I. SHOENBERG.

FREQUENCY MULTIPLIER.

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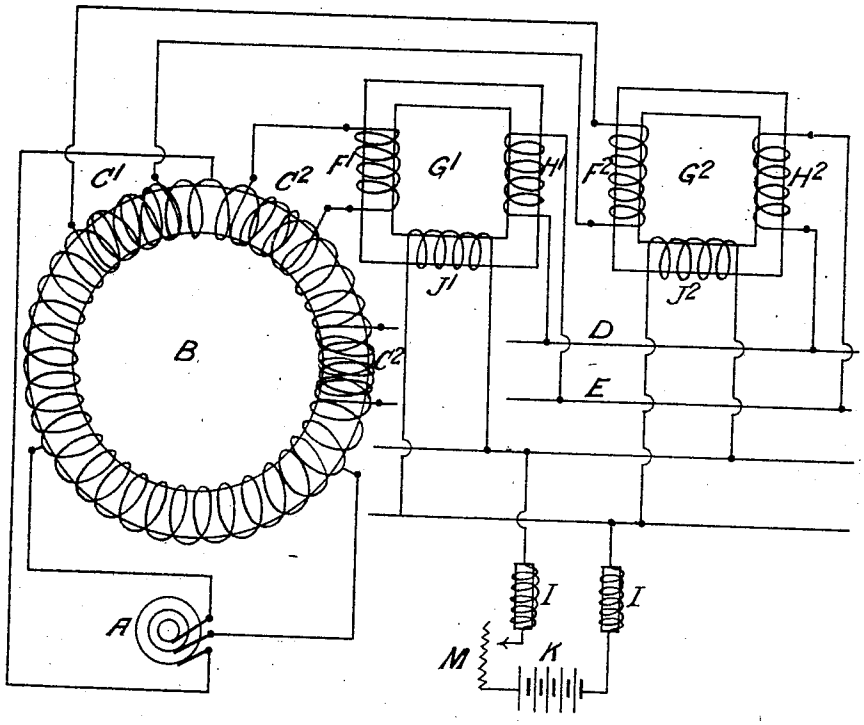
**1,372,203.**

**Patented Mar. 22, 1921.**

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# UNITED STATES PATENT OFFICE.

ISAAC SHOENBERG, OF LONDON, ENGLAND, ASSIGNOR, BY MESNE ASSIGNMENTS, TO RADIO CORPORATION OF AMERICA, A CORPORATION OF DELAWARE.

## FREQUENCY-MULTIPLIER.

1,372,203. Specification of Letters Patent. Patented Mar. 22, 1921.

Original application filed October 7, 1916, Serial No. 124,251. Divided and this application filed February 12, 1919. Serial No. 276,564.

*To all whom it may concern:*

Be it known that I, ISAAC SHOENBERG, a Russian subject, residing at Marconi House, Strand, London, England, have invented new and useful Improvements in Frequency-Multipliers, of which the following is a specification.

This invention relates to improvements in frequency multipliers for alternating electric currents whereby the frequency may be multiplied any desired number of times by means of a single apparatus having no moving parts, this application being a division of my prior case, Serial No. 124251.

My invention is illustrated by the accompanying diagram in which A is a three-phase generator connected to the terminals of the primary winding of a transformer B having secondaries $C^1$, $C^2$ . . . $Cn$. These coils are connected to the primaries $F^1$, $F^2$, of $n$ transformers $G^1$ $G^2$. The secondaries $H^1$, $H^2$, of these transformers are connected in parallel to leads D, E, and the transformers are provided with third windings $J^1$, $J^2$, which are energized from a source K of direct current through large choking coils I, I, and a resistance M.

The change of frequency is effected in the following way:—The cores of the transformers $G^1$, etc., are saturated by means of the source K so as to be above the knee of the magnetization curve. The degree of saturation will have to be chosen (up to a certain extent) in accordance with the number of coils as well as with the phase difference on the common terminals of the coils $C^1$, etc. Owing to this saturation the currents in coils $E^1$, etc., get distorted, or in other words, are made to possess even harmonics. Since all these coils are connected in parallel, all harmonics will be destroyed except the one of which the order is given by the number of coils.

When odd multiples are desired no special windings J for direct current are required, the distortion in this case is effected by a suitable choice of the strength of the alternating current, and of course there must be an odd number of secondary coils $C^1$, etc.

Instead of using several transformers $G^1$, etc., one may be made.

What I claim is:—

1. An apparatus for multiplying frequency comprising means for producing a rotating magnetic field, a plurality of differently phased circuits inductively connected thereto, a plurality of transformers having cores saturated above the knee of the magnetization curve, primary and secondary coils for each transformer, the primary coil of each transformer being connected to one of the circuits associated with the rotating magnetic field and the secondary of each transformer connected to an output line.

2. An apparatus for multiplying frequency comprising means for producing a rotating magnetic field, a plurality of differently phased circuits inductively connected thereto, a plurality of transformers having cores saturated above the knee of the magnetization curve by direct current, primary and secondary coils for each transformer, the primary coil of each transformer being connected to one of the circuits associated with the rotating magnetic field and the secondary of each transformer connected to an output line.

3. An apparatus for multiplying frequency comprising means for producing a rotating magnetic field, a plurality of differently phased circuits inductively connected thereto, said circuits having equal phase differences, a plurality of transformers having cores saturated above the knee of the magnetization curve by direct current, primary and secondary coils for each transformer, the primary coil of each transformer being connected to one of the circuits associated with the rotating magnetic field and the secondary of each transformer connected to an output line.

4. An apparatus for multiplying frequency comprising a multiphase source of supply, a closed magnetic core having a winding connected thereto capable when excited of producing a rotating field in said core, a plurality of spaced secondary circuits inductively associated with said core, a source of direct current, a number of transformers, each having a saturated core, each of said transformers having three coils, one connected to one of the secondary circuits, the second connected to the output line, and the third connected to the direct current source and adapted to magnetize the second mentioned core to substantially the saturation point.

5. An apparatus for multiplying fre-

quency comprising in combination a multiphase source of supply, transformers in the phases of said source, and coils carrying continuous current for magnetizing the cores of said transformers above the knee of their magnetization curves, the secondaries of said transformers being connected together.

6. An apparatus for multiplying frequency comprising in combination a multiphase source of supply, transformers in the phases of said source, and coils carrying continuous current for magnetizing the cores of said transformers above the knees of their magnetization curves, the secondaries of said transformers being connected directly in parallel.

In testimony that I claim the foregoing as my invention I have signed my name this sixteenth day of January, 1919.

ISAAC SCHOENBERG.