

# THE S 52

A new electronic instrument  
for musical research

KUDELSKI (Lausanne)

*Realised by*

*Claude Cellier and André Kudelski  
on the basis of the theory proposed in the  
"Semantique Musicale" of Alain Daniélou*

Study of Oriental and African Music  
New bases for Contemporary Music  
Musicotherapy  
(53 intervals in each octave)

# S 52

Cellier-Kudelski

The S 52 is an electronic musical instrument built according to the theories presented by Alain Daniélou in his book « Musical Semantics ». The instrument has been realised by two electronic experts, Claude Cellier and André Kudelski, in the technical department of the Kudelski works in Lausanne where the famous Nagra tape-recorders are built.

Based on observations on the psycho-physiological effect of intervals corresponding to precise numerical factors, this instrument presents new possibilities for the study of extra-European music. But it also offers a sound material extremely diversified and precise to the modern composer since it permits of sound effects and expressive structures completely new. It is also a basic instrument indispensable for musical therapeutics. Musical structures utilising particular groups of intervals, which can for the first time be realized on this instrument have a powerful psycho-physiological effect.

Of a technical conception extremely modern the instrument offers a range of eight octaves each of which is divided in 53 intervals, 54 with the octave. The keyboard is of a new conception easy to utilise. The sound is of the organ type but with an expressive keyboard.

## A meaningful musical vocabulary

The expressive quality of the sounds in the musical vocabulary offered by the S 52 is based on experimental data. In Indian music a musician can easily indicate the type of feeling attached to each note of the scale of a rāga and the slight fluctuations which change this character.

Alain Daniélou has for years noted these expressions while measuring the exact value of the corresponding micro-intervals, which are called *Shruti* in Indian music.

The *Shrutis* presenting a similar expression are grouped into families (*Jati*). Once established the permanent connection between particular intervals and particular emotional evocations, the numerical frequency ratios of the intervals and their common characteristics had to be investigated.

Tonique + 52 notes  
(intervalles)

x 2

mal  
dir

A combination of systems of numeration binary-ternary-quinternary used for the classification of expressive intervals appeared to be the only way to explain their significance, their number and its limits. This theory also explains the relative intensity of the expressive contents and the relative importance of the intervals when the component factors evolve from simple to more complex ratios.

Intervals based on a binary system of numeration appear neutral. The octave is a typical example. Binary factors bring practically no variation in the semantic contents of intervals. On the other hand ternary and quinternary systems of numeration give for each interval a particular expressive character in relation to a basic sound. This character appears stronger when the ternary or quinternary factor is placed in relation to a neutral binary. It is modified by the presence of other factors. The significance of an interval is determined by the resulting effect of ternary and quinternary factors.

The intensity of the meaning becomes weaker with the multiplication of the ternary factor. In the ascending scale of fifth (ratio 3/2) the expressive character will be stronger for the first fifth (G), the tonic being C, than for the second one (D). The successive intervals determined by a series of fifths have a common expressive character which becomes gradually weaker in the order: (C) G D A+ E+ B+. The fifth degree is the limit of the analysing mechanism of the human brain with regards to ternary elements. For quinternary elements the second degree is the practical limit although the third degree is recognizable. The factor 25 is therefore commonly used while intervals based on the factor 125 appear somewhat odd.

The number of distinct sounds within an octave on which can be built the musical vocabulary in any system of music is strictly limited. In modal music based on a fixed tonic this number is 28. Indian musical theory reduces it to 22 (leaving aside variants of D and F, one of the 4 variants of D flat and two of the variants of F sharp). The total number of significant intervals perceptible within one octave when making use of modulations (changes of tonic) is 52. The notes number 54 if we include the tonic and the octave.

When describing intervals and to facilitate the analysis and transcription of intervals we shall indicate their value in numerical ratios but also through symbols indicating their value in the various systems of numeration: B for binary, T for ternary, Q for quinternary, as well as their multiples in each system.

Thus the number 16, in binary 10.000, will be transcribed as B<sup>4</sup>; the number 27, written 1.000 in ternary, will be transcribed as T<sup>3</sup>; the number 25, written 100 in quinternary will be

transcribed as Q<sup>2</sup>. The limma 135/128 = 5×27/128 will appear as QT<sup>3</sup>/B<sup>7</sup>.

The expressive value of intervals is determined by the following figures and their combinations:

|                  |                                |
|------------------|--------------------------------|
| Q <sup>2</sup> / | sad, melancholy                |
| Q/               | tender, soft                   |
| T/               | brilliant, sunny, glorious     |
| /T               | calm, peace, night             |
| /Q               | aggressive, passionate, erotic |
| /Q <sup>2</sup>  | hard, cruel                    |

Thus with relation to C as tonic: the harmonic third E ( $5/4 = Q/B^2$ ) will be soft, tender; the pythagorean third E+ ( $81/64 = T^4/B^6$ ) is brilliant, radiant.

A ( $5/3 = Q/T$ ) will be similar to E but calmer.

A+ ( $27/16 = T^3/B^4$ ) similar to E+.

Ab— ( $25/16 = Q^2/B^4$ ) is pathetic

Ab ( $128/81 = B^7/T^4$ ) is calm, peaceful

Ab+ ( $8/5 = B^3/Q$ ) is erotic, enterprising

Db— ( $25/24 = Q^2/TB^3$ ) is desperate, pathetic but calm

Db ( $135/128 = QT^3/B^7$ ) is tender, confident

Db+ ( $16/15 = B^4/QT$ ) is erotic, loving, calm

Db++ ( $27/25 = T^3/Q^2$ ) is harsh, self asserting.

The meaning or semantic content of the intervals as perceived in the practice of Indian music strictly corresponds to the values of B, Q and T, i. e. to the relations of the frequencies in terms of binary, ternary and quinternary numerations.

Similar characteristics can be observed in the visual field where the same rules of non-verbal counting apply.

The phonetic alphabet out of which are formed all spoken languages is also made of 54 distinct elements of articulation. It appears that the number 54 corresponds to a limit of our possibilities of mental classification of sound-elements that can be used for the transmission of a significant content.

### The realisers of the S 52

Alain Daniélou has been the Director of the Research Department of the Benares Hindu University and the Director of the International Institute of Comparative Music Studies in Berlin and Venice. After music studies in Europe he travelled widely in Asia and Africa. He settled in India where for 20 years he studied Indian classical music. His profound know-

| NUMERATION |        |         |             |
|------------|--------|---------|-------------|
| décimal    | binary | ternary | quinternary |
| 1          | 1      | 1       | 1           |
| 2●         | 10●    | 2       | 2           |
| 3●         | 11     | 10●     | 3           |
| 4●         | 100●   | 11      | 4           |
| 5●         | 101    | 12      | 10●         |
| 6■         | 110    | 20■     | 11          |
| 7          | 111    | 21      | 12          |
| 8●         | 1000●  | 22      | 13          |
| 9●         | 1001   | 100●    | 14          |
| 10■        | 1010   | 101     | 20■         |
| 11         | 1011   | 102     | 21          |
| 12         | 1100   | 110     | 22          |
| 13         | 1101   | 111     | 23          |
| 14         | 1110   | 112     | 24          |
| 15■        | 1111   | 120     | 30■         |
| 16●        | 10000● | 121     | 31          |
| 17         | 10001  | 122     | 32          |
| 18■        | 10010  | 200■    | 33          |
| 19         | 10011  | 201     | 34          |
| 20■        | 10100  | 202     | 40■         |
| 21         | 10101  | 210     | 41          |
| 22         | 10110  | 211     | 42          |
| 23         | 10111  | 212     | 43          |
| 24         | 11000  | 220     | 44          |
| 25●        | 11001  | 221     | 100●        |
| 26         | 11010  | 222     | 101         |
| 27●        | 11011  | 1000●   | 102         |

A round dot indicates a strong psychological action  
A square dot a mixed action

ledge of different musical languages led him to the theory exposed in his books of which the S 52 is an application.

*Claude Cellier* born in 1955, specialised in electroacoustics, is a graduate of the Department of Electricity of the Ecole Polytechnique of Lausanne. Interested in the problem of the synthesis of sounds, he constructed his first monodic synthesiser in 1976 and started to work on the S 52 in 1977 while continuing his studies.

*André Kudelski* born in May 1960 is at present a student in the Department of Physics of the Ecole Polytechnique in Lausanne. He is a highly qualified specialist of microprocessors and collaborated to the realisation of the S 52 for all the elements concerned with informatics in particular the programming of the microprocessor incorporated in the S 52.

#### Technical data

The instrument can produce sounds (pure or with harmonics) within a range going from about 30 Hertz to 8000 Hertz.

The keyboard covering three octaves with 53 notes in each octave represented by 53 keys. A simple device allows to obtain on the same keyboard higher or lower octaves so as to cover 8 octaves.

The diapason can be adjusted to that the instrument may be tuned to the tonic chosen by the oriental musician or the A of various orchestras. To compare modes more easily, a memory permits to hold the tonic as a drone.

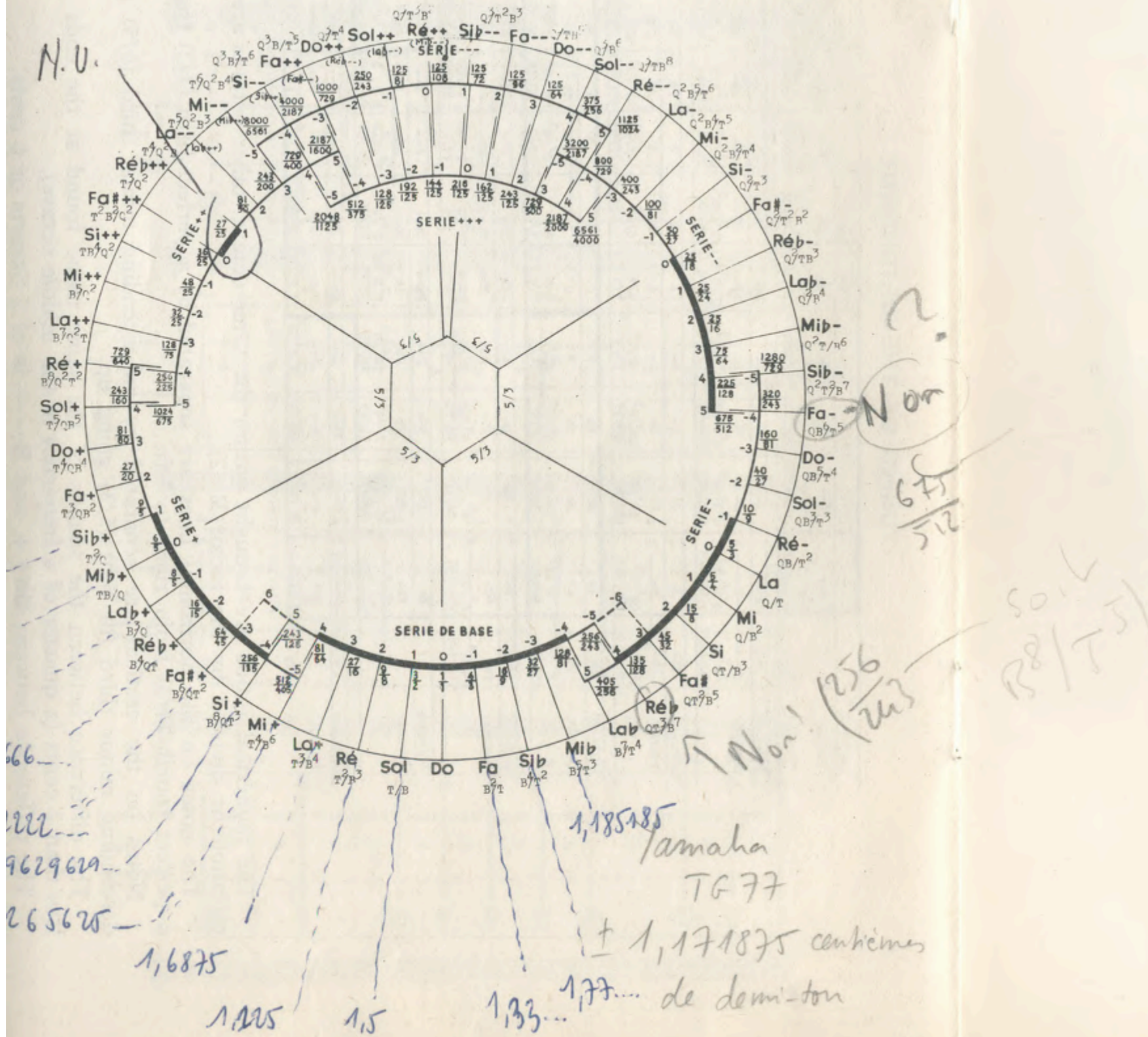
One can also choose, according to chords, obtained through various cycles of fifths, the limmas 256/243 or 135/128 (difference 2 cents).

A microprocessor (a kind of micro ordinator) incorporated in the instrument gives it a great adaptability. It is thus possible to produce automatically chords of up to 8 notes, the amplitude of its components can be controled separately allowing of an additional synthesis of the sound-effect desired. The microprocessor permits to compose a music piece in a slow movement and play it later at the desired tempo and also to play (record) a musical phrase or a piece and to obtain a play-back on which each of the relative sounds can be modified independently.

On the keyboard the division of the white and black keys permit to play easily the « medium », « plus » and « minus » values of each note.



# THE CYCLE OF INTERVALS



For all information concerning the S 52 write to  
 Claude Cellier, Kudelski S. A.  
 CH 1033 Cheseaux, Lausanne Suisse  
 or to  
 Alain Daniélou  
 59, rue Froidevaux  
 F - 75014 Paris

The « Semantique Musicale » of Alain Daniélou is published by Editions Hermann 293, rue Lecourbe F - 75015 Paris (New edition 1978)