current of tube **1** from flowing through tube **11**. When the key **32** is closed, the negative potential of battery **33** is applied to the grid of tube **24**, which cuts off its plate current. When no plate current flows, there is no IR drop through resistance **29**, thus a smaller negative potential, or a positive potential, as previously indicated, is placed upon the grid of tube **11**, which causes the screen grid current of tube **1** to flow through tube **11** and permits tube **1** to function properly.

The choice of tubes having suitable characteristics, and the regulation of voltages for successful operation of such a system as herein disclosed, will be obvious to those skilled in the art. It will be noted that when the necessary adjustments have been made, no current will be broken by the key contacts, which makes possible very high keying speeds.

The present system is readily applicable to circumstances requiring a combined telegraph and telephone transmitter. Obviously, the change from telegraph to phone, and vice versa, may be made with no sacrifice in efficiency. The adjustment of the transmitter for best modulation is taken care of in the modulator unit only. Such a system adapts itself to transmitters which use rectified grid current for bias control, thus making it possible to obtain high modulation with minimum distortion.

It will be obvious that stages either of radio or audio amplification may be employed as may be found necessary or desirable; for example, audio amplification may be interposed between the microphone M and the grid filament circuit of tube **11**, as shown in Fig. 1, in accordance with the voltages required on the grid of said tube **11** and to conform to the type of microphone and microphone transformer used.

The invention has been described in connection with certain preferred embodiments, but it is understood that it is capable of changes and modifications within the scope of the appended claims.

What is claimed is:—

1. A system of screen grid modulation, comprising in a transmitter circuit, an electron tube to be modulated, having anode screening grid means; means for maintaining a positive bias on said anode screening grid means; a modulator tube operatively coupled in series with said first named tube; an auxiliary tube operatively coupled with the said modulator tube; and means for impressing modulating frequencies upon said anode screening grid means through said auxiliary tube and said modulator tube, including means to start and stop the flow of screen grid current through said modulator tube.

2. A system of screen grid modulation, comprising in a transmitter circuit, an electron tube having an anode and anode screening grid means; a screen grid circuit and means in said circuit for maintaining a positive potential on said anode screening grid means, but of less positive value than on said anode; a modulator tube in said screen grid circuit operatively coupled in series with said first named tube; and modulating means to start and stop the flow of screen grid current through the modulator tube, said means including an auxiliary tube coupled ahead of the modulator tube.

3. A system according to the preceding claim in which said modulating means to start and stop the flow of screen grid current through the modulator tube comprises keying means; variable resistance means; a variable source of potential; and an auxiliary tube, all interposed between the keying means and said modulator tube.

4. A system of screen grid modulation, comprising in a transmitter circuit an electron tube to be modulated, said tube having anode screening grid elements; a modulator tube in said circuit operatively coupled in series with the first named tube; a keying control tube in said circuit operatively coupled with said modulator tube; means for impressing modulating variations upon said anode screening grid elements through said keying control tube and said modulator tube, said means comprising a key and grid biasing means operative through said keying control tube to start and stop the flow of screen grid current through said modulator tube as said key is closed and opened.

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