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CONTROLLED DYNAMIC FILTER

3,519,720

Filed April 24, 1968

2 Sheets-Sheet 1

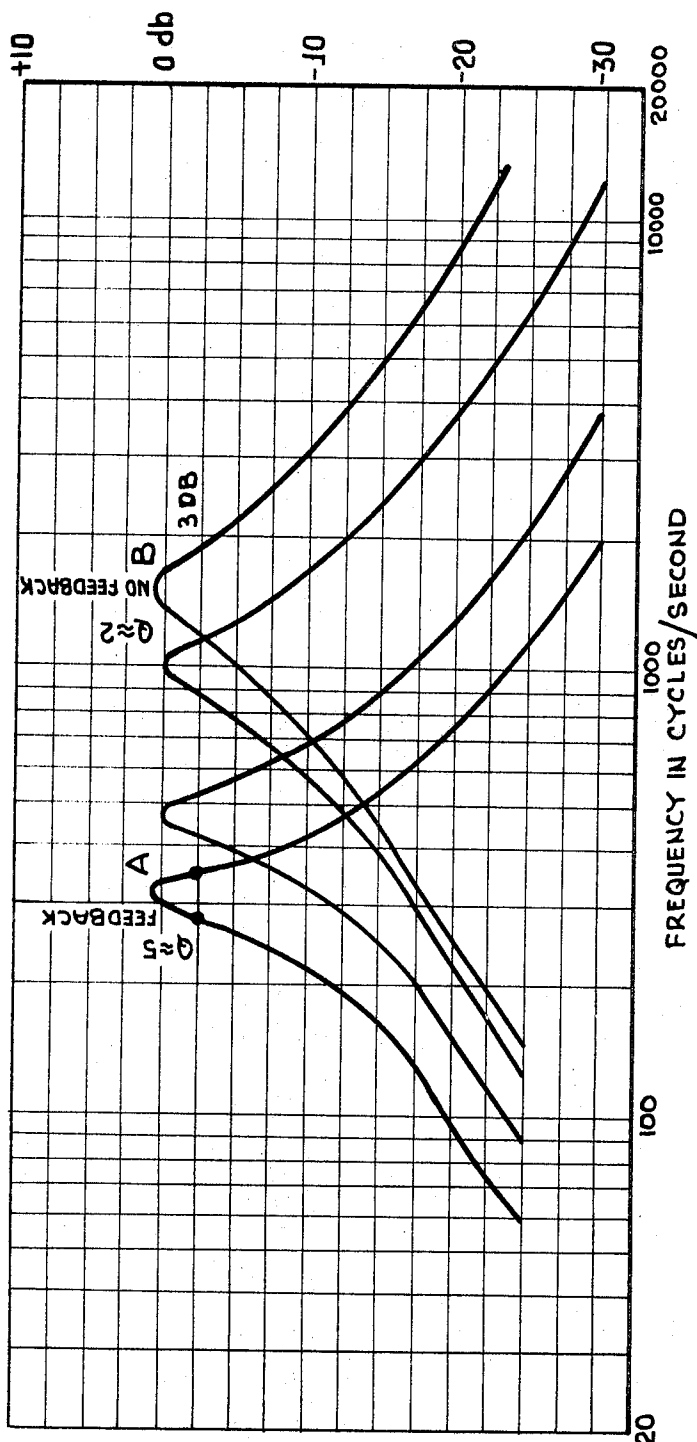


FIG. 1

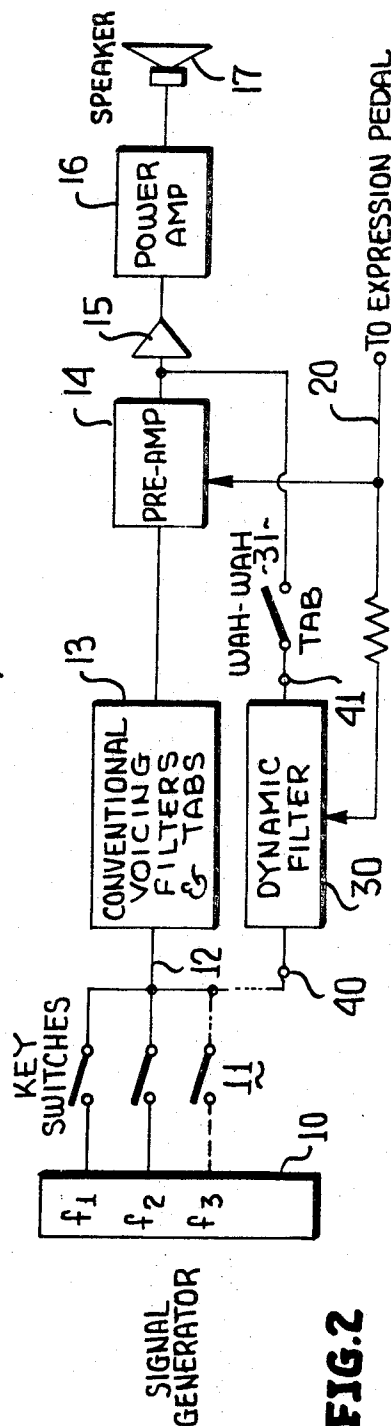


FIG. 2

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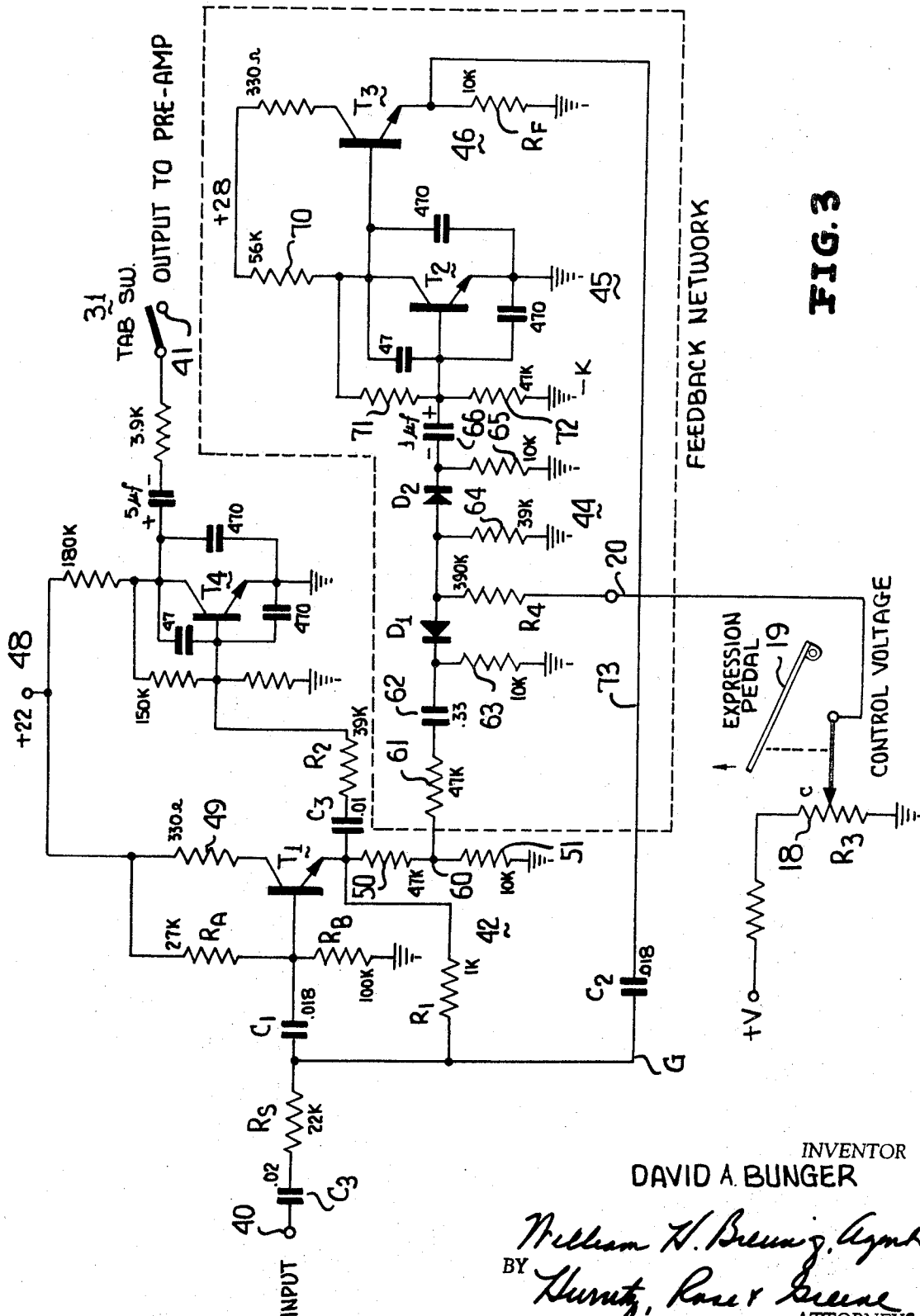


FIG. 3

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ORGAN HAVING VARIABLE TIMBRE WITH TRANSISTORIZED PLAYER CONTROLLED DYNAMIC FILTER

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9 Claims

ABSTRACT OF THE DISCLOSURE

An electric organ having conventional voicing circuits is also supplied with an auxiliary dynamic voicing filter including transistors, controlled by the expression pedal of the organ. The voicing filter is an active RC filter, having a feedback loop of controllable gain, that gain determining the peak frequency of the filter. A diode gate in the feedback loop is controlled by a control voltage established as a function of position of the expression pedal of the organ.

BACKGROUND OF THE INVENTION

Prior U.S. patents relating to the subject of this invention are: Peterson, 3,255,296; Peterson, 3,316,341; Neustadt, 3,166,622.

These patents involve dynamic modification of the output of tone generators of an electric organ. The present invention involves use of an active tunable RC filter of novel configuration, as a device for dynamically modulating the timbre of a tone, but in addition involves the use of the in any event available expression pedal of an organ to control timbre modulation, while that pedal remains available to the organ for expression control. Thereby the total number of controls which the player is called on to manipulate, in practicing the present invention, is not increased over the number required in the conventional organ, yet the total number of musical effects available to the instrument being played is increased.

SUMMARY OF THE INVENTION

An electric organ conventionally includes a tone generator having discrete complex tone sources which can be selectively called forth by key switches. The complex tones, i.e., tones containing many partials, are passed through voicing filters which are selectively placed in circuit by voicing tabs. The voicing filters determine the relative amplitudes of the partials, for each tone, which are passed on to amplifiers and eventually to loudspeakers. Expression is the term employed to indicate loudness of the radiated acoustic sound, and in the conventional organ expression is controlled by a foot pedal actuated by the right foot of the player.

According to the present invention, a dynamic voicing filter is provided which is additional to and connected in parallel with the usual voicing filter and which can be selectively operatively connected in the system at will, either in place of or in addition to the usual voicing filters. The peaking frequency of the dynamic voicing filter is a function of the position of the expression pedal. The

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dynamic voicing filter per se represents circuitry and principles of operation which are novel.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a graph depicting various available response curves of a variable timbre control filter, employed in the system of the invention;

FIG. 2 is a block diagram of a system of the invention; and

FIG. 3 is a schematic circuit diagram of a dynamic filter of the system of FIG. 2, and of controls for the dynamic filter.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 2, 10 is a signal generator which contains a signal source for each of the array of complex tones required in an electronic organ. The separate tones are called forth by closing key switches 11, as by keys or pedals (not shown) in the process of playing the organ. The tones called for by the key switches 11 are collected on a bus 12, which leads to conventional organ voicing filters 13. The latter are conventionally selected by voicing tabs, not separately shown. The outputs of the voicing filter or filters selected by the voicing tabs proceed to a preamplifier 14, followed by an amplification stage 15. The latter drives a power amplifier 16 which in turn drives a loudspeaker 17. A control voltage derived from a voltage divider 18 actuated by an expression pedal 19 (FIG. 3) is applied to lead 20. That control voltage is applied as a gain control signal to preamplifier 14, so that the loudness of sound radiated by the loudspeaker 17 is a function of the position of the expression pedal 19. The detailed description of the system, to this point, fits many conventional organs.

A dynamic filter 30 is connected to the bus 12. Filter 30 is a bandpass filter which has an adjustable peaking frequency as a function of control voltage, and a relatively low Q which varies between values of about 2 and 5 as the control voltage varies. Peak frequencies may vary from 300 Hz. to about 1.5 kc., as the control voltage varies. The output of filter 30 proceeds via a tab switch 31 to preamplifier stage 15, following the preamplifier 14 which is subject to gain control. Stage 14 may be incorporated in preamplifier 15. The expression pedal thus simultaneously controls gain of the conventional organ output, and tonal characteristics of a subsidiary output which itself has constant gain.

The dynamic filter 30 includes an input terminal 40 and an output terminal 41. See FIG. 3. A first transistor stage 42 employing a transistor T_1 in an emitter follower configuration having circuitry arranged to provide a bandpass filter response having a peak at about 1.5 kc. and drives the base of an output transistor T_4 arranged to operate as a linear amplifier, and the collector of the latter is connected to output terminal 41.

The emitter follower T_1 also drives a feedback loop, including in cascade a voltage controllable diode gate 44, a phase reversing amplifier 45 employing transistor T_2 , and an emitter follower stage 46 which provides a low resistance feedback point.

More specifically, the input terminal 40 is connected to the base of T_1 via blocking capacitor C_3 , isolating resistance R_5 , and a filter capacitor C_1 having capacitance

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selected to roll off only lower frequencies of the spectrum. A bias circuit for the base of T_1 extends from a positive voltage supply 48, to ground via resistances R_A and R_B , in series with each other. The junction of the latter resistances is connected to the base of T_1 . A small collector resistance 49 is provided and an emitter load, consisting of resistances 50 and 51 connected in series to ground, in the order named. A resistance R_1 is connected between the emitter of T_1 and the junction of R_s and C_1 . Circuit values are provided in the drawings.

The gain of the amplifier 42 is a function of frequency, as follows:

$$G' = \frac{\frac{R_1}{R_1 + R_s} \frac{R_A R_B}{R_A + R_B} C_1 S}{1 + \frac{R_1 R_s}{R_1 + R_s} C_2 S + \frac{R_A R_B}{R_A + R_B} C_1 S + \frac{R_1}{R_1 + R_s} \frac{R_A R_B}{R_A + R_B} C_1 S + \frac{R_1 R_s}{R_1 + R_s} \frac{R_A R_B}{R_A + R_B} C_1 C_2 S^2}$$

The derivation of this formula is not given, but it proceeds on the assumption that the junction of R_s , R_1 is at AC ground potential, as is also the junction of R_A , R_B . S is the usual symbol for complex frequency.

The actual ground is provided by the emitter follower resistance R_F of T_3 . This accounts for the presence of terms

$$\frac{R_1 R_s}{R_1 + R_s} \text{ and } \frac{R_A R_B}{R_A + R_B}$$

Assuming zero feedback from T_3 , the characteristic of the amplifier is that illustrated at B of FIG. 1.

The AC output voltage available at point 60, at the junction of resistances 50, 51, is applied through resistances 61, capacitor 62 to the cathode of diode D_1 . That cathode is connected to ground through a resistance 63. The relative values of 61 and 63 essentially determine the signal level transmitted to diode D_1 , the capacitor 62 introducing low frequency roll off and thus introducing minor filtering into the feedback path which assists in controlling low frequency response. The anode of D_1 is connected to the anode of diode D_2 , in a back-to-back configuration and the anode of D_2 is connected to ground via resistance 64. The anodes of D_1 and D_2 are connected to control lead 20, via R_4 to which is applied control voltage decreasing as a function of extent of depression of expression pedal 19.

The cathode of D_2 is connected to ground via a resistance 65, and through a coupling capacitor 66 to the base of transistor T_2 . Transistor T_2 has a grounded emitter and a collector load 70. A bias circuit and feedback is connected from the collector of T_2 to ground and consists of two resistances 71, 72 in series, the base of T_2 being connected to their junction. The collector of T_2 is directly connected to the base of an emitter follower transistor T_3 . The latter has a relatively low resistance R_F to ground. From the emitter of T_3 is connected a lead 73, which connects to one side of capacitor C_2 , the other side of which communicates with the junction of R_s and C_1 and R_1 . The capacitance of C_2 is selected to roll off only higher frequencies of the spectrum.

Diodes D_1 and D_2 provide gating of signal through the feedback path. In absence of control voltage at the anodes of D_1 , D_2 the gate represents an open circuit and therefore there is no feedback. The filter characteristic is then of type B, FIG. 1 of the accompanying drawings.

With no feedback the filter characteristic is determined by the values of C_1 , C_2 and associated resistances, as seen from point G.

As control voltage to the gate is increased, the feedback loop becomes more and more effective. This has the effect

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of increasing the effective capacitances of C_2 and of C_1 and of the associated resistances. If we consider

$$\frac{R_1}{R_1 + R_s} = A$$

$$\frac{R_1 R_s}{R_1 + R_s} = B$$

$$\frac{R_A R_B}{R_A + R_B} = C$$

the overall gain of the system without feedback is

$$\frac{X}{Y} = G' = \frac{ACC_1 S}{1 + BC_2 S + BC_1 S + ACC_1 S + BCC_1 C_2 S^2}$$

Here S is complex frequency.

With feedback, the overall gain is

$$\frac{S}{T} = \frac{X}{Y + KBCC_1 C_2 S^2}$$

where $-K$ is gain of the feedback loop.

The net effect is to increase the last term of the denominator of G_1 by a factor of K , K depending on the impedance of the gate as a controllable factor, and since the last term of the denominators Y and T are the same, except for the factor K , the net effect of the feedback loop is to increase the effective values of all frequency determining values of the filter in the same degree.

The mathematics of the system are approximate, so that the several curves of FIG. 1 are only approximately identical in shape, but the relative accuracy of the mathematics is attested to by the similarity of shape of the several curves representing different values of gating voltage. Some deviation of the frequency response of the actual circuit from calculated response as a result of phase shift in the amplifier 45 which was assumed to have 180° phase shift in the calculated expressions. The dots on curves A and B represent points 3 db down, and indicate circuit Q. Calculations of Q are not provided.

What is claimed is:

1. A system for modifying timbre of an electronic organ controllably as a function of time, wherein said electronic organ has an expression pedal,

a gamut of tone sources covering a musical scale,

plural selective voicing filters connected in cascade with said tone sources,

key switches for selectively at will connecting said tone sources to said voicing filters for transfer of tones therethrough,

means for rendering said voicing filters operative selectively at will,

an amplifier in cascade with said voicing filters,

an acoustic radiating system connected in cascade with said amplifier,

a further filter having an input circuit and an output circuit and arranged and adapted to dynamically modify its pass characteristic,

means connecting said input circuit to said tone sources via said key switches,

means coupling said output circuit to said acoustic radiating system, and

means responsive to actuation of said expression pedal for varying the gain of said amplifier and for concurrently modifying the bandpass characteristic of said further filter.

2. The combination according to claim 1 wherein said further filter is a bandpass filter, and wherein said characteristic of said bandpass filter is its mean frequency, and wherein the bandpass of said bandpass filter encompasses plurality partials of each of the tones provided by said tone sources, said tone sources generating partial rich tones.

3. The combination according to claim 1, wherein said further filter is a dynamic filter arranged and adapted to modify its pass characteristic in response to amplitude of a control voltage, and

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means responsive to the actuated position of said expression pedal for determining said amplitude of said control voltage.

4. In an electric organ,

a gamut of sources of partial rich musical tones,
an array of voicing filters for said tones,
a bandpass filter having a variable pass band within
the spectrum of said partial rich tones,

key switch means for selectively at will connecting
tones derived from said sources jointly to input circuits
of said voicing filters and of said bandpass filter,

a volume controlling expression pedal,

means responsive to the actuated position of said expression pedal for generating a control voltage instantaneously representative in amplitude always of
said actuated position,

means responsive to said control voltage for modifying
said pass band of said bandpass filter, as a function
of said amplitude of said control voltage,

a gain controllable amplifier means responsive to the
outputs of said voicing filters and of said bandpass filter,

means responsive to said control voltage for modifying
the gain of said gain controllable amplifier, and
a loudspeaker driven by said gain controllable amplifier.

5. The combination according to claim 4, wherein said
bandpass filter has a variable pass band which is a function
of the mid frequency to which it is tuned, said variable
pass band being at least 50% wider when tuned to its
uppermost value than when tuned to its lowermost
value.

6. The combination according to claim 4, wherein said
pass band has a peak frequency, and wherein the peak
frequency at said uppermost value is at least three times
the peak at said lowermost values.

7. The combination according to claim 6 wherein said
peak at said lowermost value is about 300 Hz. and at
said uppermost value is about 1500 Hz.

8. In a system for modifying the tonal characteristics
of musical tone,

a tone generator comprising a gamut of sources of
partial rich musical tone signals,

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a dynamic bandpass filter having a pass band within
the spectrum of said musical tone signals,

key operated means for at will selectively supplying
said musical tone signals to said dynamic bandpass
filter, wherein said bandpass filter is a dynamic filter
and includes,

an amplifier having an input circuit and an output circuit,

a negative feedback loop for said amplifier,

means including a series capacitor and resistance connected
between said sources of partial rich musical tones and said input circuit,

a relatively low resistance connected in said output
circuit across which output signal is developed and
having a ground point, and

a feedback capacitor connected from an ungrounded
point of said resistance to said input circuit, said
series capacitor having a capacitance selected to roll
off only lower frequencies of said spectrum, said
feedback capacitance having a capacitance selected
to roll off only higher frequencies of said spectrum,
said capacitors being connected in series in said
negative feedback path.

9. The combination according to claim 8 wherein is
included a voltage responsive gate in said negative
feedback loop, whereby the amplitude of feedback signal
may be adjusted in response to a control voltage.

References Cited

UNITED STATES PATENTS

Re. 24,743	12/1959	Anderson	84-1.24
2,835,814	5/1958	Dorf	84-1.01 X
3,004,460	10/1961	Wayne	84-1.01
3,098,077	7/1963	Brand et al.	84-1.11
3,166,622	1/1965	Neustadt	84-1.01
3,255,296	6/1966	Peterson	84-1.24

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U.S. Cl. X.R.

84-1.21, 1.24; 307-295