March 17, 1942. L. W. FRANKLIN 2,276,952

WAVE TRANSMISSION SYSTEM

Filed Nov. 4, 1938

FIG. 1

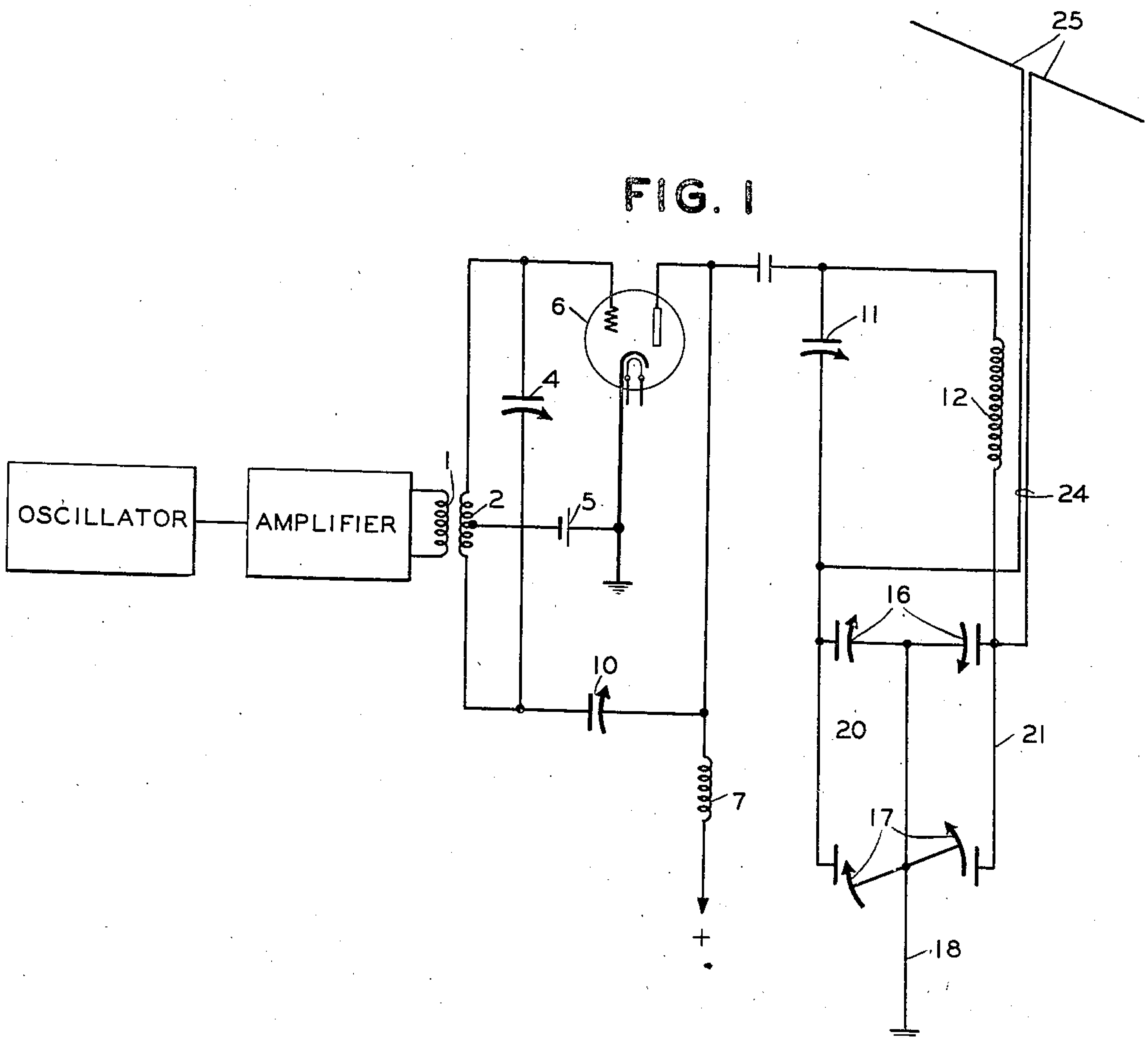
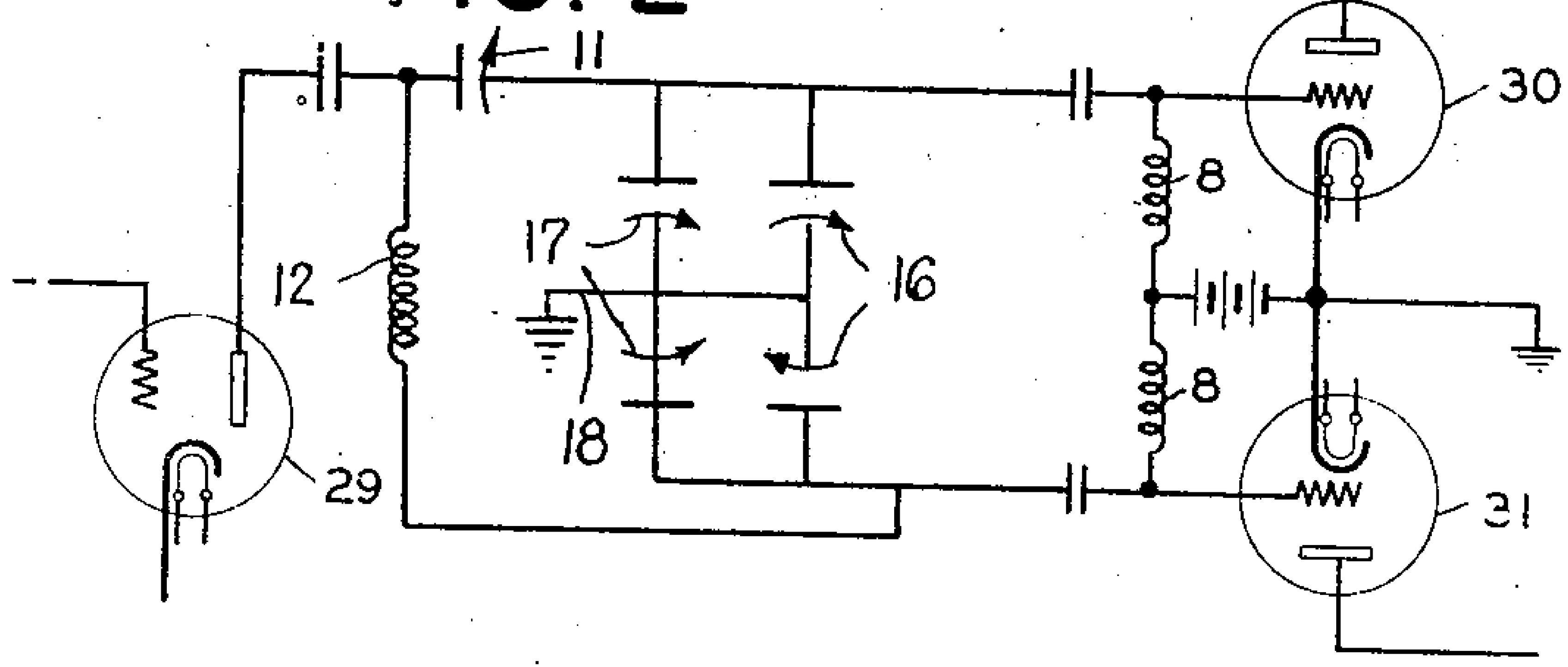


FIG. 2



INVENTOR
L. W. FRANKLIN
BY *A. A. Smith*
ATTORNEY

Patented Mar. 17, 1942

2,276,952

UNITED STATES PATENT OFFICE

2,276,952

WAVE TRANSMISSION SYSTEM

Lawrence W. Franklin, Hasbrouck Heights, N. J., assignor to The Western Union Telegraph Company, New York, N. Y., a corporation of New York

Application November 4, 1938, Serial No. 238,737

8 Claims. (Cl. 250—17)

This invention relates to wave transmission systems and more particularly to coupling devices whereby a single-phase circuit may be coupled to a two-phase circuit, and vice-versa.

In one embodiment of the invention, a single-ended radio-frequency amplifier may be coupled to a two-wire antenna feed system, symmetrical with respect to ground, such as is commonly used with the doublet type antenna, so as to provide efficient power transfer and ease of adjustment, both as to loading and as to obtaining equal feeder currents, even though the antenna system may be slightly unsymmetrical.

Heretofore various arrangements such as impedance matching networks comprising tapped or variable inductances and capacities, or variable coupling coils have been employed for this purpose, with their attendant complexity of adjustment, inefficiency and bulkiness. These networks require extra controls and extra coils which must be changed whenever the transmitter is shifted from one operating frequency to another. These extra coils necessarily cause some loss in efficiency, and the space required for these networks is quite often inconveniently large. For these reasons push-pull final amplifiers are often used instead of single-ended amplifiers when a radio transmitter is to be used to drive a symmetrical antenna system in order to avoid the disadvantages of former arrangements for feeding a symmetrical antenna feed line. According to this invention, a double-section condenser, having a grounded rotor, is substituted for the impedance matching networks of the prior art. Another double-section condenser, connected in parallel to the one above-mentioned, may also be used for correcting for any lack of symmetry in the feed line.

The principal object of this invention is to provide an improved means for coupling dissimilar circuits.

Another object of this invention is to provide a novel means for feeding a two-wire line from a single-ended amplifier.

A further object of this invention is to provide a novel system embodying double-section condenser for feeding a doublet antenna from a single-ended amplifier, thereby simplifying the connection and adjustment and improving the efficiency of the system.

A further object of the invention is to provide an improved means for coupling an alternating current circuit, balanced to ground, to a circuit unbalanced to ground, particularly where the frequency and/or loading should be readily variable.

A still further object of the invention is to provide an improved coupling means for interstage coupling between single-ended and push-pull amplifier stages.

Other objects and features of the invention will appear in the following detailed description of the preferred embodiment thereof shown in the accompanying drawing, wherein:

Fig. 1 of the drawing is a circuit diagram of the invention as applied to a radio transmitter.

Fig. 2 shows an interstage coupling system.

The circuit shown in Fig. 1 represents generally a radio transmitting circuit comprising an oscillator, an amplifier, a coupling device and a doublet antenna. The vacuum tube **6** represents the last stage of radio frequency amplification and is coupled to the preceding stages of amplification by means of the transformer **1** having a secondary **2**. The battery **5** provides the usual grid bias. The plate circuit of tube **6** is energized through the conventional type of radio frequency choke **7**. The plate circuit of tube **6** feeds a tank circuit which comprises a tuning condenser **11** and inductance **12** both in series with paralleled condensers **16** and **17**. The coupling means between the amplifier and the antenna comprises the two split stator condensers **16** and **17**. The two-wire transmission line **24** to the doublet antenna **25** is connected across condensers **16** and **17** which are of conventional construction and have grounded rotors. The condenser **17** is of a type wherein, as the rotor is adjusted, the capacity of each half of the condenser is varied equally in the same direction while condenser **16** is of the type wherein one section is 180 degrees out of phase with the other section so that as the rotor is turned the overall capacity will remain constant; that is, each section of condenser **17** will always have the same capacity to ground, but the relative capacity to ground of each section of condenser **16** is changed inversely as that of the other section when the rotor is adjusted.

In the previous systems, it has been necessary to use either a push-pull form of amplifier or an impedance matching circuit wherein variable inductances and condensers were used. According to this invention, it is unnecessary to use variable inductances since the split stator condensers are used for varying the coupling to the load and in balancing the current in the two feed wires. Thus the single-ended amplifier **6** can feed into a two-wire transmission line **24** under much more efficient conditions whereby less power is dissipated in the controlling apparatus.

The transmitter is tuned to resonance in the usual manner by varying condenser 11. However, the total capacitative reactance across the inductance 12 is actually that of the paralleled condensers 16 and 17 in series with the main tuning condenser 11. Since most feed lines are of a relatively low impedance as compared to the optimum plate impedance of the usual final amplifier tube 6, the coupling device should operate as a step-down transformer. For this reason, condensers 16 and 17 are selected with several times the capacity of condenser 11. Since the voltage across 16 and 17 is correspondingly lower than that across the condenser 11, they may be quite compact. After the condenser 11 is tuned to resonance, the load reflected by the feed line on the tube 6 may be adjusted by varying the capacity of condenser 17. Since the capacity of 17 is much larger than that of 11, the change in overall capacity across inductance 12 caused by varying condenser 17 over wide limits is relatively small. Therefore the readjustment of condenser 11 to exact resonance after adjusting condenser 17 to the proper load is relatively small. Finally, after proper loading has been adjusted by means of condenser 17, and the circuit has been readjusted to exact resonance by means of condenser 11, if it is desired to secure exactly the same current in each feed line when the line or antenna is slightly unsymmetrical to ground, this may be accomplished by varying condenser 16, with little or no retuning necessary on condensers 11 or 17.

This same coupling circuit, so labeled in the drawing, may be advantageously used in a multistage amplifier in coupling from a single ended amplifier stage 29 to a succeeding push-pull stage 30 and 31, as is shown in Fig. 2. In this case, radio frequency choke coils 8 are used to supply the required direct current bias to the push-pull stage in a conventional manner. In this arrangement, the grids of the push-pull stage connect to the coupling system in the same way the feed lines 24 do in Fig. 1.

While I have shown specific embodiments of my invention, it will be obvious to those skilled in the art that many other modifications are possible within the spirit and scope of the appended claims.

I claim:

1. In a radio transmitter, a radio frequency amplifier having a single wire output, a doublet antenna, a two wire transmission line connected thereto, an inductance connected between said single wire and one wire of said transmission line, a condenser connected between said single wire and the other wire of said transmission line, a split-stator condenser connected across said transmission line and a second split-stator condenser connected across said transmission line, one section of said second condenser being 180 degrees out of phase with the other section, the rotors of both condensers being grounded.

2. In a radio transmitter, a radio frequency amplifier having a single wire output, a tank circuit connected between said output and ground, a doublet antenna connected to said tank circuit, a split-stator condenser connected across said doublet and in series with said tank circuit and another split-stator condenser connected across said doublet antenna.

3. In combination, a single ended radio frequency amplifier, a tank circuit connected in the output of said amplifier, a two wire transmission line, capacitative means in the tank circuit for symmetrically feeding said transmission line from said tank circuit and capacitative means in the tank circuit for matching the impedances of said amplifier and said transmission line.

4. In combination, a single ended amplifier, tuning means connected in the output of said amplifier, a transmission line connected to said tuning means, capacitative means in the tuning means for symmetrically feeding said transmission line from said output and capacitative means in the tuning means for correcting for lack of symmetry in said transmission line.

5. In combination, an unbalanced transmission line, a balanced transmission line, a tuned circuit connected between said lines, a split-stator condenser connected therein and across said balanced line for matching line impedances, a ground connection to the rotor of said condenser and a balancing condenser connected in the tuned circuit and across said balanced line.

6. In combination, a single wire line, a two wire line, a tuned circuit connected between said lines, a split-stator condenser connected therein and across said two wire line for matching line impedances and a balancing condenser connected in the tuned circuit and between said two wire line and ground.

7. In combination, a single ended amplifier, a push-pull amplifier and coupling means for coupling said amplifiers comprising a tuned circuit including an adjustable split-stator condenser connected therein for matching impedances and and a split-stator balancing condenser in parallel with said adjustable condenser.

8. In combination, a doublet antenna, an amplifier having a single wire input and means for coupling said doublet antenna to said amplifier comprising a single tuned circuit connected to said antenna and comprising an inductance and a pair of coupling condensers connected in series with each other and across said doublet antenna for matching impedances, the midpoint of said coupling condensers being grounded.

LAWRENCE W. FRANKLIN.