

Nov. 1, 1927.

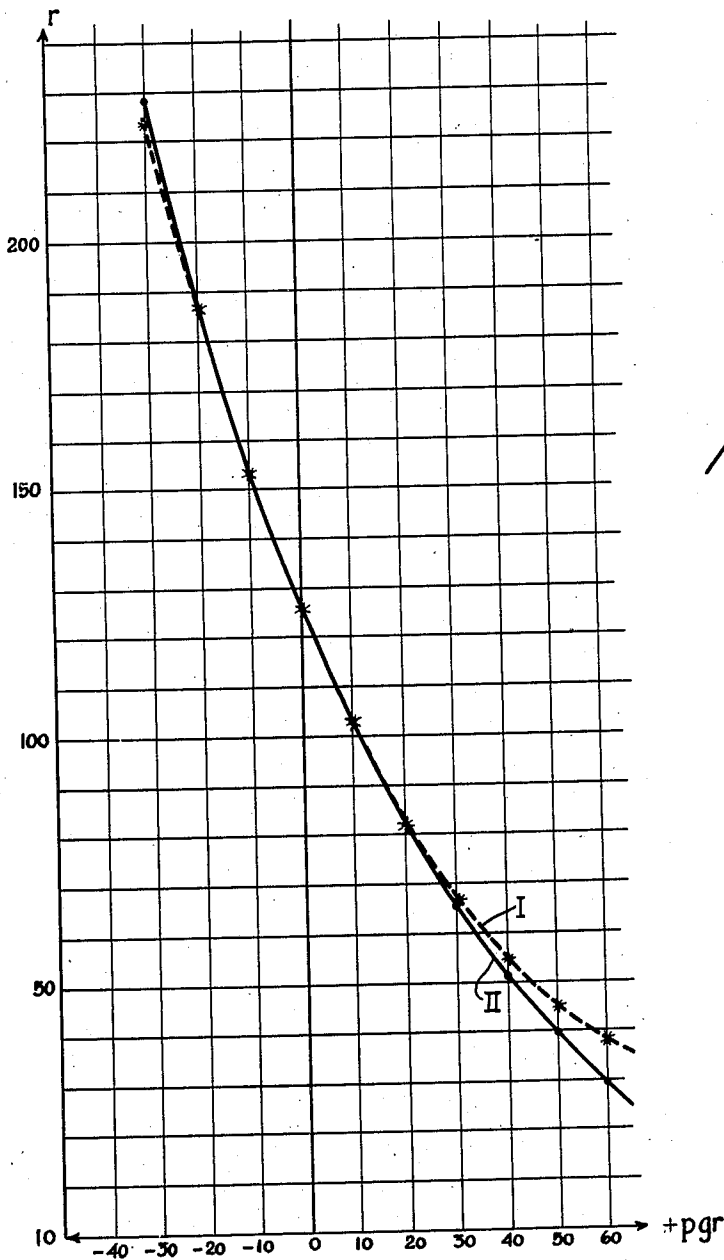
1,647,659

H. PAULI

TRANSMITTER CIRCUIT

Filed Aug. 12, 1926

2 Sheets-Sheet 1



p	r	
	Observed Curve I	Calculated Curve II
- 30	222	229,0
- 20	188	186,9
- 10	154	153,0
0	125	125,0
+ 10	103	102,6
+ 20	83	83,0
+ 30	67	66,5
+ 40	55	52,45
+ 50	44	40,0
+ 60	36	29,05

Fig. 1.

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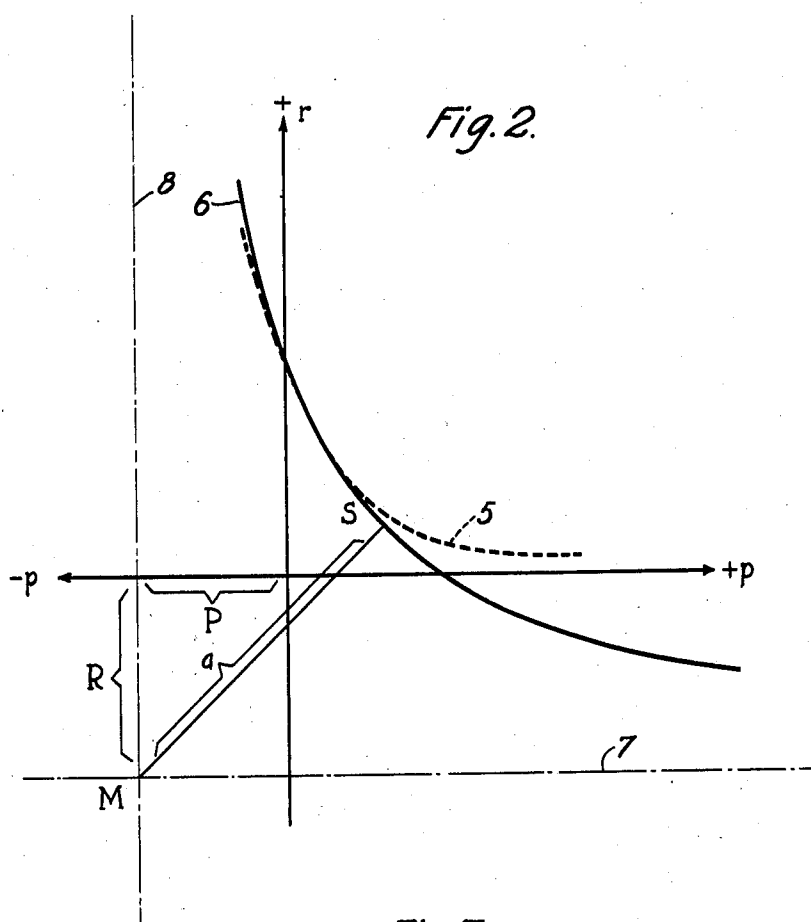
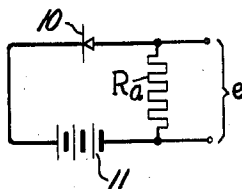


Fig. 3.



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UNITED STATES PATENT OFFICE.

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TRANSMITTER CIRCUIT.

Application filed August 12, 1926, Serial No. 128,878, and in Germany August 12, 1925.

The invention relates to an adjustment between a transmitter and a consumer device, on which it acts (ohmic resistance primary winding of a repeater), and the object is to transform without distortion into electric currents, the pressure variations acting on the transmitter diaphragm (sound waves).

Figures 1 and 2 are curves relating to the invention while Figure 3 illustrates the circuit.

In an article on transmitters (Elektrotechnik und Maschinenbau, 1925, No. 13, page 239) R. Kelch gives carbon transmitter curves for the current i in relationship to the pressure p on the diaphragm, the battery pressure V being steady. If the relationship of the transmitter resistance r to the pressure p be ascertained from these curves, it will be found that the function $r=f(p)$ in the neighborhood of $p=0$ approximates very closely to one branch of an equilateral hyperbola having its asymptotes parallelly displaced with respect to the rectangular co-ordinate system r, p . In Figure 1 the dotted line represents the curve for $r=f(p)$ obtained by Kelch's tests, while the full line curve is a branch of an equilateral hyperbola, which approximates to the relationship between r and p when $p=0$ nearly. The example shows that this approximation is very good for many positive and negative values of p .

It is often found to be a defective feature of the resistance transmitter that the sinoidal variations of its resistance cause, not only alternating currents of the same frequency, but also currents of higher frequencies. This is due to the fact that according to Ohm's law the relationship between resistance and current is reciprocal value. But in reality it is of little importance whether the variations in the resistance give rise to distortionless transmitter currents; but it is important that the current shall closely correspond to the variations in pressure on the diaphragm of the transmitter effected by the sound waves. This result can be closely achieved by making use of the beforementioned fact that there is a reciprocal relationship between the pressure on the diaphragm and the resistance of the transmitter. The following remarks will show how a linear, that is to say distortionless, relationship between the cur-

rent and the pressure can be obtained by suitably adjusting the constants of these two reciprocal values representing the magnitude of the resistances.

Within the limits of the beforementioned approximation, the relationship between r and p can be represented by a function having the form:

$$(r-R)(p-P) = \frac{a^2}{2} = C;$$

where R and P are the co-ordinates of the middle point M , and $a=MS$ is half the large axis of the equilateral hyperbola. R also represents the value of the resistance, which would correspond to an infinitely great pressure p on the diaphragm (see Fig. 2). Hence within the range of this approximation,

$$r = R + \frac{C}{p-P}.$$

If the transmitter be located in series with the battery V and the consuming resistance R_a , then the current

$$i = \frac{V}{R_a + r} = \frac{V}{R_a + R + \frac{C}{p-P}}$$

The approximate hyperbola curves obtained by the measured values for $r=f(p)$ have M always located below the p axis of the r, p co-ordinates; that is to say R has always a negative value.

The invention makes use of this fact. Because according to the invention, the resistance, on which the transmitter works, is made equal to the value of R . Therefore R_a has such a magnitude that $R_a + R = 0$.

Then

$$i = \frac{V}{C}(p-P)$$

and the pressure variation Δp have corresponding current variations

$$\Delta i = \frac{V}{C} \Delta p;$$

that is to say the variations in the current become proportional to the pressure variations.

This holds good for the pressure variations within the range of the approximate

hyperbola. For the example shown in Figure 1 it is very accurate for $-30 \text{ gr.} < p < +30 \text{ gr.}$; and it is $P=108.2$; $R=-144.5$; $a^2/2=C=29160$. Suppose now the transmitter be used in a circuit according to Figure 3, wherein 10 is the transmitter, 11 the transmitter battery and Ra the resist-

ance, on which the transmitter works. Let the voltage of the battery 11 be represented by V , then with $V=30$ volts, the distortionless maximum amplitude e of the alternating tension across Ra is obtained when $Ra=R$, and

$$e = Ra \Delta i = (R) \frac{V}{C} \Delta p = 144.5 \frac{30}{29160} 30 = 4.5 \text{ volts.}$$

The direct current transmitter current then is

$$J = \frac{V}{C}(P) = 111.1 \times 10^{-3} \text{ amps.}$$

- 15 Hence very considerable undistorted amplitudes of current can be obtained by adjusting the consuming resistance according to the invention.

- 20 In order to effect an adjustment in a transmitter circuit according to the invention, it is first necessary to make tests to find the relationship between the transmitter resistance r and the pressure p on the diaphragm for a number of positive and negative values of p in the neighbourhood of $p=0$. The constants R , P and C for the equilateral hyperbola which best approximates the tested relationship of the r , p values in the neighborhood of $p=0$ then have to be determined, preferably, by calculation. The resistance Ra , on which the transmitter works, is then selected, according to the invention,

so that it equals the absolute value (negative) R , which has been found according to the above method.

What is claimed is:

In a circuit arrangement for transmitters, a transmitter whose resistance varies with the pressure on the diaphragm according to a hyperbolic function, said hyperbolic function approximating, for small positive and negative values of pressure, an equilateral hyperbola whose asymptote corresponding to infinite pressure is displaced on the resistance axis of co-ordinates in a negative direction from the corresponding asymptote of the first mentioned hyperbola, and a load, having a resistance equal to the difference in the resistance ordinates between said two asymptotes, connected to the transmitter whereby increments in pressure cause proportional increments in current.

In witness whereof, I hereunto subscribe my name this 26th day of July A. D., 1926.

DR. HEINRICH PAULI.