

Sept. 3, 1946.

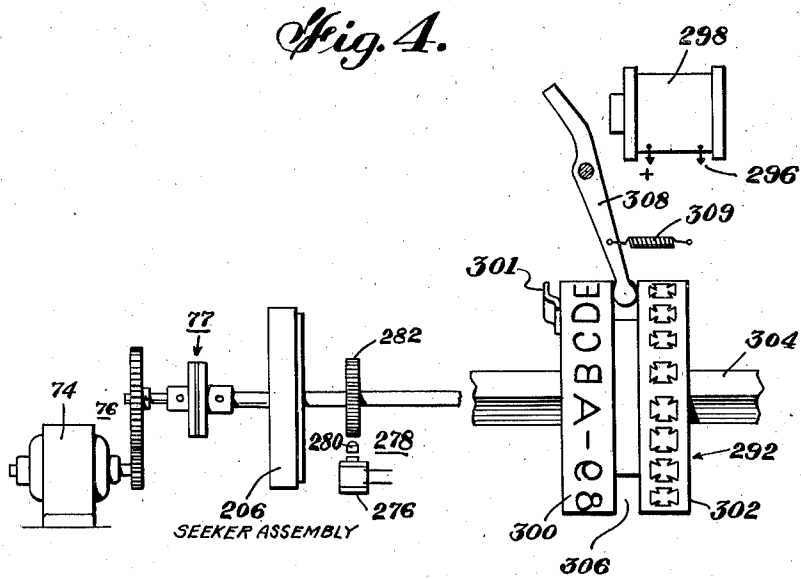
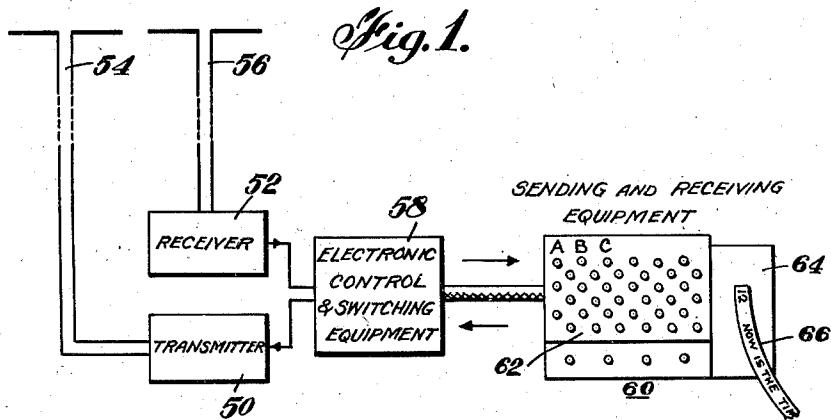
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2,406,835

METHOD AND MEANS FOR TRANSMITTING INTELLIGENCE

Filed Aug. 20, 1943

4 Sheets-Sheet 1



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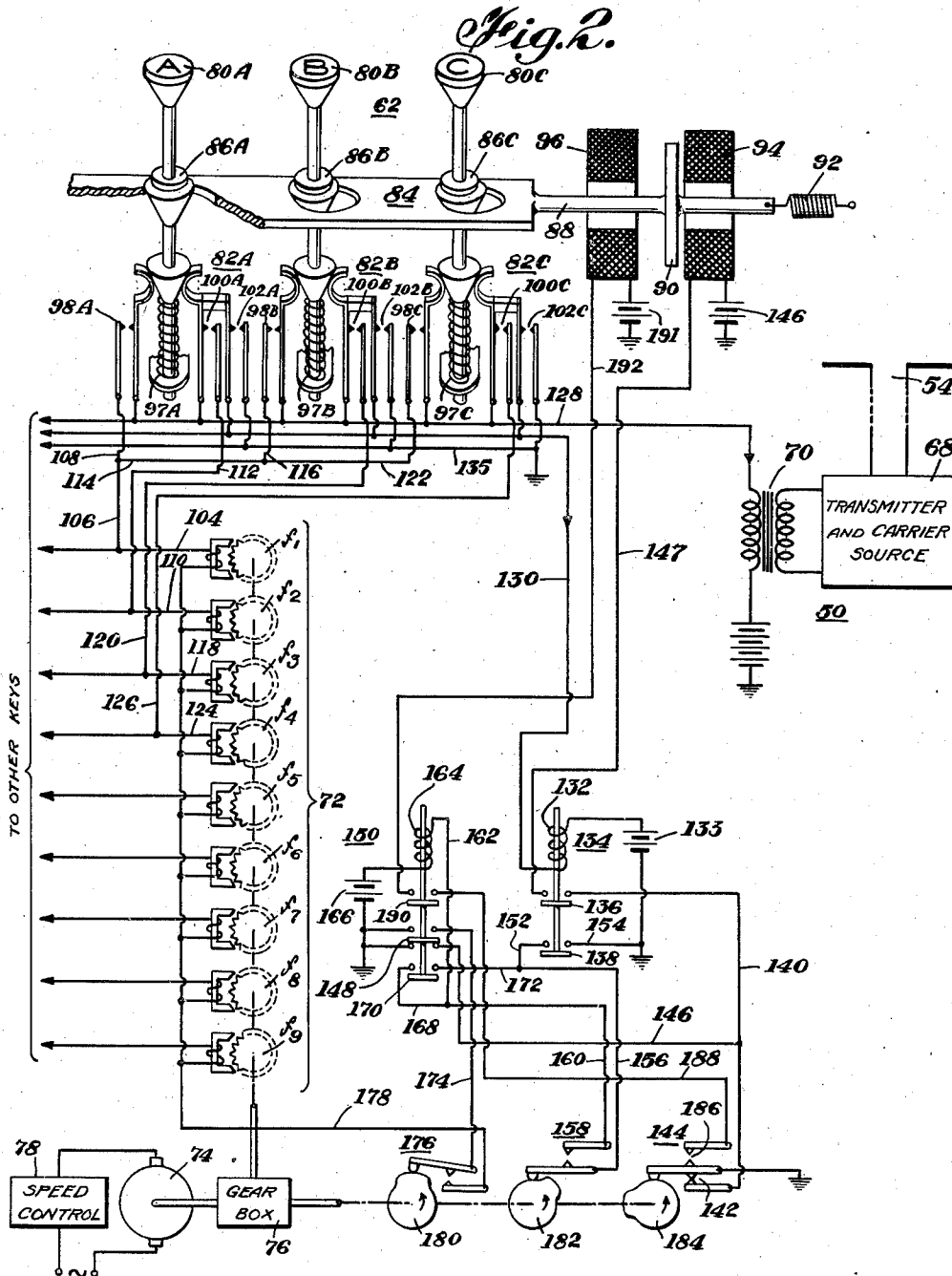
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METHOD AND MEANS FOR TRANSMITTING INTELLIGENCE

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4 Sheets-Sheet 2



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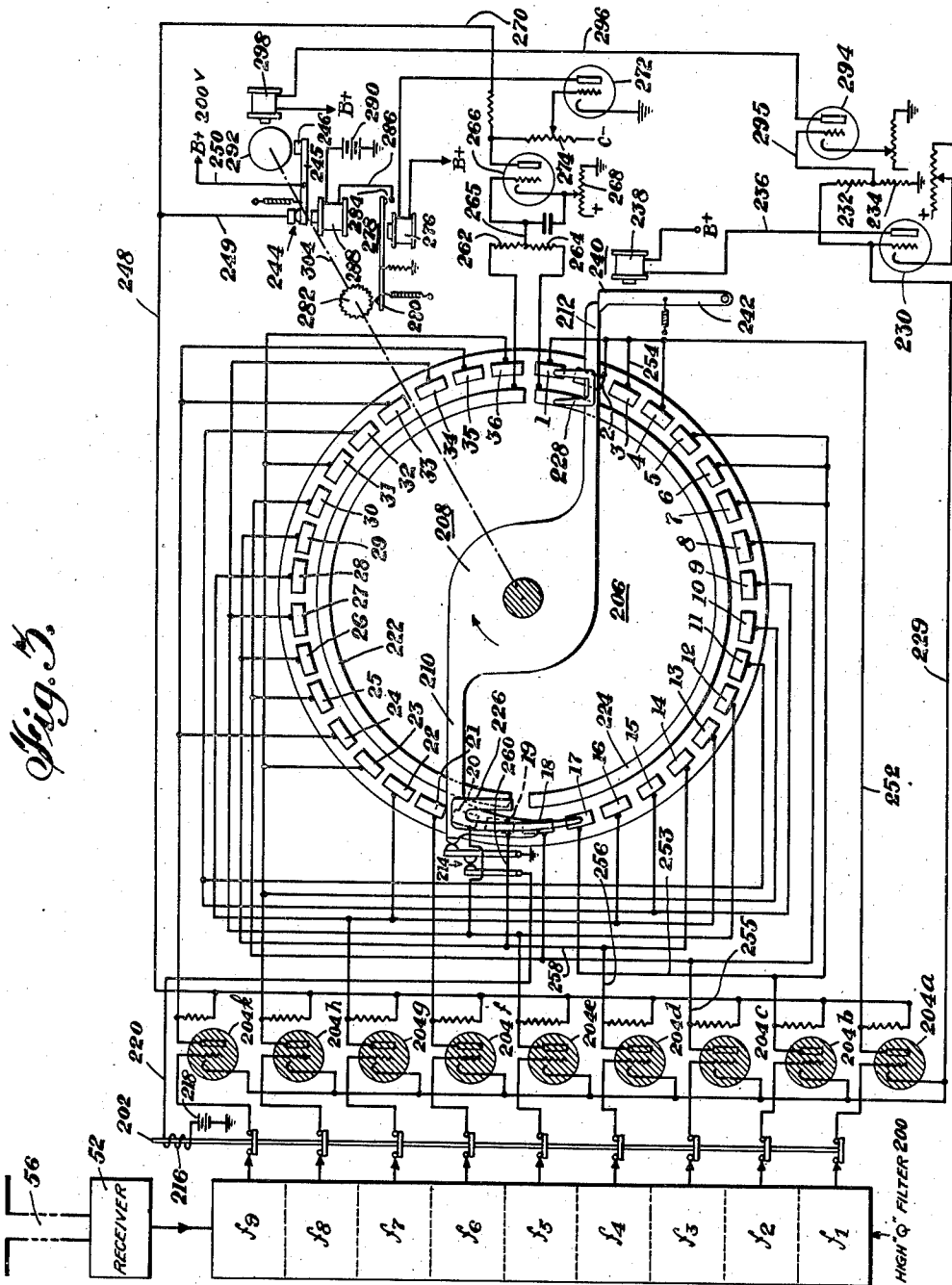
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METHOD AND MEANS FOR TRANSMITTING INTELLIGENCE

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4 Sheets-Sheet 3



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METHOD AND MEANS FOR TRANSMITTING INTELLIGENCE

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Fig. 5.

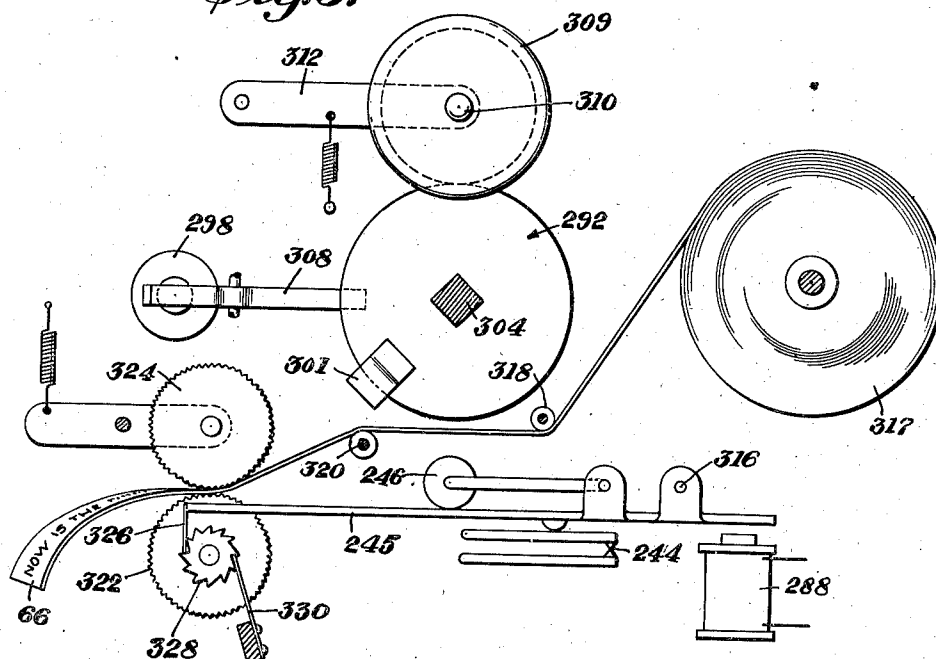
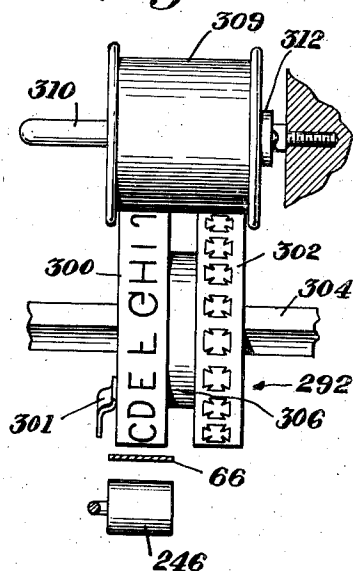


Fig. 6.



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METHOD AND MEANS FOR TRANSMITTING INTELLIGENCE

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Application August 20, 1943, Serial No. 499,341

22 Claims. (Cl. 178—32)

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This invention relates to improvements in methods and means for transmitting intelligence, and more particularly to a system in which intelligence is transmitted as coded frequency combinations which are reconverted and reproduced at the receiver.

An object of this invention is to provide a novel intelligence transmission system in which various characters are coded by predetermined frequency combination.

Another object of this invention is to provide a receiver unit for such a transmission system, in which the angular position of a selector switch and a type wheel rotating therewith can be controlled by the particular frequency combination transmitted and received.

A further object of this invention is to provide a novel transmission system in which characters to be transmitted are coded by different pairs of frequencies derived from individual different frequency sources, (for example nine, producing a possible total of thirty-six different characters), and in which the characters are automatically reproduced in a receiver upon the reception of the different frequency pairs.

A subsidiary object of this invention is directed toward a frequency-responsive selector system, in which the rotary position of a selector switch is determined in accordance with the application thereto of currents derived from particular combinations of different frequencies.

Other objects will be in part obvious from the annexed drawings and in part indicated in connection therewith by the following analysis of this invention:

This invention accordingly consists in the features of construction, combination of parts and in the unique relations of the members and in the relative proportioning and disposition thereof, all as more completely outlined herein.

To enable others skilled in the art so fully to comprehend the underlying features thereof that they may embody the same by the numerous modifications in structure and relation contemplated by this invention, drawings depicting a preferred form have been annexed as a part of this disclosure, and in such drawings:

Fig. 1 is a block circuit diagram of a combined receiving and transmitting unit formed in accordance with the present invention;

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Fig. 2 is a circuit diagram of the transmitting apparatus according to the present invention, illustrating additionally some of the mechanical structure used in connection with the circuit;

Fig. 3 is a circuit diagram of the receiving apparatus according to the present invention, also illustrating diagrammatically some of the mechanical features of the apparatus used in connection therewith;

Fig. 4 diagrammatically illustrates further mechanical details of the receiving apparatus;

Fig. 5 is a side elevation of the details of the printing apparatus used in the receiver; and

Fig. 6 is a front view of a preferred form of type wheel and ink roller shown in Fig. 5.

As indicated above, the present invention contemplates a system for the transmission and reception of intelligence in which the characters to be transmitted and reproduced are coded as different frequency combinations. The number of characters which can be formed in such a system depends, of course, upon the number of individual frequency sources and secondly upon the manner in which they are combined. While it is not intended that the system should be limited thereto, as a practical example of such a system I contemplate one using nine different frequency sources which will provide thirty-six different frequency pairs, thus permitting the transmission and reception of thirty-six different characters. This covers all of the letters of the alphabet, and all of the numerals (using "I" and "O" as "one" and "zero"), with two additional characters which may be a space and a dash (—). This will be sufficient for ordinary transmission requirements but it is to be understood that more or less characters can be utilized, as desired, in which case the system will become relatively more complicated or less complicated as the case may be.

While in the detail description of the invention to follow, the transmitting and receiving apparatus has been, for the sake of clarity, described as two individual units, it is contemplated that each station in the system may be in the form of a combined transmitter-receiver unit, of the type generally indicated in Fig. 1. As therein shown, such a unit would contain a transmitter 50 and a receiver 52 respectively connected to antennas 54 and 56, although, as is well-known in this art, a single antenna may, with proper precautions

be used for both transmitter and the receiver. The output from receiver 52 will preferably be supplied to a unit 53 containing the entire electric control equipment, being specifically all connected to that part of the control equipment needed for the reproduction of the incoming signals. The unit 53, in turn, is connected to a second unit 60 which may house the mechanical sending and reproducing equipment; more specifically, the incoming signals will operate a suitable printing device indicated at 64 equipped to reproduce the incoming intelligence upon means such as a tape 66. The transmitting equipment will consist of a keyboard 62 and other mechanical devices to be explained in more detail hereinafter which control and are controlled by further electrical devices contained within the unit 58, from whence the output is directed to the transmitter 50. It is to be understood, however, that the particular arrangement and division of parts as shown in Fig. 1 is given only by way of example to illustrate the general application of my invention and that other separation or integration of the equipment can be used, as desired.

The details of a preferred form of transmitting apparatus are more particularly shown in Fig. 2. This shows the transmitter and carrier source 68 which is supplied with modulating current through the modulating transformer 70. The transmitter and carrier source may be connected to an antenna 54, or to any other transmitting medium. In accordance with the combinations of frequency determined by the keyboard 62, modulation is effected from a plural frequency source 72 which may consist, for example, of nine commonly driven tone wheels $f_1, f_2, f_3, f_4, f_5, f_6, f_7, f_8$, and f_9 , each producing current at a different frequency. This frequency difference between them is not critical, but may for example, for the sake of simplicity be 30 cycles. These tone wheels are driven by means such as an electrical motor 74 through gearing 76, and their speed can be controlled by any suitable speed control device for the motor, indicated at 78.

A keyboard which may be of any well-known type will be provided, in the particular system described, with thirty-six keys, three of which 80A, 80B, and 80C are illustrated in Fig. 2. These three keys control normally open switches 82A, 82B, and 82C respectively. In order to prevent the depression of more than one key at a time, means are also provided for locking the remaining keys after one key is depressed. Such locking means may take the form of a latch bar or plate 84 acting in conjunction with collars or stops 86A, 86B, and 86C on the respective keys. The latch bar is attached to one end of a control rod 88 upon which is mounted an armature 90. The latch bar 84 is normally biased to locking position by means such as a spring 92, but the effect of this bias can be overcome by the depression of any key and the reaction of its attached collar with an opening in the latch bar itself. When it is desired to lock the keys in position, a locking magnet 94 is energized which attracts the armature 90 in one direction, whereas if it is desired to release the latch bar, the electromagnet 96 attracting the armature 90 in the other direction is energized. Springs 97A, 97B, and 97C are used respectively to urge the keys into their normal position in which the switches controlled by these keys are open.

Each switch 82A, 82B, and 82C preferably includes three normally open contact pairs, designated respectively as 98A, 100A and 102A for the

switch 82A; 98B, 100B and 102B for the switch 82B; and 98C, 100C and 102C for the switch 82C. It is to be noted that in accordance with the example given, the switch 82C for the character "C" is supplied with current to two of its contact pairs from the tone wheels f_1 and f_4 . Such circuit may be traced, for example, from the tone wheel f_1 through conductors 104, 106 and 114 to the contact pair 98C, and from the tone wheel of f_4 through conductors 124 and 126 to the contact pair 100C. Thus the coded signal for the letter "C" is formed by a combination of frequencies f_1 and f_4 . The letter "B" on the other hand is formed by a combination of frequencies f_1 and f_3 . This can be ascertained from the fact that frequency f_1 is connected to switch pair 98B through conductors 104, 106, 114 and 116, while tone wheel f_3 is connected to switch pair 100B through conductors 118 and 120. The letter "A" is formed by a combination of frequencies f_1 and f_2 , this being ascertainable by the fact that tone wheel f_1 is connected to contact pair 98A through conductors 104, 106 and 108, while tone wheel f_2 is connected to contact pair 100A through conductors 110 and 112. Switches 98A, 100A, 98B, 100B, 98C, 100C, and all other comparable key-controlled contact pairs lead to a common conductor 128 and thence to the modulating transformer 70.

The third contact pairs 102A, 102B, 102C, etc., for each switch are connected in parallel between conductor 130 leading to actuating coil 132 of control relay 134, and the grounded conductor 135. Thus the closure of any character-controlling switch will complete the circuit for the relay coil 132 and its source of power 133, thus energizing this coil and raising the contacts 136 and 138 of the relay 134. The closure of this relay establishes a circuit for the key lock magnet 94 so that after a key has been depressed the remaining keys are locked in place. The circuit for the key lock 94 may be traced from the source of power 146, the magnet itself, conductor 147, relay contacts 136, conductor 140 and thence alternatively either through the normally closed contacts 142 of cam-operated switch 144 to ground, or through conductor 146 and normally closed contacts 148 of relay 150 to ground. The purpose of this alternative circuit will be explained in more detail hereinafter.

Closure of the lower contacts 138 of the relay 134 also prepares an energizing circuit for the actuating coil 164 of relay 150. This circuit may be traced from ground through conductor 154, contacts 138, conductor 152 and conductor 156 to the normally open cam-operated contact switch 158. The circuit may then be continued through conductors 160 and 162 to the relay coil 164 and thence to a source of power such as battery 166.

If the switch 158 is closed and the relay 150 is moved to its closed position by energization of the coil 164, further control circuits are then completed. In the first place, a holding circuit irrespective of the position of the cam-operated switch 158 is first established. This circuit may be traced from the battery 166 through actuating coil 164, and thence through conductors 162 and 168 to the closed contactor 170 of the relay 150; from thence the circuit continues through conductors 172 and 152, the closed contactor 138 and conductor 154 to ground. The upward movement of contactor 148 closing a second pair of contacts completes, through the cam-operated switch 176, the connection of the tone wheels to the transmitting apparatus. It will be noted that

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the output of all of the tone wheels has one common lead 178 which through switch 176 and conductor 174 is grounded when the contactor 148 is raised. When this happens the circuit to the transmitter through the transformer 70 is completed and the particular frequency pair determined by the operation of one of the keys is applied to the transmitter.

The switches 144, 158 and 176 are illustrated as being operated respectively by cams 184, 182 and 180 mounted upon a common shaft which may also be driven by the motor 74 through the gear box 76. The three cams are so angularly positioned upon the shaft that they operate their respective switches sequentially. In the position of the cams as illustrated in Fig. 1, the normally closed switch 176 is open, the normally open switch 158 is open while the switch 144 is in its normal position for closure of the lower contact pair 142. When the cam 184 rotates so as to break the contact pair 142 and close the contact pair 186, and assuming that the relay 150 is in its last position, a circuit will then be completed for the release magnet 96. This circuit may be traced from the source of power such as battery 191, the release magnet itself, conductor 192, closed contactor 190, conductor 188 and closed switch 186 to ground.

The manner in which the foregoing transmitting system will operate for the transmission of a character will now be followed through by way of example. If, for instance, it is desired to transmit a coded signal corresponding to the letter "C" and the relays and cams are in the position shown in Fig. 2, the key 80C will be depressed, operating the switch 82C to close contacts 90C, 100C and 102C. Immediately, output leads 104 from the tone wheel f_1 and 124 from the tone wheel f_4 will be electrically commonly connected to one end of the transformer 70, in the manner previously traced, but the circuit to the transmitter will not be completed since the common output lead 178 from all of the tone wheels is still broken. Closure of the switch 102C will energize the relay 134 and, through contactor 136 completes an energizing circuit for the key lock magnet 94 holding the armature 90 to the right. This holds the remaining keys in their raised position, as through stops such as 86A and 86B, but holds the key 80C in its depressed position since it is prevented from rising because the collar 86C is now below the latch bar. The reason for the alternative key lock circuit may now become apparent to those skilled in this art. For example, while the cam 184 is shown in such a position that the contact pair 142 is closed, thus completing the key lock circuit to ground, there is no synchronization or coordination between the time the operator may depress the key and the position of this rotating cam. Accordingly, it is possible that the cam 184 might be in such a position that the switch pair 142 were open when a key was depressed. However, in this case the key lock circuit would still operate through the alternative circuit formed by conductor 146 and the contactor 148 in its lowered position.

Assuming now that the key 80C is locked in its depressed condition and the relay 134 is energized, a circuit previously traced in connection with the general description of the invention is prepared for the actuating coil 164 of relay 150, and this coil will be energized when the cam 182 rotates sufficiently to close the switch contacts 158. The closure of relay 150 will then complete

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the circuit from common lead 178 of the tone wheels to the transmitter, since the actuating portions of the cams 180 and 182 are so angularly related that the switch 176 will be closed when the switch 158 is closed. Moreover, the cam 184 is so related to the cam 180 that the contacts 186 of the switch 144 will remain open for a predetermined time after the switch 176 is closed. Accordingly, the circuit for the release magnet 96 is not completed until the transmitter has been modulated by the particular tone wheel combination of frequencies for a certain predetermined period of time. However, at the expiration of this period the switch 144 will be operated to break the contact pair 142 and close the contact pair 186. This operation energizes the release magnet 96 through the closed relay 150, and at the same time breaks the circuit for the key lock magnet 94, since in this case its alternative energizing circuit has been broken by the raising of the contactor 148. De-energization of the coil 94 and energization of the coil 96 permits the key 80C to move upwardly to its normal position breaking the circuit to the actuating coil of relay 134 which, in turn, breaks the circuit to the actuating coil of the relay 150, and the parts are now in position to go through another sequential operation upon the depression of the same or another key.

While in Fig. 2 I have only illustrated the circuit connections between three keys and the nine tone wheels, it will be understood that the remaining circuits for the remaining thirty-three keys will be similar, each key in each case completing a circuit for the relay 134 and also connecting one lead from a pair of tone wheels to one side of the modulating transformer 70, the particular frequency pair combination which is connected for each character being dependent upon the coded system in use.

The receiving apparatus shown by way of example in Fig. 3 provides a system for combining the coded frequency pairs transmitted from apparatus such as shown in Fig. 2, into characters corresponding to those chosen by the operator in his operation of the keyboard. This receiving apparatus will, of course, embody a suitable antenna 56 feeding to a detector and receiver 52 which may also include suitable amplifying apparatus, the output of the receiver 52 being fed to a suitable high "Q" storage filter apparatus 200 designed to pick out from the received frequency pairs, the individual frequencies f_1 to f_n corresponding to those generated by the tone wheels of the transmitter. Connections are made from the nine sections of the filter 200 through a normally closed switch 202 to the respective grids of nine gaseous discharge tubes 204a, 204b, 204c, 204d, 204e, 204f, 204g, 204h and 204k.

The receiving apparatus also includes a seeker assembly which will include a circular disk 206, equally spaced about whose circumference are a plurality of contacts 1 to 36 inclusive, the number of contacts depending upon the number of frequency pairs obtainable from the original number of frequency sources. In this case, since nine different frequency sources were originally chosen for the transmitter, there will be thirty-six equally spaced contacts. The seeker assembly also includes a rotatable mounted seeker arm 208 having two substantially oppositely directed extensions 210 and 212. The one extension 210 is adapted when in its "normal" position to actuate a pair of contacts 214 to closed position. Closure of these contacts maintains the switch 202

in its "normally closed" position by completing the energization circuit for its actuating coil 216 to its source of power 218 through conductor 220. The disk 206, in addition to the spaced contacts 1 to 36 inclusive, also supports a pair of oppositely spaced separate slip rings 222 and 224 while the extensions 210 and 212 of the seeker arm 208 respectively bear spring contact bridges 226 and 228, whose contacts are so spaced that one wipes the individual spaced contacts and the other alternatively wipes the slip rings 222 and 224. It will thus be seen that as the seeker arm 208 rotates, contacts 1 to 18 are sequentially interconnected with the slip ring 224, and contacts 18 to 36 inclusive, are sequentially connected to the slip ring 222 by the contact bridge 228. Contact bridge 226 on the other hand, is formed with its outer arm of greater length than the corresponding outer arm of contact bridge 228 causing such an overlapping that it first interconnects contacts 17 to 34 inclusive with the slip ring 222, and contacts 35, 36 and 1 to 16 inclusive with the slip ring 224. The anodes of the gaseous discharge tubes 204a to 204k inclusive are then interconnected with the contacts 1 to 36 inclusive in such a manner and in such a sequence that in connection with the contact bridges 226 and 228 there appears on the slip rings 222 and 224, potentials derived from all possible pairs of tube combinations, in this case thirty-six different combinations.

The cathodes of tubes 204a to 204k inclusive are, on the other hand, connected through a common conductor 229 to the grid of a vacuum tube 230, and to ground through two serially connected cathode resistors 232 and 234. The anode of the tube 230 is connected through the electromagnet 238 of a latch 240 to its suitable high voltage supply line. The latch 240, in addition to the electromagnet 238, also includes a latch arm 242 normally urged into such a position as to intercept and hold the extension 212 of the seeker arm 208 in the previously referred to "normal position." Energization of the electromagnet 238 in a manner to be described in more detail hereinafter will, however, release the latch arm 242 and permit operation of the seeker arm.

The anodes of the gas discharge devices 204a to 204k, in addition to being interconnected with the various contacts 1 to 36 inclusive are also supplied with a suitable operating voltage through conductors 248 and 249 and normally closed contacts 244 of a printing arm 245. From the printing arm a conductor 250 leads directly to the high voltage supply which, for example, may be 200 volts.

Before describing any of the other receiving apparatus in detail, it is believed that the invention may be best understood if an actual example of the operation of the same is traced. If it is assumed that the transmitter has been operated to transmit a pair of frequencies, in this case frequencies f_1 and f_4 which are coded to indicate the letter "C," these frequencies will appear in their respective storage filter sections of filter 200, while the remaining filter sections will produce no output current. If the seeker arm 208 is in its "normal" position and the switch 202 is then closed, and after sufficient energy has been stored in the energized filter sections this will cause energization of the grids of gaseous discharge tubes 204a and 204d. As these tubes discharge, cathode current through the conductor 229 will flow through cathode resistors 232 and 234 raising the grid potential of vacuum tube 230 causing it to

pass sufficient current to its plate circuit to energize the electromagnet 238, releasing the latch arm 242. The seeker arm 208 then begins to rotate and will apply through the contact bridges 226 and 228 to the respective slip rings 222 and 224 the normal anode potential of 200 volts across the resistors 262 and 264 connected together at their midpoint at one end and at their other ends to slip rings 222 and 224 respectively. However, when one of the gaseous discharge tubes is fired, as in this case the tubes 204a and 204d, the anode potential will drop to 70 volts and whenever one of the bridge contacts wipes an individual spaced contactor connected to either of these tubes, a voltage of 70 volts will be placed across the corresponding resistors 262 and 264 instead of 200 volts. The common connection 265 from these two resistors will apply the mean potential across the two resistors to the grid of a vacuum tube 266 which is biased to be normally conductive for a mean grid potential above 135 volts, but will become non-conductive if this mean grid potential drops to 70 volts. Now as the seeker arm 208 rotates, various combinations of these potentials will be impressed across the two resistors 262 and 264 depending upon the different pairs of contacts simultaneously contacted by the two bridges 226 and 228. For example, in the initial (starting) position of the seeker arm the slip ring 224 is connected to contact 1, while the slip ring 222 is connected to contact 17. Contact 1 is connected to the anode of conductor of tube 204a to conductor 252 while contact 17 is connected to the anode of tube 204b through conductor 253. This will produce across resistors 262 and 264 the mean potential of 200 and 70 volts, or 135 volts, which is too high to render the tube 266 non-conductive. In the next position of the seeker arm the contact 2 will be connected with slip ring 224 and contact 18 will be connected with slip ring 222. The contact 2 is likewise connected to the anode of tube 204a by conductor 252, while contact 18 is connected to the anode of tube 204c. Again a mean potential of 135 volts is impressed on the grid of tube 266 and the same remains conductive. In the next position, however, contact 3 is connected with slip ring 224 and contact 19 with slip ring 222. Contact 3 is connected with the anode of tube 204a through conductors 254 and 252, while contact 19 is connected with the anode of tube 204d through conductors 256, 258 and 260. Since both tubes 204a and 204d are conducting, being energized in response to frequencies f_1 and f_4 , the anode potential on both has dropped to 70 volts and the mean potential on the grid 266 therefore drops to this value and the tube becomes non-conductive.

When the tube 266 becomes non-conductive, the vacuum tube 272 whose grid is biased therefrom through controllable resistors 274 now becomes conductive and energizes electromagnet 276. The electromagnet 276 forms part of a stop mechanism 278 and the energization of the electromagnet operates a normally inoperative detent 280 to engage a stop wheel 282 provided with indentations corresponding to the various contacting portions of the seeker arm 208. Thus, when the seeker arm 208 reaches a position in which the anode potential from tubes 204a and 204d, corresponding to the reception of frequencies f_1 and f_4 causes cessation of the operation of tube 206, the stopping mechanism 278 operates to hold the seeker arm in this position. The actuation of the stop mechanism 278 addition-

ally closes a pair of contacts 284 completing through conductor 286 the energization of a second electromagnet 288 to its source of power 290. This second electromagnet operates the printing arm 245, actuating the printing hammer 246 toward the printing wheel 292 and simultaneously opening the contacts 244 which breaks the anode circuit for all of the gaseous discharge tubes 204a to 204k inclusive, rendering them non-conductive. The printing wheel 292 is formed with a plurality of characters about its periphery corresponding to the characters on the keyboard of the transmitter and these characters are so aligned with respect to the seeker arm 208 that when the seeker arm is stopped in a particular position in response to a particular combination of frequencies, for example, in the instance given the frequencies f_1 and f_4 for the letter "C," this letter will appear on the printing wheel 292 opposite the hammer 246 and thus, upon operation of the hammer, print this character upon a tape or other reproducing medium which may be placed intermediate the two. When the anode circuits of the gaseous discharge tubes were broken at contacts 244, relay 230 was de-energized which in turn de-energized release magnet 238 allowing the latch to resume its normal position whereby the seeker upon completing its rotation is stopped. It may, however, proceed immediately on another rotation as soon as switching relay, upon the closure of contacts 214, is re-energized, providing filter sections corresponding to a pair of frequencies have in the meantime become charged from a new signal transmission.

Since as above stated it is only after sufficient energy has been stored in the filter that the potential becomes high enough to cause energization of the grids, it is obvious that this storing period does not operate to slow down the speed of receiver action. For the process of storing incoming energy can take place while the mechanical operations for recording the previous signal are going on. This feature is of considerable advantage not only in expediting rapid reception but produces a reliable control for its uniformity. As elsewhere explained a receiver and a transmitter unit are tied together mechanically so that the degree of speed regulation deemed necessary to produce sufficiently stable transmitting frequencies will at the same time govern both the timing of the key action at the transmitter as hereinbefore shown and also that of the receiver. The system is thus inherently free from effects due to irregularity of the key operator.

While a particular example in connection with the letter "C" has been given above by way of illustration, the system as shown in Fig. 3 has been developed so that each position of the seeker arm, and thus each position of the printer wheel 292 will respond to a particular character in response to the transmission and reception of a particular frequency pair, but in each instance the operation of the system will be identical. The particular frequency pair assigned to a particular character, resulting in a particular pair of segments producing the reduced mean voltage on the grid of the tube 266 may be varied in accordance with a particular chosen code. In the following table, however, are indicated the different frequency pairs for each character, the resulting order of frequencies on the various segments, and the consequent segment pair corresponding to each frequency pair and character of the system which has been chosen by way of

example. While it is not believed necessary to trace all of the circuits for all of the characters, since the one example given is believed to be sufficient for the purposes of this description, it will be found that the circuits illustrated in Fig. 3 will produce the frequency pair and segment pair combinations set forth on this table:

Segment No.	Order of frequencies	Character	Frequency pair	Segment pair
1	1	A	1-2	1-17
2	1	B	1-3	2-18
3	1	C	1-4	3-19
4	1	D	1-5	4-20
5	2	E	2-6	5-21
6	2	F	2-7	6-22
7	2	G	2-8	7-23
8	3	H	3-9	8-24
9	7	I	7-3	9-25
10	8	J	8-4	10-26
11	9	K	9-5	11-27
12	5	L	5-6	12-28
13	6	M	6-4	13-29
14	4	N	4-3	14-30
15	7	O	7-8	15-31
16	6	P	6-7	16-32
17	2	Q	2-9	17-33
18	3	R	3-5	18-34
19	4	S	4-9	19-35
20	5	T	5-8	20-36
21	6	U	6-1	21-1
22	7	V	7-1	22-2
23	8	W	8-1	23-3
24	9	X	9-1	24-4
25	3	Y	3-2	25-5
26	4	Z	4-2	26-6
27	5	Space	5-2	27-7
28	6	2	6-3	28-8
29	4	3	4-7	29-9
30	3	4	3-8	30-10
31	8	5	8-9	31-11
32	7	6	7-5	32-12
33	9	7	9-6	33-13
34	5	8	5-4	34-14
35	9	9	9-7	35-15
36	8	—	8-6	36-16

The system as aforedescribed is fool-proof against two types of errors which may possibly occur. For example, if a single frequency rather than a pair of frequencies is inadvertently transmitted, it will be seen that the receiving system will not operate since the voltage on only one of the gaseous discharge tubes will drop to 70 volts and therefore the mean voltage on the grid of the vacuum tube 266 will not have fallen below 135 volts. Thus, the tube 266 will always remain conductive upon the reception of a single frequency alone and even though the latching mechanism 238 may operate to release the seeker arm 208 for one rotation, nothing will appear upon the printing tape.

On the other hand, if more than two frequencies, for example, three frequencies are simultaneously received, the mean voltage on the tube 266 may drop at a point in the rotation of the seeker arm 208 to give a false operation of the stop mechanism and printing hammer and a resulting false printing. However, the reception of three different frequencies simultaneously, resulting in the activation of three of the gaseous discharge tubes will cause such a great current through the cathode resistors 232 and 234 as to result in the energization of a normally inoperative vacuum tube 294 through the grid connection 295. Operation of the vacuum tube 294 will cause energization of the electromagnet 298 serially connected through the conductor 296 to the voltage supply for the anode of this tube.

The operation of the electromagnet 298 for preventing the printing of a character in response to a false signal is best shown in Figs. 4 and 6. Fig. 4 illustrates the general mechanical arrangement of the receiver and shows, for example, a motor 74 which, if the receiver is built as a unit with the transmitter as illustrated in Fig. 1, may

be the same motor used for driving the transmitter tone wheels. Through gearing 76 the seeker assembly 206 may be driven through a friction clutch 77. On the same shaft with the seeker assembly 206 is positioned the stop wheel 282 and, it will be noted that even though the motor 74 may run continuously, when the stop mechanism works upon the stop wheel 282 the seeker arm 208 of the seeker assembly will also cease rotation, as previously described, because of the use of the intermediate friction clutch 77. The printing wheel 292 may be mounted on the same shaft as the seeker assembly 206 and the stop wheel 282, but preferably slidably upon a section of the shaft 304 having a square or other non-circular cross section. The printing wheel 292 will consist of two sections, one section 300 bearing on its periphery suitable raised characters for printing operation in response to desired coded signals, as well as a space lug 301, and a second portion 302 bearing a plurality of special identical error-signifying characters shown in Figs. 4 and 6 as being Maltese crosses. The two sections of the printing wheel are separated by an annular depressed portion 306 serving as a slot for a pivoted arm 308 held in a normal position by a spring 309, but movable to a second position upon actuation of an electromagnet 298. When the electromagnet 298 is not actuated, the portion of the printing wheel 300 bearing the characters will be reproduced in response to normal signals will be positioned in alignment with the print hammer 246 and the printing tape 66. However, whenever the electromagnet 298 is energized in response to the simultaneous reception of more than two frequencies, the printing wheel 298 is shifted on the shaft 304 so that the portion 302 bearing the Maltese crosses will be in alignment with the print hammer and tape. Thus, if more than two frequencies are simultaneously received while the printing operation will take place, a special character, such as the Maltese cross will be printed on the tape so that the receiving operator will know that an error has occurred. The printing wheel 292 may, in both cases receive ink from a common ink roller 309 slidable on a shaft 310 with the sliding of the printing wheel.

The general mechanical set-up of the receiver parts is further illustrated in Fig. 5. As there shown the ink roller 309 and its shaft 310 may be supported on the end of a spring-drawn lever arm 312 pressing the ink roller against the printing wheel. The print hammer 246 is pivotally mounted upon a lever 245 pivoted at 316, one end of this lever being controlled by the print magnet 288, as previously described, to move the print hammer 246 toward the tape and printing wheel. Such movement of the lever 245 also releases normally closed contacts 244 which may be actuated in any suitable manner by another portion of this lever. The tape 66 may come from a suitably positioned tape roll 317 and pass through roller guides 318 and 320 between the hammer 246 and the printing wheel 292. It then passes between a tape feed wheel roller 322 and a tape feed idler 324 to outside of the conductor where it may be read. Forward movement of the tape after each printing operation can be effected in any well-known manner, as by the use of an extension 326 on the end of lever 245, operating a ratchet wheel 328 upon its downward movement or upon return of the print hammer to its normal position. A pawl 330 acting on the ratchet wheel 328 prevents backward movement of the tape feed wheel.

While, for the sake of making a clear presentation of the operation of a multiple frequency transmitting system according to the present invention I have disclosed certain specific apparatus which is suitable for carrying out the principles of my invention, it will be obvious to those skilled in this art that many variations, particularly from the mechanical standpoint, but also electrical changes may be made without departing from the spirit and scope of this invention. For example, the particular type of keyboard and keyboard structure to be used are of no particular importance. The specific key-control switch structure shown in Fig. 2 may be varied in detail and, moreover the switching may be done indirectly through relays instead of directly as shown. Other and equivalent key-latching and release mechanisms may be used. While the system has been designed to utilize nine different frequency sources which, in pairs will produce thirty-six different characters, it will be obvious that more-or-less frequency sources could be used, depending upon the number of characters it is desired to use in the final system. Frequency sources other than tone wheels are contemplated and the transmission may be by radio, as illustrated, or be directly wired.

As far as the receiver equipment is concerned, variations may be made, for instance, in details of the seeker assembly. For example, instead of providing one row of spaced contacts circumferentially about the seeker base, a smaller base can be used having two rows of such contacts in which case the rotating seeker arm may be only single ended, bearing on the one end two sets of contact bridges cooperating with two radially spaced, circular slip rings. Where a double-ended seeker arm is used, the angle covered between the two sets of contact bridges can be varied. Particular details of the printing mechanism are of no significance except insofar as they permit a general realization of the principles of the present invention and, moreover, it is not necessary that the received message be printed, but the same may be reproduced in any manner, keeping in mind, however, that in accordance with the present invention the character received in response to any particular frequency combination will be determined by the relative angular position of the rotating seeker arm and the mechanism rotating therewith.

While the invention is particularly applicable to systems in which characters are rotated by different pairs of frequency, it is also possible within the broad principle of the present invention to make the system responsive to combinations of more than two frequencies.

Accordingly, while I have described above the principles of my invention in connection with certain specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of my invention as set forth in the objects and the accompanying claims.

I claim:

1. In an intelligence transmission system wherein the intelligence is transmitted by a combination of frequencies selected from a number thereof, a receiving station having a receiver, filter means connected to said receiver for separating the combination of transmitted frequencies, intelligence reproducing means, variable energy control means between the filter means and the reproducing means and means responsive to the output of said filters for controlling said

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reproducing means to reproduce the intelligence transmitted.

2. A system according to claim 1, wherein the reproducing means controls the energy control means.

3. A system according to claim 1, comprising means whereby the reproducing means at the initiation of its operation cuts off incoming signal energy thereto and at the completion of its operation admits further signal energy.

4. A system according to claim 1, wherein means acting through the energy control means and responsive to sufficient storage of received energy by operating filters initiates operation of the reproducing means and thereby causes the exclusion of further energy in flow from the filters.

5. A system according to claim 1, wherein means controlled by the reproducing means excludes output energy from filter sections in storage operation during reproduction of a signal, but enables entry thereof immediately upon completion of a reproduction of said signal for operation for a succeeding signal.

6. In an intelligence transmission system wherein the intelligence is transmitted by a combination of frequencies selected from a number thereof, a receiver including filter means separating the received signals into channels corresponding to the different frequency sources of the transmitter, selector means having circumferentially spaced contacts, means interconnecting the output of each filter with one or more of said contacts in such a manner that all desired frequency pairs may be derived from said selector means, a rotary contactor engaging said contacts to scan the possible frequency pair combinations, means driving said rotary contactor, means for stopping the rotation of said contactor whenever it engages contacts energized by an incoming frequency pair, and means for determining the received intelligence by the angular position of said rotary contactor.

7. The combination according to claim 6, in which said last means includes a type wheel having characters on its periphery, whose angular position corresponds to the coded frequency combination as determined by the position of the contacts on the selector means, means driving said type wheel in angular synchronism with said rotary contactor, and further means responsive to incoming frequency pairs for reproducing the character on the type wheel as determined by its angular position and the chosen code.

8. The combination according to claim 6, in which the means interconnecting said filter means with said selector contacts comprises a plurality of gaseous discharge tubes each having an anode, a cathode and a grid, conductors respectively interconnecting each frequency channel to the grid of one gaseous discharge tube, and other conductors interconnecting the anodes of said gaseous discharge tubes to said contacts to form frequency-responsive contact pairs, in combination with means responsive to the flow of current through said gaseous discharge tubes for controlling the operation of said rotary contactor.

9. In an intelligence reproducing system adapted to interpret intelligence in the form of coded signals in the form of frequency combinations transmitted, the combination of filter means adapted to separate the incoming signals into individual frequency components, selector means having circumferentially spaced contacts, means

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including a switch interconnecting the output of each filter with one or more of said contacts in such a manner that all desired frequency combinations in accordance with the coded signals may be derived from the contacts on said selector means, a rotary contactor engaging said contacts to scan the possible frequency combinations, means driving said rotary contactor, means for stopping the rotation of said contactor responsive to engagement thereby of contacts energized by an incoming coded frequency combination, means for determining the received intelligence by the angular position of said rotary contactor, and means whereby the contactor by its rotation controls said switch.

10. The combination according to claim 9, in which said last means includes a type wheel having characters on its periphery whose angular position corresponds to the coded frequency combination as determined by the position of the contacts on the selector means, means driving said type wheel in angular synchronism with said rotary contactor, and further means responsive to the incoming frequency combination for reproducing the character on the type wheel as determined by its angular position and the chosen code.

11. In an intelligence reproducing system adapted to interpret intelligence in the form of coded signals as determined by different received frequency pair combinations, the combination of filter means separating the incoming signals into individual frequency components, a plurality of gaseous discharge tubes each having an anode, a grid and a cathode, the number of tubes corresponding to the number of different frequencies used, means connecting the individual outputs of said filter means to the grids of the respective tubes, a seeker assembly comprising a disk provided with a plurality of sequentially spaced contacts of a number corresponding to the number of characters reproducible by the number of frequency pairs obtainable, and a pair of slip rings, and a rotatable seeker arm carrying two sets of spaced contacts, so spaced that one contact of each set moves along the contacts on the disk and the other engages the slip rings, conductors interconnecting the anodes of said tubes to the contacts on said disk, the connections between said anodes and said contacts being so arranged relatively to the sets of contacts on said seeker arm that the outputs from said tubes are paired on said slip rings in all possible combinations, a vacuum tube having an anode, a cathode and a grid, an anode voltage supply means for said gaseous discharge tubes and said vacuum tube, means applying the mean voltage on said slip rings as determined by the position of said seeker arm to the grid of said vacuum tube, means biasing said vacuum tube to be normally conductive, said biasing means being so dimensioned that said tube becomes non-conductive if the mean voltage on its grid as derived from said slip rings falls to a value indicative of the simultaneous appearance on said slip rings of a lowered potential on the anode of two of said gaseous discharge tubes when in conducting condition, means for rotating said seeker arm, normally inoperative stop means for stopping said seeker arm in any one of its contacting positions, means responsive to the non-conductivity of said vacuum tube for actuating said stopping means, and means responsive to the actuation of said stopping means for indicating the intelligence determined by the frequency pair

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combination causing the firing of two of the gaseous discharge tubes and consequent non-conductivity of said vacuum tube.

12. The combination according to claim 11, in which said stop means comprises a toothed wheel rotatable with said seeker arm, a latch adapted to engage said wheel, and an electromagnet for controlling said latch, and in which said actuating means comprises a second vacuum tube having an anode, a cathode and a grid, means connected between the anode of the first vacuum tube and the grid of said second vacuum tube for rendering the latter conductive when the first vacuum tube is non-conductive and vice versa, and means energizing said electromagnet from the anode of said second vacuum tube.

13. The combination according to claim 11, in combination with normally operative latch means holding said seeker arm in a predetermined starting position, and means responsive to flow of current through two of said gaseous discharge tubes for releasing said latch.

14. The combination according to claim 11, in combination with normally operative latch means holding said seeker arm in a predetermined starting position, an electromagnet for releasing said latch means, a second vacuum tube having an anode, a cathode and a grid, means supplying current to said electromagnet from the anode of said second vacuum tube, common means interconnecting the cathodes of said gaseous discharge tubes with the grid of said second vacuum tube, and means biasing said second vacuum tube to render the same conductive only when two or more of said gaseous discharge tubes are conductive.

15. The combination according to claim 11, in which said last means comprises a printer wheel rotatable with said seeker arm bearing a plurality of characters about its periphery, a printer arm movable toward said wheel, printing tape intermediate said printer arm and the periphery of said wheel, and means responsive to the actuation of said stopping means for operating said printer arm.

16. The combination according to claim 11, in which said last means comprises a printer wheel rotatable with said seeker arm, said printer wheel having two sections, one bearing a plurality of different characters about its periphery corresponding to the intelligence to be reproduced and another section bearing a plurality of like characters about its periphery, a printer arm normally positioned opposite to the section of the wheel bearing the different characters, printing tape movable between said printer arm and said printer wheel, and means responsive to the actuation of said stopping means for operating said printer arm, in combination with means responsive to the activation of more than two of said gaseous discharge tubes for shifting said printer wheel so that the section bearing the like characters is opposite to the printer arm.

17. The combination according to claim 11, in combination with normally open switch means intermediate the individual filters and the grids of their respective gaseous discharge tubes, a closing coil for said switch means, latching means normally holding said seeker arm in a predetermined starting position, a pair of normally open contacts actuated to closing position by said seeker arm when in its starting position, means for energizing said closing coil through said contacts, electromagnetic means for releasing said

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latching means, and means responsive to the flow of current in two or more of said gaseous discharge tubes for operating said electromagnet, and in which the means for indicating intelligence includes a printing wheel rotatable with said seeker arm and bearing a plurality of different characters on its periphery, a printing arm cooperating with said wheel, a printing tape intermediate said printing wheel and printing arm, and means responsive to the actuation of said stopping means for operating said printing arm, in combination with means responsive to the operation of said printing arm for interrupting the anode voltage supply of said gaseous discharge tubes and said vacuum tube.

18. The combination according to claim 11, in which the means for rotating said seeker arm comprises a motor and a friction clutch intermediate said motor and seeker arm.

19. A frequency-responsive receiving system comprising, in combination, a plurality of different frequency sources, a corresponding plurality of gaseous discharge tubes each having an anode, a cathode and a grid, means respectively connecting each frequency source to the grid of one of said gaseous discharge tubes, a seeker assembly comprising a disk having a plurality of circumferentially spaced contacts, the number of contacts being equal to the number of different pairs of frequencies possible from the number of frequency sources, and a pair of slip rings, and a rotatable seeker arm carrying two sets of spaced contacts, so spaced that one contact of each set wipes the contacts on the disk and the other engages the slip rings, conductors interconnecting the anodes of said gaseous discharge tubes with the contacts on said disk, the connections between said anodes and said contacts being so arranged relatively to the sets of contacts on said seeker arm, that the outputs from said tubes are sequentially paired on said slip rings in all possible combinations, a vacuum tube having an anode, a cathode and a grid, anodes supply voltage means for said gaseous discharge tubes and said vacuum tube, means applying the mean voltage on said slip rings as determined by the position of said seeker arm to the grid of said vacuum tube, means biasing said vacuum tube to be normally conductive, said biasing means being so dimensioned that said tube becomes non-conductive if the mean voltage on its grid as derived from said slip rings falls to a value indicative of the simultaneous appearance on said slip rings of a lowered potential on the anodes of two of said gaseous discharge tubes when in conducting condition, normally inoperative stop means for stopping said seeker arm in any one of its contacting positions, and means responsive to the non-conductivity of said vacuum tube for actuating said stopping means, whereby the angular position of said seeker arm is indicative of the particular frequency combination applied to said gaseous discharge tubes.

20. In an intelligence transmission system, wherein the intelligence is transmitted by the combination of frequencies selected from a number thereof, a signal station comprising transmitting apparatus including means controlling the selection of combinations of different frequencies corresponding to respective signals, means for receiving and reproducing similar incoming signals, and common driving means for governing the selection controlling means and the receiving and reproducing means.

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21. Apparatus according to claim 20, including means for generating the different frequencies under control of the common driving means.

22. Apparatus according to claim 20, wherein the receiving and reproducing means includes 5 frequency filters for selectively storing and passing incoming signal energy and means under

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control of the reproducing means for governing successive transfers of stored signal energy to the reproducer and enabling reproduction of a signal during the energy storing for a succeeding signal.

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