History of Strings with Horns: A Study Overview

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Introduction

Hybrid string-horn instruments, with a Stroh violin as the most famous example, had a narrow time period of manufacturing from 1904 to 1942. The idea of rejecting the wooden resonator box – and using the horn with a diaphragm driven by bridge vibrations instead – was innovative with respect to the traditional lutherie school as a total reorganization of the instrument, and came up with methods of acoustical recording, which were widely used from 1877 until the discovery of the microphone recording technology around 1925. The Stroh violin was probably one of the first important steps in evolution of string instruments and the transformation to the electric amplification principle, such as in e-violin: first, because of revised physical organization, and second, because of functionality needs. The ordinary baroque violin and other string instruments were found inappropriate for recording due to their weak projection, so the Stroh-violins were quite commonly used in the recording studios for two decades [5].

Various names for string-horn violins exist: Stroh violin, vioară cu goarnă, horn-violin, violinophone, cornet-violine, Tiebel-violin, and derivatives for other string instruments, such as the Cellocordo, phono-ukulele, et cetera.

The following section provides an overview on different string-horn instrument designs.

Instrument designs and concepts

Stroh-violin and other bowed instruments such as cello, bass, viola: they implement a corrugated aluminum diaphragm with ripples, as described further in section 3. In some models, a small horn for the ear of the player can be attached to the big horn or to the soundbox. Horns were made of spun alum or of sheet metal [1]. The tone produced is a little '*flutely*' and has no metallic sound [4].

Phonofiddle or 'Jap Fiddle' with internal mica (a naturally occurring aluminosilicate mineral) sheet-resonating diaphragm mounted vertically under the bridge, flared bell and curved stem. The timbre of a phonofiddle is 'quite unlike that of any other instrument, akin if anything to the singing saw' as stated by Pilling, but a single string is a possible reason for no further development. Strohs company manufactured three models of one-string fiddle: 'Home', 'Concert' with tinplate diaphragms and the 'Professional' model with mica diaphragm. Phonofiddles with curved horn and an aluminium diaphragm were produced by Arthur Howson. A gramophone soundbox as a diaphragm is implemented in instruments of Rose Morris and Co. Pilling points out the tone color difference between the diaphragm types: 'Tinplate gave a reedy and viol-like sound while the aluminium and mica diaphragms gave a full, unique tone color' [1].

Vioară cu goarnă or *higheghe* is a four-string phonofiddle, that is still produced in Bihor and Crişana, Romania. It is also called *violară cu palnie* (funnel violin) and *violară-corn* (horn violin). In some cases, to insure the mechanical stability of the instrument, the G string is replaced by a thinner string [2]. Sound of the vioară cu goarnă is even more projected than that of the Stroh violin due to the trumpet-like horn.

Various forms of hybrid guitar, mandoline and ukulele were also manufactured by Arthur Howson. Rupert Hazell designed an instrument known as Cellocordo. These are often favored by jazz musicians.

The following section outlines the protected inventions in the string-horn instrument family.

Inventors and Patents

Stroh, John Matthias Augustus

- UK Patent №189909418, Accepted 24th Mar., 1900: "Improvements in Violins and other Stringed Instruments" describes the new violin body with sounding boards omitted. The materials are not specified, and large variations are allowed in the construction. The corpus of the instrument is 'a suitable frame made of aluminium, wood or other suitable material'. The diaphragm of a not specified flexible material is enclosed in a 'circular frame or drum-head'. Sketch of the instrument is shown in Figure 1. The same invention is protected by the US Patent №US644695, 1900 "Violin" [3].

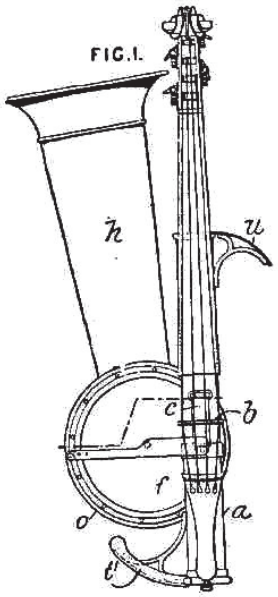

Figure 1: The first model of a Stroh violin was without a small monitor horn. Patent UK 189909418, 1900 [3]

- UK Patent №190103393, Accepted 14th Dec., 1901: “Improvement in the Diaphragms of Phonographs, Musical Instruments, and analogous Sound-producing, Recording or Transmitting Contrivances” extends the specification from a previous patent, presenting the diaphragm which is ‘flat or corrugated in its outer portions and has a central conical portion, to the apex of which the vibrating attachment is made. [...] As a material for the diaphragm, metal, ebonite, celluloid or ‘other suitable material can be used.’ This invention is meant as an improvement for violins, mandolins, guitars and the like instruments, but also for sound recording and reproducing instruments such as phonograph.

Howson, Arthur Thomas

- UK Patent №191326143, Accepted 17th Sept., 1914: “Improvements in or connected with Phonofiddles, Violins and other Stringed Musical Instruments” uses the principle of a telephone transmitter in such a way, that ‘the vibrations of the strings are transmitted to a diaphragm connected to the diaphragm of a microphone. Several instruments, each provided with a microphone, may be connected to a single receiver’ [3].

Blieberger, Charles

- USA Patent №US1691721 28th Mar., 1923: "Apparatus for recording and reproducing sound" describes not a musical instrument improvement, but the recording apparatus with a horn and a flat glass membrane corrugated at its edges, which is claimed to reproduce sound in ‘a better and more efficient way’ [3]. The invention should overcome problems of other diaphragm types in recording, such as overdrive effects ('blasting', 'shattering'), overtones lost in distortion, and frequency-dependent sensitivity. As Blieberger states, a large diaphragm for reproducing devices 'requires no tone arm and no horn'.

Hazell, Rupert Alexander

- UK Patent №276416, 19th Aug., 1927: “Improvements in stringed musical instruments” presents an improved ukulele played with a bow, by means of which 'new effects can be obtained by playing upon three, four or more strings simultaneously.' A metal bridge is extended perpendicularly to the strings down into the hollow body, on a side of which the diaphragm is mounted with an aperture leading to the horn, though the usage of a horn as a sound amplifier is stated as 'not absolutely essential' [3].

Tiebel, Willy

An instrument maker from Markneukirchen, Germany, Tiebel was producing instruments similar to Augustus Stroh’s in the late 1920s, made of maple and mahogany. The instruments were usually rectangular in cross-section, whereas the Stroh violin has a round supporting rod. As is pointed out by Rabinovici, this instrument had enough differences from Stroh violin, so Tiebel could register his own patent in patent bureau (Reichspatentamt) in 1928 [6].

Dopyera, John

Dopyera patented his resonator guitar with a few built-in diaphragms (“Dobro” guitar, which is acquired now by Gibson Guitar Corporation) in France, UK, USA and Canada in 1928. Its sketch is shown in Figure 2. The improvements are described as follows: 'The bridge of a guitar is loosely supported on a spider whose arms rest on points attached to the centres of conical metallic resonators mounted on the partition, a resonator mounted on the back being also connected by an interposed spring. The resonators have beads near their edges. A hand-rest is secured over the bridge, being attached to the metal cover. Amplifying horns may be provided.' [3]

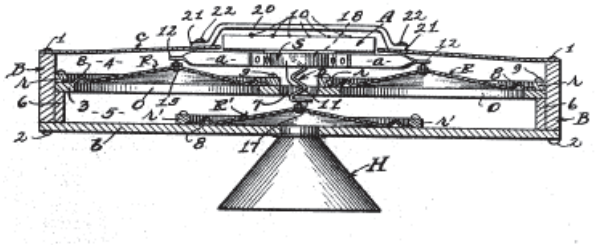

Figure 2: Dopyera’s Resonator guitar, patent UK294806, 1928

Musicologic publications on Stroh violins

Donovan, D.: **The Stroh Violin**. The Strand Magazine, 1902 [4]

In this advertising article, Donovan writes that the Stroh violin ‘has the reserve power of three Josephs [Guarnerius], and is as loud as 4 ordinary violins’. He assessed the tone quality as follows: ‘The G string is a dream. It possesses the deep rich quality of a fine cello A, but there is no unevenness in the strings. The harmonics are loud and pure, and what is of great importance is an entire absence of "scrape"’ [4].

Pilling, J.: Fiddles with Horns. The Galpin Society Journal, 1975 [1]

Pilling concludes that the acoustic sound recording was the first purpose of the Stroh violin, which is supported by illustrations from Joe Batten’s Book [13]. After this, the instrument often appeared in dance orchestras and ‘probably is responsible for the present interest in the instrument as a vehicle for "folk music"’. Pilling characterizes the D. Donovan’s report as a ‘very laudatory article’. He assumes the sales of Stroh cellos, violas, mandolines, ukuleles and guitars to be small, whereas the Stroh violins sales were “slow but steady”.

Proposing that the bumbass and bladder-and-string are the ancestors of phonofiddle, inasmuch as the modern japanese fiddle (which probably got this name after the japanese exhibition in London), Pilling calls the phonofiddle an updated version of a bowed monochord. George Chirgwin, a music hall stage musician, contributed a lot to its popularization.

Alison Rabinovici: Augustus Stroh's phonographic violin. A journey: Victorian London, Australia, Transylvania. The Galpin Society Journal, 2005 [5]

This publication provides a precise and full description of patented instruments with numerous illustrations. Five years later, in 2010, Rabinovici accomplished her master research thesis 'A History of Horned Strings: Organology and Early Sound Recording 1899-1945' [6], an investigation of the Stroh violin and phono-fiddle. She examines how Stroh violin is related to the development of a phonograph and the scientific methods in acoustics. Phono-fiddle, in contrast to Stroh violin, has a background of the 'blackface minstrelsy and popular music-hall entertainment'. Methods of recordings' re-interpretation and cross-referencing of the photographic documents and matrix numbers of records are examined in attempt to specify the role of the Stroh violin in a soundscape of that time period: it is observed that it was used until the end of the acoustic era (circa 1926) in the orchestral and, more often, solo violin recordings. Also, an experiment with wax cylinder recording of the 'horned chordophones' was made. Rabinovici refers to the research work of Cary Clements in 1990s, which offers a history outline of the Stroh violin [15], [16], [17].

Acoustical research

Ghosh, R. N.: A study of the Acoustics of Stroh Violin, Allahabad University, 1926 [7]

In this early paper, the Stroh violin is taken for the verification of the theory of bowed instruments due to its simpler mechanical systems compared to an ordinary violin. However, the illustration shows a phonofiddle instead of the Stroh violin.

Ghosh reports about the increase of the radiation at high frequencies and at the resonance frequency of a diaphragm and of a horn; calculations agree that attachment of a flange or a horn significantly increases the output. Damping coefficient of the string and the minimum bowing pressure also rise considerably at the resonance pitch of the diaphragm. The theoretical estimations agree with observed values.

Mores, R.: Acoustical measurements on experimental violins in the Hanneforth collection. Springer Int. Publishing, 2013 [9]

Three experimental violins, including the Stroh-violin, are compared to the reference Stradivari masterwork by means of measured bridge admittance. Their relation is shown on Figure 3. Mores concludes that the body resonances of the violin are 'replaced' by the principles of a compression wave in a horn, so the horn is adjusted in a way to fit the A0 mode, which is the fundamental resonance of a violin body, and the signature modes (below 600 Hz) of the plates. [9], [14].

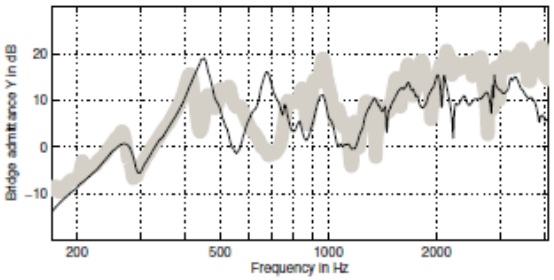

Figure 3: Bridge admittance of the 1910 Stroh violin (thin, black) in relation to the 1712 Stradivari violin (thick, gray).

Gautier, F., Curtit, M., Fréour, V., Vaiedelich, S., and Juarez, A. V. 'Acoustic characteristics of the Stroh-violin, 2014 [10]

Researchers in ITEMM, France, made measurements and physical modeling on Stroh violin, as described in the abstract: 'Firstly, the directivity is strong and directly linked to the properties of the horn. Secondly, the spectral analysis of sounds produced by the instrument shows a filtering effect induced by strong resonances of the coupled bridge-diaphragm-horn system. A detailed experimental study of these two characteristics is performed on a modern Stroh instrument. Complementary investigations are also provided on historical Stroh-violin and Stroh-cello. A physical model of the instrument is done: the horn acoustic input impedance of the horn and the bridge admittance are modeled using a lumped element model, permitting an interpretation of the instrument response. The resonant behavior of the bridge has similar features with the one encountered in some classical violins and known as Bridge Hill. A discussion on the importance of the resulting filtering effect is made' [10].

Recent experimental works

Linden Instruments, Finland

Olavi Linden – a violinist, an instrument maker and a designer of Fiscars garden tools – developed multiple acoustically amplified instruments and multi-soundhole technology, experimented with various designs of horns and membranes (mostly of carbon fiber), and has founded the company Linden Instruments [11].

Motivated by the observation that the string instruments with horns often become 'too nasal and unpleasant if there is no filtering of frequencies', Linden found a number of ways to implement this filtering. One of them is an inner horn, shown on a Fig. 3, which reduces nasality by attenuating some energy around 1500 Hz. In addition, the throat cavity, which is a space just behind the diaphragm, has the effect of limiting high frequency performance, as mentioned by Dinsdale [8]. Modifications on the violin horn were partly made in experimental way, attempting to create 'a violin-like tone'. Linden emphasizes that for reproduction of low frequencies huge horns are needed, considering as a rule that the circumference of the horn's large end should be equal with the wavelength of the lowest note played; he notes also that 'well designed horn systems can have a very high efficiency, more than ten times the efficiency of traditional instruments.'

La Fausse Compagnie, France
The musical ensemble (Claire-Noel Le Saulnier, Thomas Le Saulnier, Samuel Tailliez), with assistance of instrument makers and specialists of metal work, experimented with various designs and manufactured a violin, cello and double bass for their performances [12].

Christophe Boutin, who is working in a factory of metal fabrication, designed a resonator. Christophe Perrin, a specialist in industrial glue, made a diaphragm using carbon fiber and epoxy. New ergonomic design concept of the instrument body, made of steel supportive frames, is developed in atelier de Laurent Cadilhac. Robert Kieffer, doctor at CERN in Genève and a musician, is working on a new shape for the resonator and the Stroh-bass horn, and on the improvement of the transverse rocking lever.

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Figure 4: Vivaldi a- minor concerto with Pekka Kuusisto playing violin solo at Kuhmo Chamber Music Festival in Finland, 2013

Among the musicians who used Stroh violin are Tom Waits, múm, R. Crumb & His Cheap Suit Serenaders, Strohviols quartet, Cristóbal Repetto and Javier Casalla (Bajofondo Tango Club). Vinorosso ensemble performs in Germany [18].

An ensemble of three horn violins, horn viola, horn cello, a huge horn bass and cembalo performed the Vivaldi a- minor concerto at Kuhmo Chamber Music Festival in Finland is shown in Figure 4 [11].

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