This invention relates to the production of improved current for radio apparatus and has special reference to the provision of improved sources of energy for such apparatus although the invention may have other applications than to radio.

As is well known, the filament of an electron tube employed in a radio receiving set, is energized by direct current and usually from a battery, as it has been found that dynamically generated current has variations which produce objectionable noises in the receiver and render it unsuitable. Storage batteries are usually employed as the frequent renewals required make primary batteries too expensive and the frequent charging of the storage battery is expensive and very inconvenient.

The main object of the present invention is to remove objectionable variations from dynamically generated or other commutated current, and this is accomplished by causing the current variations or "commutator ripple," caused by the action of the commutator, to be of a frequency outside of the audible range.

Other and ancillary objects of the invention will appear hereinafter.

The accompanying drawing, which illustrates the invention, is a diagram of electrical apparatus embodying the invention.

Referring to the drawings, the generator, of the constant voltage type, comprises the usual field pole pieces 1 and 2 embracing the rotatable armature of the gramme ring type having the usual ring core 3 with the armature winding 4 suitably connected in a well-known manner by commutator leads 5 with the segments of the commutator 6 upon which bear the brushes 7 and 8. One of the brushes 8 is connected through a variable induction coil 9 to one terminal of the filament 10 of an audion electron tube having the usual grid 11 and plate 12, the other terminal of the filament being connected with the brush 7. The filament is thus connected in series with the induction coil 9 between the brushes 7 and 8. The generator operates after the well known manner of direct current dynamos to supply current to the filament 10.

The commutation of the electro-motive force generated in the armature coil does not result in an absolutely constant potential, but the curve of the electro-motive force as impressed upon the exterior circuit is serrated with indentations so that this curve of electro-motive force shows an electro-motive force of constant value having superposed thereon a comparatively slight variable electro-motive force. This slight variable electro-motive force is so relatively insignificant in such uses as power and light circuits that it may be neglected, but in the excitation of the filaments of electron tubes it is sufficient to cause objectionable noises. This slight variable electro-motive force depends for amplitude upon the number of commutator segments, and for its frequency upon the number of commutator segments and the number of revolutions per minute of the commutator. It is desirable to reduce the amplitude of the variable element of the electro-motive force as above referred to and so it is desirable that the number of commutator segments be large, but as it is the object of the dynamo of the drawing to maintain the frequency of this variable element or "commutator ripple" below the audible frequency (approximately sixteen per second) the speed must be made correspondingly low. As the speed is one of the elements determining the magnitude of the whole electro-motive force, the reduction in speed may be compensated for by increasing the diameter of the armature, whereby the peripheral speed or conductor speed of the armature is increased, the turns on the armature may be increased or the field magnets may be strengthened or all three of these expedients may be used in obtaining the desired voltage as is well understood in the art, while at the same time maintaining a large number of segments in the commutator and a low number of revolutions per minute.

With these considerations in mind, therefore, the dynamo referred to is made with a number of commutator segments and a speed adapted to produce the desired voltage (usu-
ally four volts for an audion tube) but such that the frequency of the "commutator ripple" is sub-audible. The result is that objectionable noises produced in the apparatus by "commutator ripples" within the limits of audible frequencies are avoided. The noises may also be avoided by making the ripple frequency above the upper limit of audibility or ultra audible as well as below the lower limit of audibility or sub-audible. An example of a suitable arrangement for giving a sub-audible frequency of the commutator ripple is 48 commutator bars and 10 revolutions per minute, the number and speed of the armature conductors and the strength of the field magnets being proportioned accordingly as is understood in the art, to give the desired voltage.

The inductance coil 9 is for the purpose of smoothing out sharp variations in the ripples. With some sources of current and commutating means such sharp variations may occur which would cause secondary frequencies which might be within the audible range although the primary frequency of the ripple would be outside that range. In such cases the coil would be almost indispensable in removing the ripple noise but in cases where the ripple is a sine wave or other smooth curve the coil might be dispensed with although at all times it has a smoothing influence on any variations and is therefore desirable.

While the invention has been illustrated in what is considered its best application it may have other embodiments without departing from its spirit and is not therefore limited to the structure shown in the drawing.

What I claim is:

The method of generating an effectively smooth direct current with a commutator machine having a plurality of alternating current sources and corresponding commutator segments consisting in running the commutator at such a speed that the frequency of commutator ripple is below the limit of audibility.

In testimony whereof I have signed this specification this 21st day of March, 1923.

EDWARD G. GAGE.