United States Patent

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[54] RATE CODE DECODING SYSTEM HAVING HIGH- AND LOW-PASS FILTERS

10 Claims, 3 Drawing Figs.

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[51] Int. Cl. H04q 5/00
[50] Field of Search ..... 340/167, 167 A, 171 PF

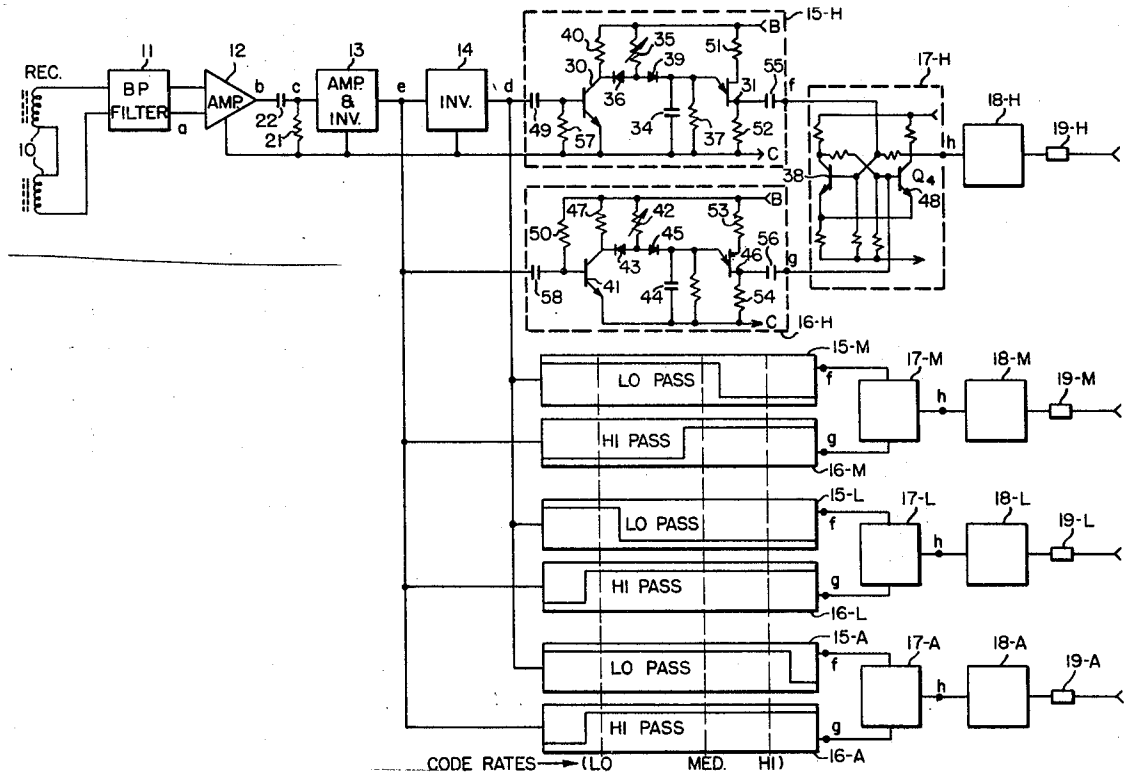
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Attorney—Harold S. Wynn

ABSTRACT: A decoding system has been provided for issuing a control signal in response to an input of one of a plurality of selected code rates. The improvement includes high-pass filtering means for each code rate responsive to the input and producing pulsed output energy when the input is at or exceeds the associated code rate and low-pass filtering means for each code rate responsive to the input and producing pulsed output energy when the input is at or below the associated code rate. Means for each code rate responsive to the associated high- and low-pass filtering means has been provided for producing the control signal when the associated high- and low-pass filters are both alternately producing pulsed outputs.



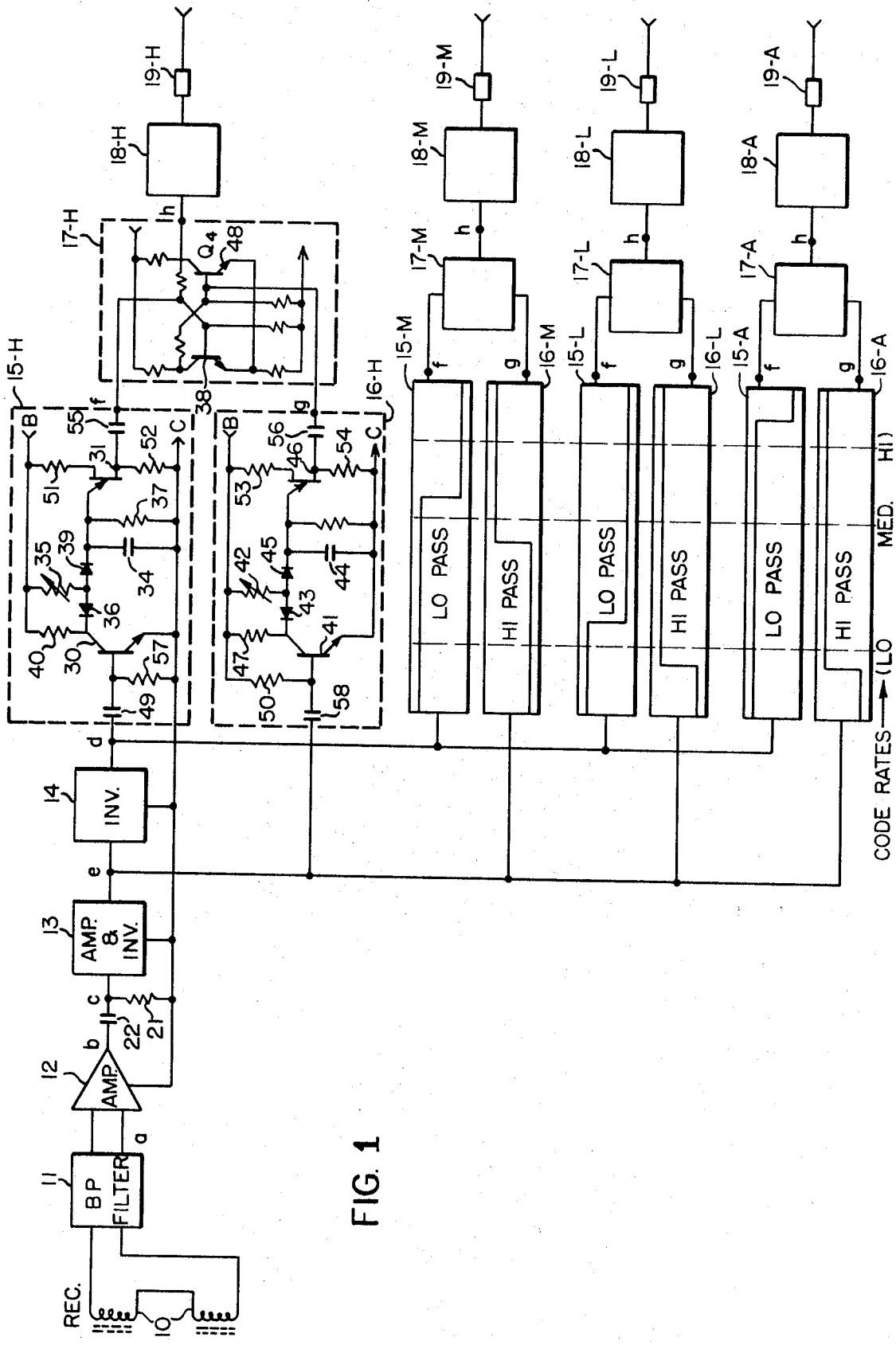

REC.
BP FILTER
AMP.
AMP. & INV.
INV.
LO PASS
HI PASS
CODE RATES (LO MED. HI)

FIG. 1

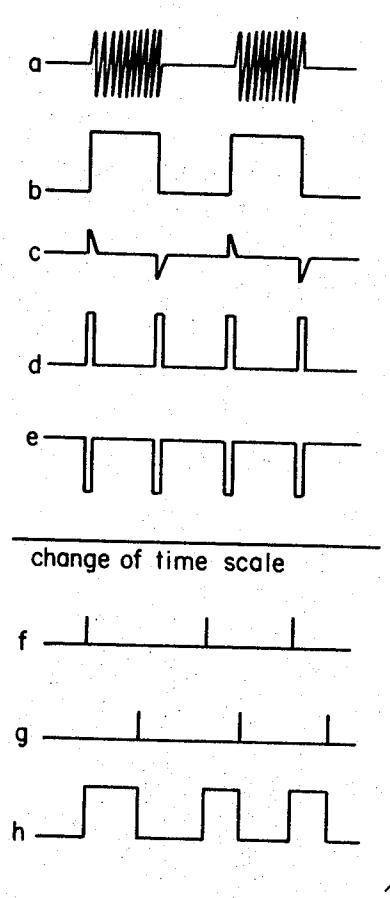

a
b
c
d
e
change of time scale
f
g
h

FIG. 2

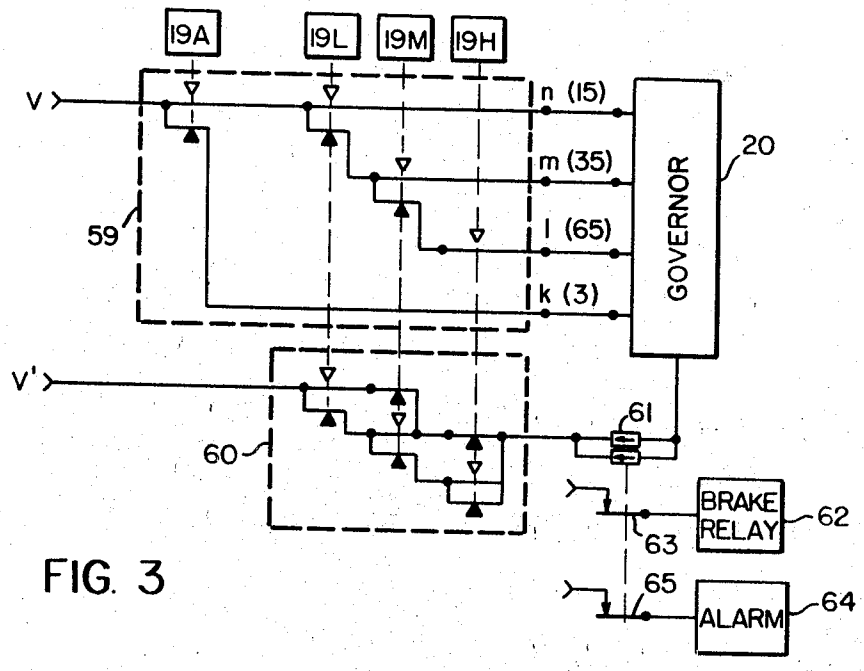

19A
19L
19M
19H
V
V'
n (15)
m (35)
l (65)
k (3)
59
60
61
GOVERNOR
20
BRAKE RELAY
62
63
65
ALARM
64

FIG. 3

RATE CODE DECODING SYSTEM HAVING HIGH- AND LOW-PASS FILTERS

BACKGROUND OF THE INVENTION

In railway signaling and communications it is sometimes necessary to communicate information via coded track circuits to train carried apparatus for controlling the mode of operation of railroad vehicles. Code transmitted by the track circuits are generally signals of different frequency rates, which rates must be received by the train carried apparatus and transmitted to control devices thereon. It is essential therefore that the proper code rate is detected and transmitted to the appropriate control device. Oftentimes filters are used which will respond only to particular frequencies or ranges of frequencies and transmit signals that indicate the presence of a particular code rate on the track circuit. However, it is essential that only one of each of these frequencies is detected and filtered at one time.

In the speed control of a locomotive, signals from the decoding system may be transmitted to indicator lights for observation by the operator of the vehicle or may in turn be transmitted to an automatic speed governing device. If more than one of the lights or control devices is actuated simultaneously, then a conflict will occur which may call for an automatic braking or at least a maintenance of the most restrictive signal. In speed control, there may be one or more code rates. A simple system would have one code rate which means proceed and no code which means stop. Some systems require 5 or 6 code rates or more. Three ranges of frequencies for providing the signals necessary for efficient control of the vehicle were used in this case to illustrate the idea. These frequencies can be called low, medium and high ranges corresponding to the anticipated speed of the vehicle. When a low-frequency range signal is received by the decoding apparatus, a filtering device responsive only to that range of frequencies will react and produce an output signal which will be coupled to either indicator light or an automatic speed governing device. If a higher speed is permitted, the speed range signal is transmitted over the track rails and is interpreted by a second filter in the decoder responsive only to that particular range of frequencies. In order to permit these vehicles to exceed the low range speed, it is essential to deactivate the low range filtering device and activate the midrange so that the low aspect will not be transmitted to the control apparatus. In order to do this, it would be necessary to provide a band-pass filtering means for each range of speed which will only respond to a particular frequency plus and minus some deviation relative to that particular frequency different from the other frequency ranges.

Ordinary inactive filtering apparatus can be provided for producing these low, medium and high range band passes. However, it has been discovered that active filtering elements provide the cut off frequencies of the ranges more efficiently. These systems, however, are rather costly as such there is generally complicated apparatus involved. In addition, each filter must be checked as to its operability before the vehicle can be permitted to accelerate to the next speed range or in any event change from a speed range which it has been operating in. Previously, checking relays which are usually of the safety type are used to provide a fail-safe aspect to the signaling system, however, they are also expensive and rather cumbersome. In order to avoid these shortcomings, the system of the present invention has been provided with a unique checking system for assuring that only one band pass or frequency range is detected at any one time, and that nonvital relays may be used to check that only one of the filters is activated at any one time.

It is therefore an object of the present invention to provide a system for overcoming the foregoing problems.

It is another object of the present invention to provide a simplified system for receiving different code rate signals and providing discrete outputs for each of the code rates received.

It is another object of the present invention to provide a system for checking the operability of the various devices for each of the code rates received.

SUMMARY OF INVENTION

A decoding system for issuing a control signal in response to an input of one of a plurality of selected code rates has been provided wherein the improvement comprises high pass filtering means for each code rate responsive to the input and producing pulsed output energy when the input is that or exceeds the associated code rate and low-pass filtering means for each code rate responsive to the input and producing pulsed output energy when the input is at or below the associated code rate. Means for each code rate responsive to the associated high and low-pass filtering means has been included for producing the control signal when the associated high- and low-pass filters are alternately producing pulsed outputs.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings while its scope will be pointed out in the appended claims.

FIG. 1 is a partial schematic, partial block diagram of the decoding apparatus of the present invention.

FIG. 2 is a time scale diagram showing the various signals as transmitted through the present decoding apparatus.

FIG. 3 is a schematic drawing of the checking circuit of the present invention as connected to speed governing apparatus and the like.

DESCRIPTION OF PREFERRED EMBODIMENT

The system of the present invention follows generally a pattern of operation as set forth below.

Receiver coils **10** carried by the vehicle pick up energy via inductive coupling to the rails. This energy is generally in the form of an alternating current carrier modulated by one of the codes. The modulated carrier is filtered by band-pass filter **11** which provides a signal at its output to amplifier **12** in an anticipated range of frequencies contemplated for the system. The amplifier **12** also demodulates the signal. The respective outputs *c* and *d* of amplifier inverter **13** and inverter **14** form the input to the code filter section of the apparatus.

In the present invention, there are three ranges of speed anticipated for control and therefore there are three band-pass filters for each range respectively. These band-pass filters are combinations of low- and high pass filters **15** and **16** respectively. Each band-pass filter has associated with it a letter L, M and H for signifying low, medium and high range speeds respectively, which will be appended to the number associated with the high- and low-pass filters when necessary. There is also a fourth filtering device including high- and low-pass filters **13** and **14** with the legend A appended thereto. The any speed filter is a band-pass filter with a frequency range extending from the lowest to the highest anticipated frequencies to be received by this apparatus. This, as will be explained later on in the disclosure, is used as a checking device along with the other checking apparatus of the present invention.

Outputs from each responsive low and high pass filters are transmitted to flip-flop **17** associated with the particular range of frequencies. The flip-flop **17** being a bistable device requires an input at each input terminal *f* and *g* alternately in order for it to produce a pulsed output at *h*. This pulsed output drives relay driver **18** which in turn drives its relay **19**. The relays **19** (A, L, M, H) as shown in FIG. **3** may each control a number of contacts which in turn operate inputs to a speed governor **20** which shall be explained later on in the discussion. Each of the flip-flops, relay drivers and relays **16**, **17** and **18** respectively have also associated therewith a letter L, M, H and A which describe what speed range the particular device is associated with.

FIG. 2 shows a number of waveform diagrams which waveforms appear as voltages at various terminals of the apparatus. These waveforms are used to explain the operation of the system more clearly. As previously mentioned, the cab signal energy is picked up from the rails by receiving coils 10 and pass through band-pass filter 11 the output of which is shown at FIG. 2 waveform *a*. this signal is then passed through amplifier 12 and its output is shown at FIG. 2 waveform *b*. The output of the amplifier 12 is a square wave at the code rate frequency being transmitted to the train from the wayside. The resistor-capacitor network 21, 22 at *c* produces positive and negative pulses at twice the code rate corresponding to the leading and trailing edges of the waveform at *b*. The positive pulses at c are inverted by amplifier-inverter 13 and mixed with the negative pulses and amplified as shown at *e*. These same pulses are shown inverted by inverter 14 as shown at *d*. Since these pulses are twice the code rate, the time required to determine what the code rate is greatly reduced. The pulses are all the same amplitude and width and only differ in their repetition rate when the code rate changes. That is, the time interval between pulses is variable. These signals *d* and *e* are the outputs of amplifier-inverter 13 and inverter 14 respectively and are the respective inputs to low- and high-pass filters 16 (H, M, L, A) and 15 (H, M, L, A). Transistor 30 and unijunction transistor 31 are arranged to form a low-pass filter and transistor 32 and unijunction transistor 33 together form a high-pass filter. They are so adjusted as to form together a band-pass filter centered at the desired code rate frequency.

The low-pass filter 15H works in the following manner: transistor 30 is a switch that is normally open. Capacitor 34 charges up from energy supplied by a biasing voltage B through resistor 35 and diode 39. Resistor 37 constantly tries to bleed off or discharge capacitor 34 but the size is such relative to resistor 35 that capacitor 34 is charged faster than it is discharged and the unijunction transistor 31 fires when a specific or triggering voltage appears on capacitor 34. This completely discharges capacitor 34 and it again starts to charge. Each time unijunction transistor 31 fires, a pulse is produced as shown on FIG. 2 at waveform *f*. It will be noted at this time that waveforms *f*, *g* and *h* are of a different time scale relative to the time scale of the waveforms *a* through *e*. Because of the different adjustment of the various high- and low-pass filters, the outputs *f*, *g* and *h* will appear to be somewhat asymmetric. The pulses at *f* turn on transistor 38 of flip-flop 17H and transistor 48 is off. The flip-flop 17H stays in that state as long as pulses appear only at output *f*.

When pulses due to a code rate appear at low-pass filter 15 input, transistor 30 is turned on. When transistor 30 is on, capacitor 34 cannot charge since there is a low resistance path from resistor 35 through diode 36 and transistor 30 (now a closed switch) to the circuit common C. Diode 39 prevents capacitor 34 from being discharged through the transistor 30 when it is on. If the pulse repetition rate is high enough so that the time between pulses is not sufficient for capacitor 34 to charge up, transistor 31 does not fire and the pulses are not produced at waveform *f*. In this case, resistor 35 is set to cut off frequencies at a point a little above the highest anticipated code rate. Diode 36 isolates resistor 35 from the load resistor 40 for transistor 30.

In the high-pass filter 16H, transistor 41 is normally on. There is a low resistance path from bias B, resistor 42 through diode 43 and transistor 41 to common C so that capacitor 44 is not charged up. That is, transistor 41 is a normally closed switch. When pulses due to a code rate appear at the high pass 16H filter input *e*, transistor 41 is turned off. While transistor 41 is off, capacitor 44 can charge up. Diode 45 prevents the discharge of capacitor 44 between pulses. If the pulse repetition rate is high enough so that transistor 41 is off for a sufficient time, capacitor 44 may become charged sufficiently to trigger unijunction transistor 46. Firing the unijunction 46 produces a pulse as shown at *g*. In this case, resistor 42 is set for a cut off point to be a little below the highest anticipated code rate. Diode 43 isolates resistor 45 from the load resistor 47 for transistor 41.

If the code rate is such that it is in the pass band formed by the high and low filters 16H and 15H, there will be pulses produced at the respective outputs *g* and *f* as shown.

The flip-flop 17H will change state when a pulse at *g* turns on transistor 48. The next pulse at *f* will in turn activate transistor 38, etc. The flip-flop 17H pulsed output is shown at *h*. Relay driver 18H responsive only to an alternating current signal will produce an output for energizing relay 19H when pulses appear alternately at the output *h* of flip-flop 17H. From the above description it can be seen that each high- and low-pass filter checks the respective high and low side of the input signal independently. By this means the signaling system may be actually monitored so that signals not within the band pass of the high- and low-filters for the associated code rate will not produce the alternating inputs to flip-flop 17.

In the case of a medium code rate, the operation will be the same except that the only filters 15M and 16M respectively would produce pulsed outputs.

The any rate decoder 15A through 19A has its low pass section 15A set for the highest code rate and its high pass section 16*a* set for the lowest code rate. Any code rate between these extremes will produce pulses and operate the relay 19A.

As described previously, transistor 30 is biased at a cut off state by the coupling of the base of transistor 30 to the common C via a resistor 57. Positive pulses produced at *d* are coupled through capacitor 49 and provide sufficient energy to drive transistor 30 to a conductance state and prevent charging of capacitor 34 during this conduction time.

Resistor 50 couples positive energy from bias B through to the base of transistor 41 for maintaining the transistor 41 in a conductance state preventing the charging of capacitor 44. Capacitor 58 couples input pulses at *e* to the base of transistor 41. When negative pulses appear at terminal *e*, they drive transistor 41 to a cut off state so that capacitor 44 can be charged up during the cut off time.

Resistors 51 and 52 are connected in low-pass filter 15H as shown for biasing and loading respectively as are resistors 53 and 54 in high-pass filter 16H. Capacitors 55 and 56 of the high- and low-pass filters couple the firing pulses of the filters to the flip-flop.

Relays 19H, M, L and A control contacts which provide speed command to the speed governor 20 and are shown in FIG. 3. The contacts controlled by the previously mentioned relays are represented by triangles in FIG. 3. These triangles when pointing down indicate a front contact and with apex up indicate a back contact, the unshaded triangles represent normally open contacts while the fully shaded contacts represent normally closed contact points. There are two sets of contacts to be considered in this figure. One set 59 includes contacts controlled by relays 19A, L, M and H while contact set 60 includes contacts only controlled by relays 19L, M and H. Outputs *k*, *l*, *m* and *n* of contact set 59 control the inputs to the speed control governor 20. For the sake of example, output *k* represents a 3 mile per hour speed which is essentially a stop signal for the railroad vehicle, while outputs *l*, *m* and *n* represent 65, 35 and 15 mile per hour speed ranges respectively. The contact set 60 supplies energy to under speed relay 61 which is a checking relay. This relay is energized only when the train is under the speed called for by the code rate being received on the train from the wayside.

In order to restrict a railroad vehicle to a speed of up to 35 miles per hour, it would be necessary to provide an input signal to the receiver 10 of the medium range code rate and provide a voltage V to terminal *m* of contact set 59 via the decoding apparatus of the present invention. This would be provided by an energization of relay 19M and relay 19A. A voltage V applied to contact set 59 must be routed via 19A front contact, 19L back contact, and 19M front contact to terminal *m*. It is therefore necessary to energize relay 19A so that the voltage V will be routed over the front contact of relay 19A. In addition, relay 19L must be deenergized so that voltage V may pass over its normally closed back contact reaching the front contact of relay 19M.

A second voltage signal applied at the input of contact set **60** is used for checking the operation of the relays **19L**, M and H. These contacts provide a one and only circuit to under speed relay **61**; that is, if more than one of the relays **19L**, M or H are energized simultaneously, then the relay **61** cannot be energized. If, for example, relay **19L** and M are energized at the same time, energy from V' will be routed over a closed front contact of relay **19L** and then to open back contact of relay **19M**, open-circuiting the energy from V' to under speed relay **61** and deenergizing same. The same thing would occur if relays **19M** and H were simultaneously energized because both sets of back contacts of the relays **19M** and H would be open and both front contacts would be closed causing an open-circuit to under speed relay **61**.

Relay **19A** is included in order to provide a check on the other decoders. If no code rate were being transmitted, the any rate relay **19A** would be deenergized and terminal *k* corresponding to a 3 mile per hour or stop condition would be activated. With no code rate, the low-pass filter **15H** would be producing pulses at output *f*.

If diode **43** is open-circuited in high-pass filter **16H**, there would be an erroneous signal generated at output *g* because the transistor **41** would not properly be regulating the charging of capacitor **44**.

With pulses at both outputs *f* and *g*, the flip-flop **17H** would be pulsing and consequently relay **19H** would be energized. Since relay **19A** is down, no current can be carried over its front contact to output **1**. The any rate relay **19A** therefore checks to assume that some code rate is present before a stop signal is removed from the governor and consequently checking the operability of the other filters.

The under speed relay **61** maintains a brake relay **62** energized by a normally closed front contact **63**. The code relay **62** is slow release and when contact **63** is open, 2-½ seconds must elapse before it will deenergize and activate the brakes of the vehicle. An alarm circuit **64** becomes energized giving visual or audible indication of an overspeed condition when front contact **65** of relay **61** becomes open-circuited. If an overspeed condition exists, the alarm circuit **64** will provide the warning and the operator of the vehicle has the 2-½ second delay built into brake relay **62** to reduce the speed of the vehicle by some appropriate action. In addition to providing the appropriate warning and energizing brake application, under speed relay in the way it is connected to contact set **60** provides a check on the operability of the relays **19A**, L, M and H and then associated filtering networks.

There has been shown therefore a decoding system for providing control signals in response to inputs of various selected code rates with improvements including high- and low-pass filtering means for each code rate responsive to the one of the various code rates for producing pulsed output energy when the input is at a band pass frequency set up by the associated high- and low-filtering means. Means responsive to the associated high- and low-pass filtering means for each code rate for producing the control signal when the associated high- and low-pass filters are both alternately producing pulsed outputs. There has also been provided a safety checking circuit utilizing extra contacts of a set of nonvital output relays which provide fail-safe signaling to a speed governor when any two or more of the output relays are energized simultaneously. In addition to the safety features and efficiency of the system, a more efficient system has been provided utilizing the advantages of active solid-state filtering devices.

While there has been described what at present is considered to be the preferred embodiment of the present invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is therefore aimed in the appending claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. A decoding system for providing a control signal in response to an input of one of a plurality of selected code rates wherein the improvement comprises:

high-pass filtering means for each code rate responsive to the input and producing pulsed output energy when the input is at or exceeds the associated code rate;

low-pass filtering means for each code rate responsive to the input and producing pulsed output energy when the input is at or below the associated code rate; and

means for each code rate responsive to the associated high- and low-pass filtering means for producing the control signal when the associated high- and low-pass filters are both alternately producing pulsed outputs, whereby the input is alternately checked for compliance with the constraints of the high- and low-pass filtering means.

2. The decoder of claim **1** wherein said high- and low-filtering means include:

timing means associated with each filter, selectively adjusted for providing a triggering level, in accordance with the duration of spaced intervals between said pulsed inputs; and

output gating means responsive to the triggering level signal for producing the pulsed output energy.

3. The decoder of claim **2** wherein the timing means provides the triggering level at different times relative to the duration of the spaced intervals between said pulsed inputs and relative to each other timing means.

4. The decoder according to claim **2** wherein said timing means includes:

charging means for storing a biasing signal to the triggering level at a preset rate during the spaced intervals of said pulsed outputs.

5. The decoding system of claim **2** wherein the timing means associated with said low pass filtering means includes:

normally open input switching means responsive to the input operative for shunting the charging means and bypassing the storing of the biasing signal in accordance with the pulsed input code rate, thereby inhibiting the occurrence of the triggering level when the code rate exceeds the preset rate of the charging means.

6. The decoder according to claim **5** wherein said normally opened input switching means includes, a transistor biased to a nonconductance state, having its collector-emitter circuit in shunt with said charging means and its base responsive to said pulsed input energy for driving said emitter-collector circuit to a conductance state and shunting said charging means.

7. The decoder of claim **2** wherein the timing means associated with said high-pass filtering means comprises:

normally closed input switching means responsive to the input shunting the charging means and bypassing the storing of the biasing signal and operative for opening the shunt across said charging means in accordance with the pulsed input code rate thereby permitting the triggering level to occur when the code rate exceeds the preset rate of the charging means.

8. The decoder according to claim **7** wherein the normally closed input switching means includes a transistor biased to a conductance state, having its collector-emitter circuit in shunt with said charging means and its base responsive to the pulsed input energy for driving the emitter-collector circuit to a nonconductance state.

9. The decoder of claim **2** wherein the output gating means includes: semiconductor switching means having a conductance state responsive to said charging means for periodically producing the pulsed output energy each time the charging means achieves the triggering level of said conductance state.

10. The decoder of claim **1** wherein said means for each code rate comprises, bistable means having an input to each stable state for receiving the pulsed output energy from the associated high- and low-filtering means and operative for producing the control signal only when each input of said bistable means receives said pulsed output energy alternately from each associated high- and low-pass filtering means.