United States Patent

Randoing

[15] **3,705,353**

[45] **Dec. 5, 1972**

[54] **APPARATUS FOR THE TREATMENT OF INFORMATION SIGNALS**

[72] Inventor: **Jean-Martial Randoing,** Boissise-le-Roi, France

[73] Assignee: **Centre National D'Etudes Spatiales,** Paris, France

[22] Filed: **July 13, 1970**

[21] Appl. No.: **54,142**

[30] **Foreign Application Priority Data**

July 16, 1969 France.....6924195

[52] **U.S. Cl.**.....**325/42,** 178/66 R, 178/69.5 R, 179/100.2 K, 325/30, 325/65, 325/113, 179/100.2 S

[51] **Int. Cl.**.....**H04l 27/10,** G11b 15/52

[58] **Field of Search**....179/100.2 S, 100.2 K; 325/41, 325/42, 45, 47, 30, 58, 113, 115, 320, 325; 178/69.5 R, 66 R

[56] **References Cited**

UNITED STATES PATENTS

3,571,526	3/1971	Stockwell	179/100.2 S
3,233,181	2/1966	Calfee	178/66 X
3,464,019	8/1969	Wilkinson, Jr.	178/66 X
3,404,229	10/1968	Downey et al.	325/320 X

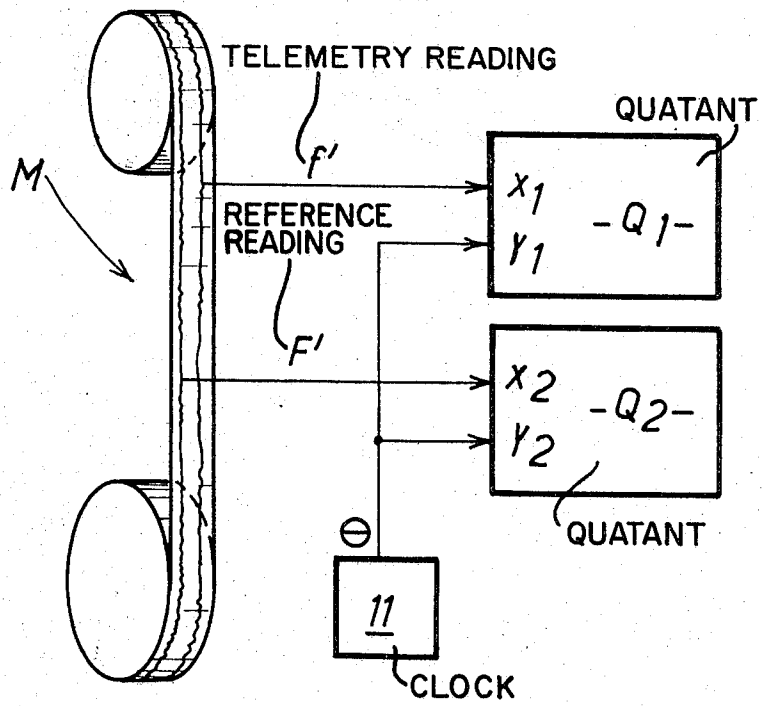
Primary Examiner—Robert L. Richardson

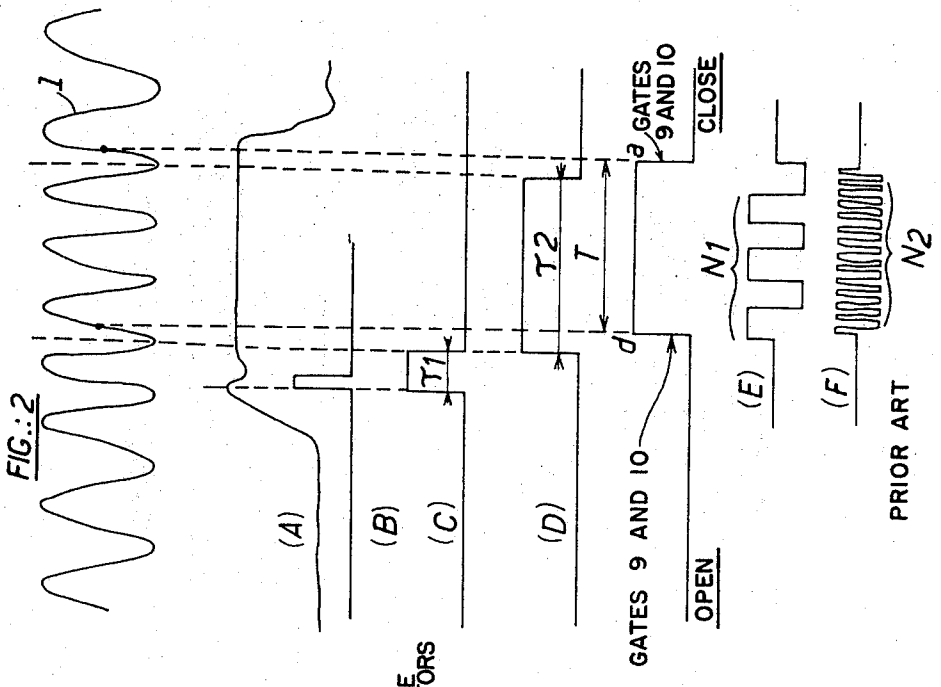
Attorney—Brufsky, Staas, Breiner & Halsey

[57] **ABSTRACT**

The processing of an information carried by a frequency with the object of digitizing it is performed along the so-called "quasi-constant" system used in PFM type telemetric data analysis. Two like but distinct circuits each operating in accordance with the "quasi-constant" system are used — the recorded information signal and a fresh reference frequency delivered by a clock are respectively applied to the two inputs of one of these circuits, whereas the recorded reference signal and the same fresh reference frequency as above are respectively applied to the two inputs of the other of these circuits.

3 Claims, 4 Drawing Figures




FIG.: 2
1
(A)
(B)
(C)
(D)
T1
T2
T
a
d
GATES 9 AND 10
CLOSE
OPEN
GATES 9 AND 10
N1
N2
(E)
(F)
PRIOR ART

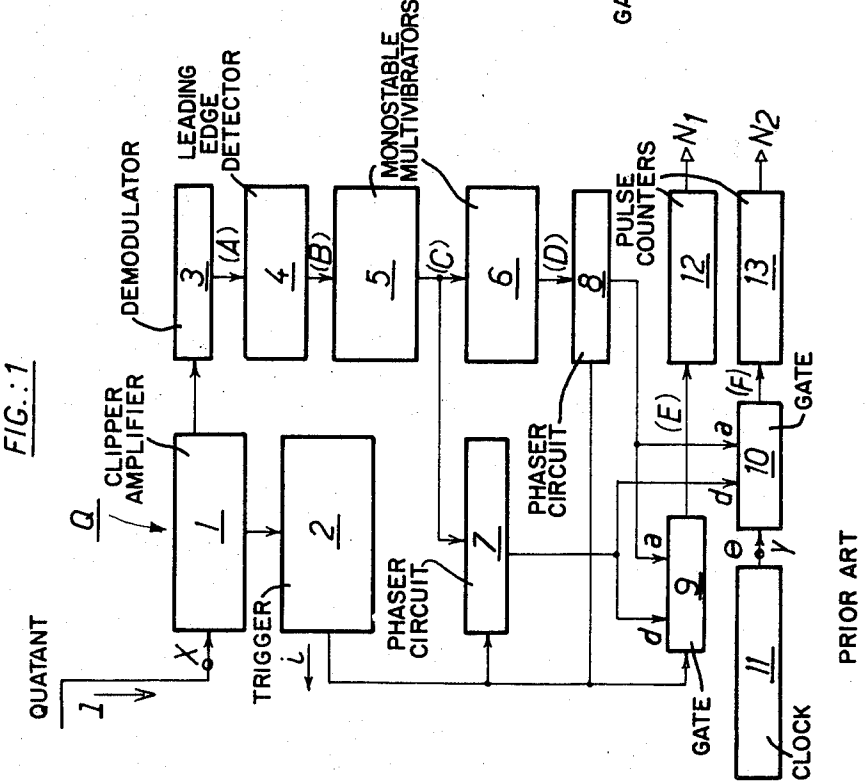

FIG.: 1
QUATANT
Q
CLIPPER AMPLIFIER
DEMODULATOR
LEADING EDGE DETECTOR
MONOSTABLE MULTIVIBRATORS
PULSE COUNTERS
PHASER CIRCUIT
TRIGGER
GATE
CLOCK
1
2
3
4
5
6
7
8
9
10
11
12
13
X
i
(A)
(B)
(C)
(D)
(E)
(F)
N1
N2
a
d
e
PRIOR ART

FIG.: 4

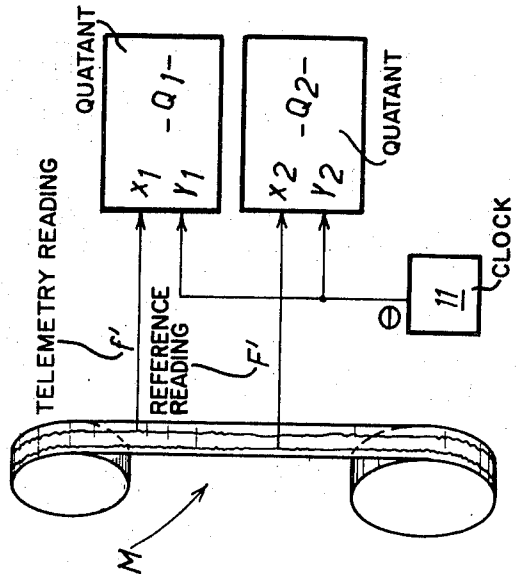
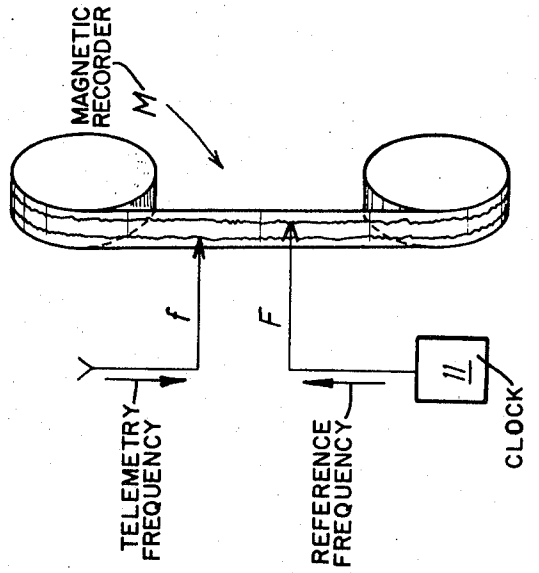


FIG.: 3



PRIOR ART

APPARATUS FOR THE TREATMENT OF INFORMATION SIGNALS

The present invention concerns the processing on a digital computer of a frequency carried information which is digitized that is translated from a voltage into a number which can be recorded in electronic multivibrators or stored on a magnetic tape.

More precisely, the present invention uses a digitization method which is derived from a known process which will be named hereafter QUATANT, but which is devised in order to neutralize the effects of flutter or distortion in the play-back of a previously recorded frequency and to reduce noises from any source. It is known that the QUATANT process is currently used with regard to the treatment of weak signal telemetries of the PFM (Pulse Frequency Modulation) type coming from satellites or other machines. It will be described briefly below, but it will just be recalled now that it uses a device delivering two numbers: first, a time measure represented by a train of impulses coming from a clock whose period is of the order of one microsecond and corresponding to a whole number of half-periods of the information signal; second, a number of ascending (or descending) passages of the carrier during this same time. A computer reckons these two numbers and derives the average period of the measurement, the latter being the period of the clock in the ratio of the two numbers in question.

A theoretical study shows that the best knowledge of the error by which the measurement is affected is had when the integration time does not depend on the measured frequency, but is constant. The principle of synchronization of the telemetry on the passages through zero does not meet this condition but comes close to it, (whence the designation of "quasi-constant" and its contraction in QUATANT).

The QUATANT device gives satisfactory results in instantaneous measurements, operating on the information signal itself upon reception. However, unavoidable difficulties arise when the measurement is made later at play-back of the recorded signal on a magnetic tape, because of the flutter due to speed variations of the magnetic tape and other disturbances or irregularities during unwinding which produce an effect that could be called pleating on the frequencies of the signal: therefore, there is a distortion of the frequency compared to the recorded frequency on the magnetic tape.

Thus, one runs into the following systematic inconvenience the QUATANT device: the play-back frequency on the magnetic tape is found subjected to flutter and suffers a pleating effect, while the digitizing or reference frequency is not subjected to the flutter of the magnetic recorder, due to the fact that it is generated on the spot at the moment of measurement; it comes directly from a quartz clock which is placed beside the magnetic recorder. Consequently, the QUATANT device will give an erroneous measurement: the quotient of a frequency which is tainted with flutter by another frequency which is not.

It has already been proposed to alleviate this inconvenience by recording the reference frequency at the same time as the telemetry signal and on the same magnetic tape but on different tracks. The reference frequency thus recorded will later serve in the counting

instead of the usual clock of the QUATANT device and, at the time of play-back, the recordings will both be equally affected by flutter: no doubt the error will be found reduced due to this fact but nevertheless not eliminated, and it is moreover indeterminable so that it is impossible to apply the necessary corrections.

Moreover, the reference frequency generally is not high enough to serve suitably for counting. If one wants to benefit from a satisfactory definition, it is necessary to have, for example, a thousand sinusoid arcs of the clock frequency per sinusoid arc of the information frequency: for a PFM telemetry signal which would be from **5** to **15** kilocycles one would have to have recourse to a reference frequency of **5** to **15** megacycles, which is unthinkable at the present time, when it is known that the ranges of bandwidth of magnetic tapes are of the order of several only a few megacycles for the most sophisticated and expensive magnetoscopes. In any event, such a way of proceeding is precluded since, for economic reasons, recordings are made at such that the bandwith of the magnetic recorder is just higher than the bandwidth of the telemetry information. Having a frequency a thousand times higher is therefore out of the question.

It was also thought of using a reference frequency of the order of 20 kilocycles and of multiplying it, but that proved illusionary, for the multiplication of a frequency is a very delicate operation when the frequency is not absolutely stable, and one could wind up with extremely complex frequency multipliers. If this crude solution could be perhaps adopted under certain conditions for a given satellite and with apparatuses of excellent quality, it must be categorically excluded when one has to deal with ten or so different satellites, in addition to rocket probes or balloon probes. As a matter of fact, a "standard" of frequency does not exist; moreover, experience shows that in the receiving stations the recorded frequencies are highly deteriorated for varying reasons: magnetic recording is a technique which demands great mastery on the part of the operator as it is subject to all kinds of hazards and to deteriorations of an electronic source, due to the instability of reference frequencies of an electronic source, due to the instability of reference frequencies (the latter are quite often unusable because their level is either too weak or too strong, or because there are comments on a side track that pass over the reference frequency, or even because, close by, the level is too strong, or still because the apparatus was jostled, etc.).

The present invention copes with the problem of flutter from a radically different viewpoint in order to arrive at a solution that is both simple and of high fidelity. The basic idea of the present invention is to consider the reference frequency no longer as an accessory for the treatment of the telemetry signal but as a main signal on the same level as the latter. In other words, the QUATANT process will be duplicated and applied on the one hand conjointly to the telemetry signal which is recorded and to a clock frequency as usual, and, on the other hand, in an independent manner, conjointly to the reference signal that is recorded and to the same clock frequency.

One will thus have recourse to QUATANT devices which are completely separate, were it not for the fact that they receive a like clock frequency, one of the

QUATANT devices being subjected to the telemetry signal and the other one to the reference signal, both being recorded on the same tape. Since the clock that delivers the digitizing frequency is common to the two QUATANT devices, the period of each of the two informations measured with the same clock is recovered. Since both of these informations are tainted with the same flutter and since they are measured with the same clock, the ratio of the two informational frequencies will permit, with all the desired precision, finding the telemetry frequency, knowing the frequency of the recorded reference signal.

In the drawing:

FIG. 1 is a block diagram of a prior art QUATANT device;

FIG. 2 represents the signals at various points of this device;

FIG. 3 illustrates diagrammatically the prior art conjoint recording of the signals on a magnetic tape; and

FIG. 4 illustrates likewise the application of the present invention.

In referring to FIGS. 1 and 2 of the drawing, it will be recalled that the know QUATANT device Q, to whose input X is applied the telemetry or information signal I having as carrier a frequency of PFM type, comprises essentially:

a clipper amplifier 1 that is subjected to the telemetry signal I and followed on the one hand by a trigger 2 or threshold decision circuit which delivers an impulse *i* at each passage of the carrier through zero, and, on the other hand by a demodulator 3 which is itself followed by a leading edge detector 4;

a logical control chain which comprises a first mono-stable multivibrator 5 tripped by the synchronization impulse emitted by the leading edge detector 4 (in the instance where one is not dealing with the PFM but with a continuous frequency, one can dispense with elements 3 and 4 and subject the mono-stable multivibrator 5 directly to an external synchronization signal) and a second mono-stable multivibrator 6 tripped by the trailing edge of the impulse coming out of 5. These two mono-stable multivibrators 5 and 6 are respectively associated with phaser circuits 7 and 8 which otherwise receive the zero passage impulse i for the "start" *d* and "stop" *a* control of two gates 9 and 10, gate 9 receiving the zero passage impulses i;

a clock 11 operating on, say, 10 megacycles and delivering, to another input Y and through the gate 10, the digitizing frequency of period θ;

two impulse counters 12 and 13 serviced by the gates 9 and 10 respectively and consequently started up and stopped simultaneously the control signals *d* and *a* that are delivered by the mono-stable multivibrators 5 and 6 after having been phase equalized at 7 and 8 as the information signal passes through zero.

In effect, it will be noted that the return of the first mono-stable multivibrator 5 to the resting position defines the "start counting" *d*. The delay which is introduced is adjusted so as to begin the counting only when the frequency of the telemetry under consideration is stabilized. For its part, the trailing edge of the pulse issuing from the second mono-stable multivibrator 6 defines the "stop counting" *a* and, as previously noted, the delay is adjusted in such a way as to stop the counting ahead of the defects which can affect the end of the telemetry or as a function of the chosen time of integration.

It can be seen, finally, that counter 13 counts a number N2 of impulses coming from clock 11 during the measuring time T which separates start *d* from stop *a* at gate 10 and which corresponds to a whole number of half periods of the information signal, while, on the other hand counter 12 counts number N1 of ascending passages through zero of the carrier during the same time T. The two counters are re-set to zero before any new counting.

The QUATANT device which has just been described thus furnishes the two numbers N1 and N2 which are supplied to a suitable computer, giving the mean period of the telemetry: θ. N1/N2.

As was mentioned in the above introduction, this result is tainted by error due to flutter if the information signal I is read on a magnetic recorder and is consequently subjected to distortions, while clock 11 remains unaffected.

This defect, even though abated, still holds nonetheless if the reference signal coming from the clock was recorded at the same time and on the same magnetic tape as the information signal, as is shown diagrammatically in FIG. 3 where *f* indicates the telemetry frequency and F the reference frequency, the magnetic recorder being at M and *f* and F being recorded on two different tracks of the tape. In this case, with the diagram of the QUATANT device Q of FIG. 1, the information signal I at input X would be the recorded telemetry signal *f* and the clock signal at input Y would be the recorded reference signal F, both being equally affected by flutter and becoming respectively f' and F' when read from the tape.

In accordance with the present invention, one procedes in an entirely different manner in that one uses two QUATANT devices Q1 and Q2 (see FIG. 4), each one analogous to the preceding device Q. One of these devices, Q1, receives the recorded signal *f'* as information signal (corresponding to I in FIG. 1), at its input XI, while the other device Q2 receives the recorded signal F' at its input X2 in the same way. A same clock 11 is connected to the inputs Y1 and Y2 of the two devices Q1 and Q2.

As was explained above regarding FIG. 1, the QUATANT system allows the calculation of the information frequency which is proportional to the ratio of the two numbers N1 and N2, the proportionality factor being the period θ of the clock signal.

The lay-out of the invention which is illustrated in FIG. 4 makes a knowledge of this proportionality factor useless and yields as output of Q1 and Q2 respectively:

$$1/f' = \theta.N1/N2$$

$$(1/F') = \theta.(N'1/N'2)$$

From which θ is eliminated in making the ratio

$$(F'/F = N1/N2 \cdot N'2/N'1.$$

Since the flutter affects *f* and F in the same ratio

$$F'/F = f'/f$$

and since F is known, it is easy to calculate *f*:

$$f = F.f'/F' = F.N2/N1 \,.\, N'1/N'2.$$

It will be convenient to choose F as large as possible so that the integration periods (T in FIG. 2) of the two QUATANT devices Q1 and Q2 may be as close as possible.

In the subjoined claims, the term "QUATANT device" will be taken to mean the prior art device designed and operating as described above with reference to FIGS. 1 and 2.

It is claimed:

1. An apparatus for the processing of a frequency-carried information signal and a reference signal both recorded on a same support subject to distortion at playback of recorded data arising from flutter or the like, comprising:

a first QUATANT device (Q1) having an information signal input (X1) and a reference signal input (Y1),

a second QUATANT device (Q2) having an information signal input (X2) and a reference signal input (Y2), and cooperatively associated with said

first QUATANT device to operate conjointly therewith,

means for picking-up from said support said information signal (f') and applying the same to said information signal input (X1) of said first QUATANT device (Q1),

means for simultaneously picking-up said reference signal (F') and simultaneously applying the same to said information signal input (X2) of said second QUATANT device (Q2), and

means (11) for delivering a same reference frequency (θ) simultaneously to both said reference signal inputs (Y1, Y2), and simultaneous with the application to said information signal inputs (X1, X2) of the respective signals (f', F'), whereby said distortion is eliminated.

2. An apparatus as claimed in claim 1, wherein said reference frequency delivering means comprises a clock.

3. An apparatus as claimed in claim 1, wherein said support is a magnetic tape having two recording tracks.

* * * * *