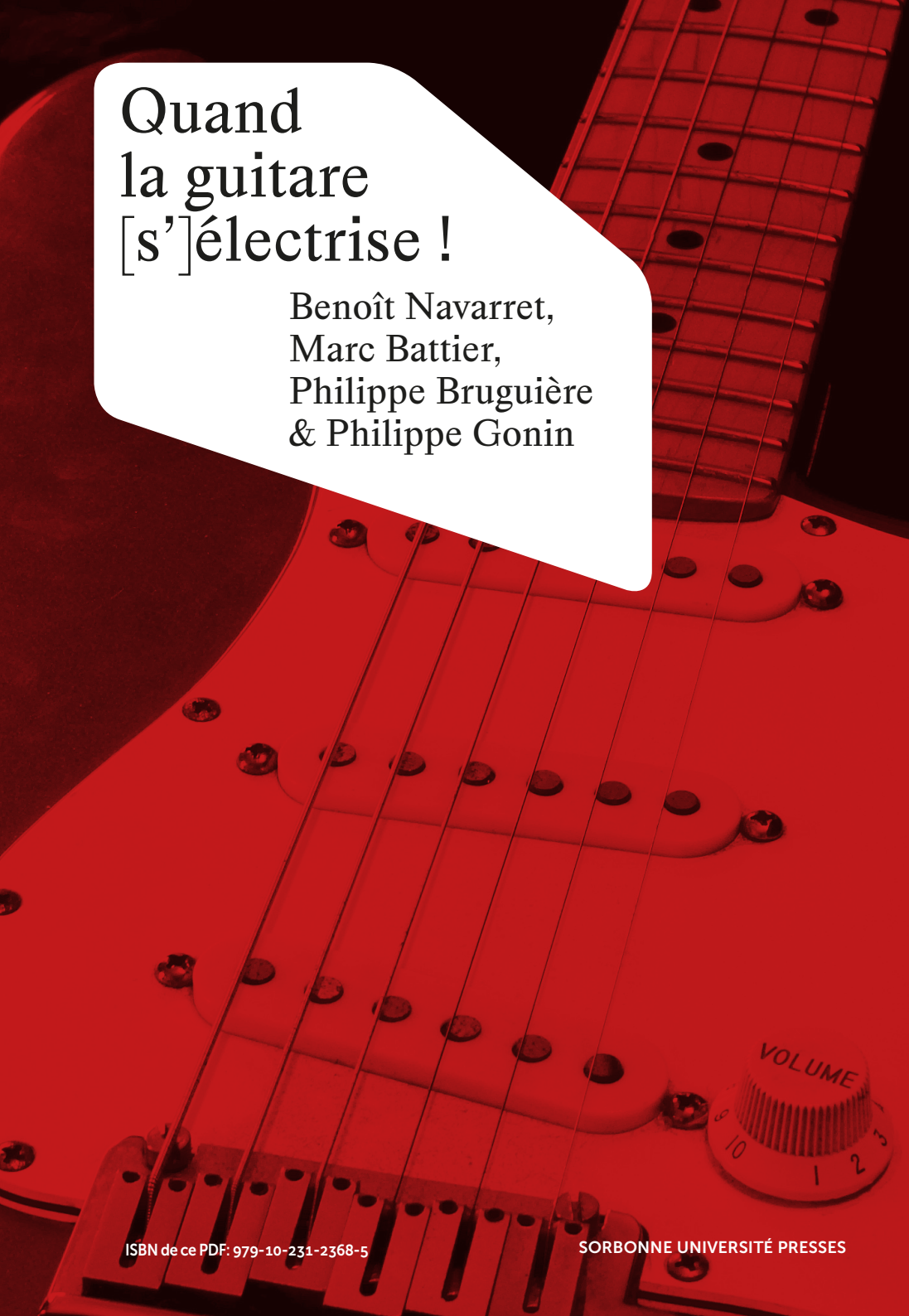
Quand la guitare [s']électrise !

Benoît Navarret,
Marc Battier,
Philippe Bruguière
& Philippe Gonin



ISBN de ce PDF: 979-10-231-2368-5

SORBONNE UNIVERSITÉ PRESSES

MusiqueS

La guitare électrique serait-elle l'instrument emblématique du XX^e siècle ? Son histoire a marqué plusieurs générations de musiciens et d'auditeurs : sa sonorité et sa puissance (qu'elle doit aussi à ses composants externes : pédales d'effets, amplificateurs et haut-parleurs), sa versatilité, son impact visuel et toutes les significations qui lui ont été associées en font un objet incontournable, une véritable icône planétaire.

Et pourtant l'étude scientifique de son histoire, de son répertoire ou de sa technologie n'a fait que commencer, tout en allant en s'amplifiant. Peu connue, la recherche menée autour de cet instrument mérite qu'on s'y attarde, tant les approches possibles sont riches et variées : car l'instrument ne peut s'étudier en-dehors de son contexte, ni sans raconter l'histoire de ces pionniers qui se mirent à bricoler des formes hybrides d'instruments, puisant dans l'organologie classique en la mêlant aux techniques de la radio, du microphone et de tout ce que « la fée électricité » a pu apporter en matière d'innovation sonore. L'on ne peut aussi ignorer la construction symbolique de ces figures mythiques, les *guitar heroes*, qui font rêver les foules et alimentent les fantasmes de nombreux amateurs. Sans oublier la multiplicité de ses usages, du club intimiste aux gigantesques stades ou festivals, de son expérimentation dans la musique contemporaine au refus délibéré de la virtuosité dans des genres plus nihilistes, et même dans certaines pratiques religieuses !

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QUAND LA GUITARE [S']ÉLECTRISE !

À la mémoire d'André Duchossoir (1949-2020)

MusiqueS

Série « MusiqueS & Sciences » – Instrumentarium

Issue des travaux interdisciplinaires soutenus par l'Institut Collegium Musicæ de l'Alliance Sorbonne Université depuis sa création en 2015, la série « MusiqueS & Sciences » est une collection dont le but est de susciter, développer et valoriser les recherches ayant pour sujet les musiques, passées et présentes, de toutes origines. Elle invite ainsi à mêler les disciplines des sciences humaines et des sciences exactes telles que l'acoustique, les technologies de la musique et du son, la musicologie, l'ethnomusicologie, la psychologie cognitive, l'informatique musicale, mais aussi les métiers de la conservation et de la lutherie.

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Benoît Navarret, Marc Battier,
Philippe Bruguière & Philippe Gonin (dir.)

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SORBONNE UNIVERSITÉ PRESSES
Paris

Ouvrage publié avec le concours du Collegium Musicæ
et de la faculté des Lettres de Sorbonne Université.
Les SUP sont un service général de la faculté des Lettres de Sorbonne Université.

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CHAPITRE 2

THE HIDDEN HISTORY OF THE ELECTRIC GUITAR
*
L'HISTOIRE CACHÉE DE LA GUITARE ÉLECTRIQUE

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ABSTRACT

Almost without question, the invention of the electric guitar is the most important development in musical instruments during the last century. No other musical instrument can claim to have had the impact on the music – and society – of the last hundred years that the electric guitar and its variants have. While the electric guitar's origins and early history have been the subject of much heated debate and the source of much mythology, it is now generally acknowledged that the first commercially successful electric guitar was the Electro "Frying Pan", invented by George Beauchamp and manufactured in collaboration and corporate partnership with Adolph Rickenbacker by the Ro-Pat-In Corporation (later known as Electro String Corporation and known today as Rickenbacker International Corporation). The technology that Beauchamp implemented and refined for the Frying Pan is the basis for the overwhelming majority of electric stringed instruments that have come after. Although electric guitars are ubiquitous today, their history – especially their early history – remains obscure and not well understood. This lack of understanding holds true not only for the general public, but for musicians and musical historians as well. This state of affairs is particularly true for the events that led up to and drove the development of the electric guitar – the prehistory of the electric guitar. This paper will examine some of this hidden history of the electric guitar and discuss the early electric guitar's place in the wider perspective of electric musical instruments. It will also discuss some of the driving forces behind the development of the electric guitar and how these forces are actually quite different from what is today typically assumed about the instrument's history.

BIOGRAPHY

Matthew W. Hill holds a BMus (Hons, 1st class) in composition from Napier University and a MMus and PhD in organology from the University of Edinburgh. His thesis entitled *George Beauchamp and the Rise of the Electric Guitar up to 1939* is devoted to the pioneers of the electrification of the guitar. A founding curator of the Musical Instrument Museum in

Phoenix (Arizona), he is also curator of the John C. Hall collection of musical instruments in Santa Ana, California. Besides academic pursuits, he has enjoyed a varied musical life that includes being a Nashville session player, art music composer, double bassist, and guitarist.

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RÉSUMÉ

Il ne fait aucun doute que l'électrification de la guitare est la plus importante innovation qu'ait connu l'instrument de musique au cours du siècle dernier et depuis, aucun autre ne peut prétendre avoir eu le même impact sur la musique et la société. Si les origines et les premiers développements de la guitare électrique ont fait l'objet de débats houleux et furent la source de nombreux mythes, il est aujourd'hui communément admis que le premier instrument à avoir été une réussite commerciale fut la « Frying Pan » Electro, inventée par George Beauchamp et produite en collaboration avec son associé Adolph Rickenbacker pour la firme Ro-Pat-In Corporation (connue plus tard sous le nom d'Electro String Corporation, aujourd'hui devenue Rickenbacker International Corporation). La technologie développée par Beauchamp pour la « Frying Pan » fut adaptée à la plupart des instruments à cordes électriques. Alors que la guitare électrique est aujourd'hui devenue un objet courant de notre environnement quotidien, son histoire – plus précisément celle de ses origines – demeure obscure et mal connue. Cette méconnaissance ne touche pas seulement le grand public mais elle existe aussi chez les musiciens et les historiens de la musique. Cela est particulièrement vrai des événements qui conduisirent à l'émergence de la guitare électrique – la préhistoire de la guitare électrique. Le texte qui suit en dévoile quelques aspects et examine la place qu'occupèrent des premières guitares électriques dans une perspective plus générale, élargie à l'ensemble des instruments de musique électriques. Il rend compte des événements qui ont conduit au développement de la guitare électrique et montre combien ils sont différentes de ceux qui sont nos jours supposés être à l'origine de l'histoire de l'instrument.

BIOGRAPHIE

Matthew W. Hill est titulaire d'une licence de musique en composition de l'université de Napier, ainsi que d'une maîtrise et d'un doctorat en organologie de l'université d'Edimbourg. Sa thèse intitulée *George Beauchamp and the Rise of the Electric Guitar up to 1939* est consacrée aux pionniers de l'électrification de la guitare. Il est conservateur de la collection d'instruments de musique John C. Hall à Santa Ana (Californie) et a été l'un des premiers experts sollicités pour l'enrichissement des collections du musée de Phoenix (Arizona). En dehors de ses activités universitaires, Matthew W. Hill est également musicien de studio à Nashville, compositeur, contrebassiste et guitariste.

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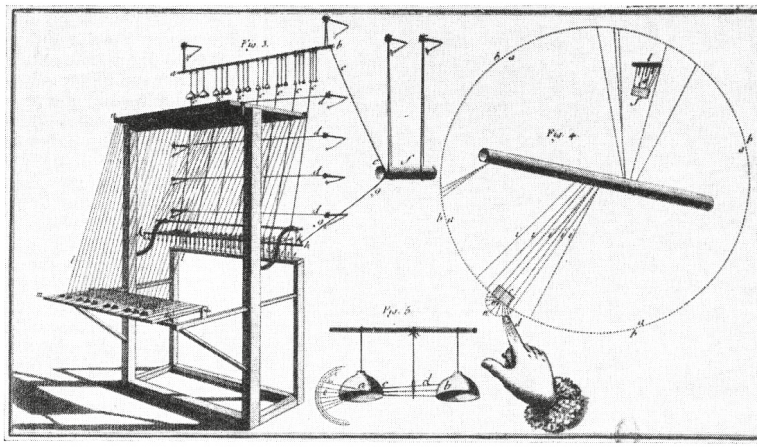
THE EARLIEST ELECTRIFIED MUSICAL INSTRUMENTS

Most people think of electric musical instruments as something modern, but the application of electricity to musical instruments dates back more than 250 years. What the first electrified instrument was has been the subject of some speculation, but it is most often identified as the *Denis d'or*, which translates as "golden Dionysus", a keyboard instrument constructed *c.* 1748 by the Czech priest Václav Prokop Diviš sometimes known in the West as Procopius Devisch who lived from 1698-1765. Diviš was an early electrical experimenter; in 1754, he erected an early type of lightning rod, which he possibly invented independently of Benjamin Franklin, on church property near his home in Přímětice, in the South Moravian region of what is now the Czech Republic (Sitter, 2003, p. 303).

Around 1748, but possibly earlier, Diviš created the *Denis d'or* and named it for himself – the "Denis" in the name is the French equivalent of the Czech surname "Diviš", both of which derive from the name of Greek god Dionysius. It was a stringed instrument, operated by a keyboard, approximately 150 cm long by 90 cm wide by 120 cm high – roughly the size of a modern spinet-style upright piano. The mechanism was extremely complicated, having over 790 strings arranged into 14 stops or registers, and the instrument was said to be able to imitate the sounds of the harpsichord, harp, lute and even wind instruments by various combinations of stops. Unfortunately, there are no drawings of the instrument, but a description written in 1753 indicates that the strings were struck rather than plucked.[1] However, the most unusual feature of the instrument was that it employed electricity, supplied by means of batteries or Leiden jars. The electricity was used for two purposes; the first was to somehow "energise" the iron strings of the instrument, which in turn enhanced the sound produced, and the second was to enable Diviš to give the unsuspecting player of the *Denis d'or* an electric shock. The second function is not as strange as it first might appear; some of the first practical applications of electricity[2] were in

1 *Tübingische Berichte von gelehrten Sachen auf das jahr 1754,* Tübingun, Johann Georg Coota, p. 395.

2 If indeed, a practical joke can be considered a practical application.



1. Delaborde's *clavecin électrique*, 1759

the creation of novelties which buzzed or shocked the unwary recipient. It is not clear how either of these electrical features functioned, but it is clear that the author of the 1753 description considered the *Denis d'or* to be a *"Electrisch--Musicalische Instrument"*, that is, an "electric musical instrument", the earliest known use of the term. After Diviš's death in 1765, the *Denis d'or* was sold and taken to Vienna; its eventual fate is unknown. Sadly, there is no clear description of the acoustic effect the use of electricity had on the strings, making it difficult to determine or even speculate on any possible circuitry of the instrument.

The next known musical instrument to employ electricity was the *clavecin* électrique invented by Jean-Baptiste Thillais Delaborde in 1759 (**fig. 1**). Delaborde, like Diviš, was also a priest. Played by means of a conventional keyboard, the instrument's mechanism was activated electrostatically using a glass globe-type generator which produced electricity by way of friction. The static electricity thus generated is simultaneously of low, continuous flowing current and high voltage. In essence, the *clavecin électrique* was an electrically activated carillon, using bells as the sound producers, with the main difference being that two bells were employed for each pitch. Both bells were electrically charged with a metal clapper suspended between them. When the key lever is depressed, one of the bells is earthed, which causes the metal clapper to violently swing

back and forth between the earthed and un-earthed bells, producing the pitch – sounding not unlike a mid-20th century mechanical alarm clock. It should be noted that Delaborde did not discover the electric principle used in the device's mechanism, which was based on a existing alarm bell-type device. Delaborde (1997) published his description and account of the *clavecin électrique* in 1761, noting that the instrument was particularly effective when played in the dark, due to the brilliant sparks produced by the instrument while it was played. Unlike the *Denis d'or*, which appears to have utilised electricity mostly as a novelty or gimmick that was adjunct to the instrument's musical functions, the *clavecin électrique*'s utilisation of electricity was an essential part of its mechanism, making Delaborde's invention the first fully electrically-powered musical instrument.

GEORGE BREED'S ELECTRIFIED GUITAR OF 1890

In 1890, a United States Naval Officer named George Breed, patented a design for an electrified guitar which appears to be the first application of electricity to a fretted string instrument. Like the modern electric guitar, Breed's patent was based on a vibrating string in an electro-magnetic field. Breed's design, though, worked on very different electrical and musical principles, resulting in a guitar with an unconventional playing technique that produced an exceptionally unusual, and un-guitar-like, continuously sustained sound.

At the beginning of 1890, Breed was attached to newly-commissioned cruiser *USS Baltimore*, the flagship of the North Atlantic fleet. Within four weeks of joining the crew of the *Baltimore*, Breed had filed his guitar patent application. Six months later, on 5 July 1890, Breed resigned from the Navy, to take effect from 7 January 1891, with leave given until that date.[3] On 2 September 1890, Breed was granted US Patent No. 435679 for his "Method of and Apparatus for Producing Musical Sounds by Electricity", less than two months after his effective resignation from the Navy (**fig. 2**). Whether these two events are related is not known, but it is

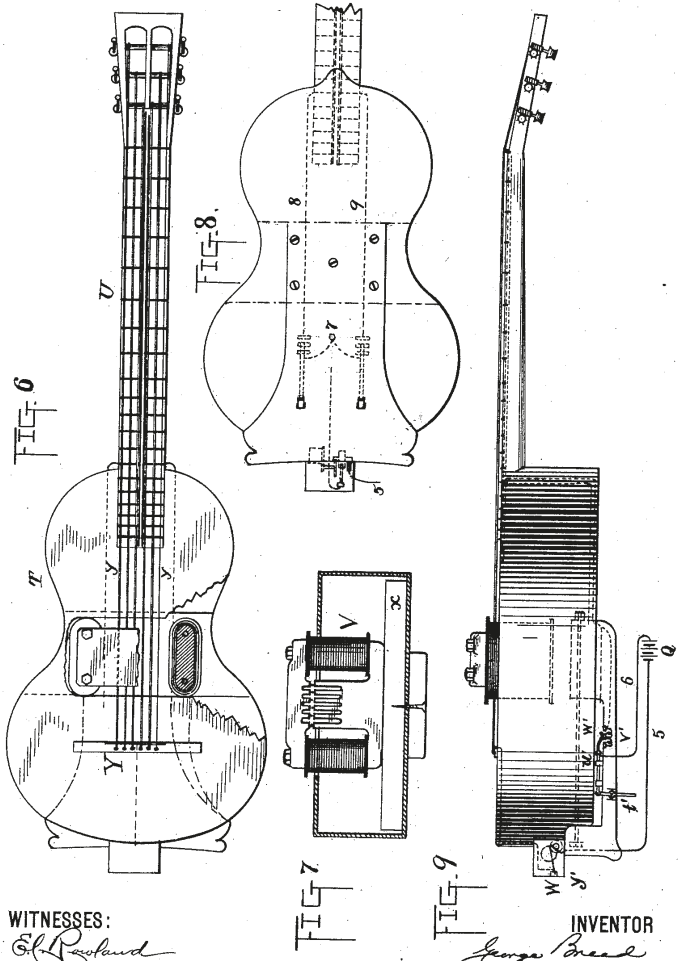
3 United States Department of the Navy, *Records of Officers*, Microfilm M330, Roll 17, Washington DC, Government Printing Office.

(No Model.) 5 Sheets—Sheet 5.

G. BREED.

METHOD OF AND APPARATUS FOR PRODUCING MUSICAL SOUNDS BY ELECTRICITY

No. 435,679. Patented Sept. 2, 1890.



2. George Breed's 1890 guitar design

tempting to speculate that the reason George Breed left the Navy was to make and market his musical instrument designs.

In considering Breed's patent, it is it important to remember that Breed was not patenting so much a specific musical instrument design as a method of setting a string in constant vibration. In Breed's patent, musical instruments are not the only application depicted; the patent shows the principle applied to a keyboard, a guitar, and as a signalling device.

To set the string in motion, Breed's design makes use of an electromagnetic principle known as the Lorentz Force. In essence, the Lorentz Force principle states that when an electrically charged particle moves through a magnetic field, there is a force on it that is perpendicular to its direction of movement and to the North-South axis of the magnetic field.

In Breed's patent, a metal string is stretched through a strong magnetic field, provided by an electromagnet which encircles the string. It should be noted that the electromagnet does not share the same circuitry as the string, each having independent circuits; in fact it is not necessary that the magnet be an electromagnet at all, a fact that Breed indirectly acknowledges by depicting a non-electrified horseshoe-type magnet in his initial illustration showing the principle of the design. However, in Breed's day, permanent magnets were incapable of producing a magnetic field of the strength required and strong permanent magnets (such as the "alnico" type) were a number of years into the future[4].

The string, in addition to its conventional function as an acoustic source, is also an integral part of the design's circuitry, as a direct current (DC) passes through it. This electric current is intermittently interrupted at rapid yet irregular intervals, producing a pulsed DC, which sets the string in motion by the rapid engaging and disengaging of the Lorentz Force created when current is flowing through the string. This pulsed DC, which is created by the rapid interruption of the string's circuit, mimics some of the properties of alternating current (AC), which in 1890 was yet to be widely used. Breed likens this rapid making and breaking of the

4 R. Vermuelen, "Forty Years of Acoustics", *GRT Monitor*, vol. 3, No. 3, June 1962, p. 74.

circuit to the effect of a metal pin being drawn across a file; his analogy is quite vivid, stating that a softer tone is produced with a finely cut file, while a coarser file generates a rougher sound. This suggests that the use of files as part of the circuitry may have been based on Breed's personal experience, and perhaps formed part of the initial discovery process. In the patent, Breed creates the rapid making and breaking of the electrical circuit by the use of a rotating wheel with randomly spaced contact points on its outer edge which he calls a "break wheel". Breed recommends that this break wheel should either be turned by clockwork or alternatively, powered by a small electric motor attached to the same battery as the electromagnet. Although not explained in the patent, the non-regularity of the pulsations in the string's electrical circuit is an important factor in the performance of the instrument. Pulsations that are too regular would cause the instrument body to resonate in a much more pronounced manner at those frequencies that matched the rate of pulsation, thus producing prominent wolf tones and making the instrument acoustically imbalanced.

The first use of the method that Breed describes in his patent is as a signalling device. In fact, Breed suggests that the circuitry of his design lends itself particularly well to telegraphy, in that it allows simultaneous transmission of multiple signals on the same wire. The circuit described in this part of the patent was slightly more complex than that used for the musical instruments, employing four independent circuits and lacking the clockwork break wheel.

The greater part of the patent concerns the application of Breed's method to musical instruments, and he gives examples of its application to the piano and the guitar. The design for the piano shown in the patent is more of an example of the possibilities of the circuit as applied to the keyboard instrument rather than a fully-realised instrument design. It is immediately apparent that keyboard instrument aspect of the patent is not nearly as developed as those of the signalling device and guitar. There are two drawings in the patent that relate to the piano circuitry; an overhead view of the proposed instrument and a drawing detailing its circuit. (As noted above, the implausibility of this instrument as shown is readily apparent: while the instrument illustrated has a keyboard with well over one hundred keys, strings are only depicted

for about 40 keys). A single large electromagnet is shown, through which the strings pass. Interestingly, unlike the electromagnet shown for the guitar (see below), this electromagnet does not appear to have any pole pieces for concentrating the magnetic field on the strings. The design includes multiple break wheels with different contact surfaces (smooth, medium and rough) that can be controlled in combination in the manner of organ stops. In addition to the break wheel tone controls, a pair of pedal-operated rheostats are shown, which would adjust the level of volume produced by the keyboard by restricting the amount of current to the strings. No details of the keyboard action are shown, only a simple key-lever with a small metal contact piece opposite the key end which rises when the key is depressed to make contact with the electrical switch, thus completing the circuit. The mechanism resembles that of a clavichord; however, unlike a clavichord, the key velocity has no impact on volume and the sound of each note is produced by a single vibrating string.[5] Breed's guitar, depicted on the fifth and final page of the patent's drawings, is shown with far more realism and detail than the piano. Breed was probably not a trained luthier; he uses unusual nomenclature for the parts of the guitar, including "head" for the body, "stem" for the guitar neck and "sounding-wires" for the strings.[6] Although the drawings and description of the guitar in Breed's patent appear to be quite comprehensive, closer examination shows that the patent conceals as much as it reveals about the guitar's circuitry and physical construction. It should be made clear at this point that this

5 The clavichord is a stringed keyboard instrument, popular in Europe from the late 15th to early 19th centuries. It has probably the simplest action of all keyboard instruments. When a key is pressed, a small metal wedge called a tangent strikes the string that produces a sound. Unlike a piano hammer, the tangent remains in contact with the string for as long as the key is depressed. A more forceful keystroke creates a louder sound, a softer stroke a quieter one. Before the invention of the piano, the clavichord was the only stringed keyboard instrument to have key-articulated dynamics. Edwin Ripin et al., "Clavichord", Grove Music Online, Oxford Music Online, OUP, on line: https://doi.org/10.1093/gmo/9781561592630.article.05909, accessed September 21, 2013.

6 Throughout the document, Breed uses the terms "sounding-wires" and "strings" interchangeably.

instrument, although powered by electricity, is not an electric guitar in the way that the term is generally understood. With an electric guitar, sound is created by the interaction of a vibrating ferrous metal string with an electromagnetic pickup which produces a signal that is then amplified through a loudspeaker.[7] Although there is a superficial physical resemblance between the electromagnet in Breed's design and an electromagnetic pickup, the employment of electromagnetism in the circuitry of Breed's guitar is not to amplify its volume, but rather to create its timbre.[8] While the strings in Breed's guitar (and the other applications in his patent) are set into motion by an electromagnetic means, it is still an acoustic instrument.

Breed's application of his patent to the guitar results in an instrument with several noteworthy playing and construction characteristics. One notable aspect is Breed's specification of metal strings. Conductive metal strings are required because the guitar's strings form part of the electrical circuit. Interestingly, Breed does not specify what type of metal should be used for the strings; since the strings help to create resistance in the circuit, their composition is a significant factor. Strings made of copper, a highly conductive metal, would have a low resistance, enabling the string to function in the circuit the same way as an electrical wire. Strings of iron or steel, which is not nearly as conductive as copper, have a much higher resistance and would function in the circuit much less efficiently, effectively adding a resistor to the circuit, and creating much more heat than the copper wire. Breed also suggests the possibility of employing non-metal strings wrapped with a conductive material.

The strings of the guitar pass through an electromagnet which is on a separate circuit, and which possibly uses a second power source. The guitar's electromagnet has six pole pieces which focus the electromagnetic field on each string as well as decreasing the magnet's weight. The

7 While some guitars use other pickup systems, such as the piezoelectric (the Parker Fly for example), the vast majority of modern electric guitars, especially solid body types, employ electromagnetic pickups.

8 This resemblance is especially striking between Breed's electromagnet and George Beauchamp's electro-magnetic pickup on the 1931 Rickenbacker "Frying Pan" electric guitar.

electrically charged strings are attached to a metal bridge that is connected to the clockwork break wheel mechanism which is then connected to one terminal of the battery. The other terminal of the battery is connected to one of two rheostats, which regulate and limit the flow of current in the string circuit. The rheostats in turn are connected to the frets, which in effect become multiple contact points. The string is set in vibration by pressing the string against one of the frets, thus completing the electrical circuit. The frets do not completely span the fingerboard but are divided between the third and fourth strings. This allows the treble and bass strings to be on two different circuits, each one controlled by one of the two rheostats and allowing for differing volumes between the two groups of strings. Breed states that the function of the rheostats is to equalise the volume between the different groups of strings and not to raise and lower the volume of the instrument as with the volume control of a modern electrified instrument.

Since this guitar can only be sounded in the manner intended when a string is pressed against a fret, it follows that, unlike a conventional guitar, open strings cannot be used in playing. Breed, however, seems to have accounted for this in his design by the use of a neck which meets the body at the 13th fret rather than the 12th fret as was more typical of the guitars of his day. This 13-fret neck seems to imply an E-flat tuning that would allow the pitches that would normally be open strings on the guitar to be played by playing the first fret.[9] One of the implications of Breed's method is that, unlike on a conventional guitar, the right hand is not used for setting the string in motion. This allows both hands to be used in playing the instrument, a feature that Breed acknowledges. Two-handed fingerboard techniques would become popular by the second half of the twentieth century (The playing of such guitarists as Eddie Van Halen and Stanley Jordan, or instruments such as the Chapman Stick are notable examples

9 There are modern acoustic guitars with 13-fret necks (but without a specifically E-flat tuning), such as the H15 model made by the Santa Cruz guitar company, which aim to create a compromise between the tonal quality of the 12-fret neck and the utility of the 14-fret neck. Interestingly, the Santa Cruz instrument's body is based on the same type of small-bodied American guitars as Breed's design.

of contemporary two-handed playing), but this appears to be one of the earliest mentions of the technique, if not the first.

From the time of Breed's invention until the mid-1920s, this guitar almost certainly would have been powered from wet-cell batteries. As with the electromagnets of Breed's day, so, too, the batteries available to him would have been large, cumbersome, and not particularly efficient, especially when compared to those available in Europe during the same period[10]. The inability of the batteries of the time to provide large amounts of current economically would have severely limited the guitar's electrical efficiency and the length of time it could be played for without recharging, which may have been as short as a few minutes[11].

Irrespective of the problems with electromagnets and the power supply, the electrical circuit of Breed's design offers some additional quirks that contribute to its impracticality as a performer's instrument. The most noteworthy of these is the tendency for the guitar to go out of tune. A current in the string that is strong enough to react to the magnetic field also tends to heat the string, which in turn causes the metal of the string to expand, making the string go flat; this effect can be quite pronounced[12]. This tendency to detune would have also limited

10 Richard H. Schallenberg, "The Anomalous Storage Battery: An American Lag in Early Electrical Engineering", *Technology and Culture*, vol. 22, n° 4 (Oct. 1981), p. 725-752.

11 An Edison battery catalogue of the time gives the price of a rechargeable type "A" wet cell battery (the smallest standard size, weighing 1 ¾ lbs. when filled, and which was typically used for powering telephones) as $0.75 with the price of the consumable materials used for each charge (Zinc and copper plates, caustic potash and paraffin oil) as $0.18. This is equivalent to $17.14 and $4.11 respectively in 2006 prices. For context, the average weekly wage of an American worker in manufacturing in 1890 was $8.56. More powerful batteries were, of course, proportionally larger, heavier and more expensive. Edison Mfg. Co., The Edison-Lalande Battery, New York, *c.* 1891. Lawrence H. Officer & Samuel H. Williamson, "Purchasing Power of Money in the United States from 1774 to 2006", MeasuringWorth.Com, August 2007, http://measuringworth.com/calculators/ppowerus/. Clarence D. Long, *Wages and Earnings in the United States* (1860-1890), New York, Arno Press, [1960] 1975, p. 42.

12 On a reproduction of the circuitry made by the author, the strings were found to go flat within a matter of seconds.

Breed's invention's usefulness as the signalling device previously discussed. Another idiosyncrasy inherent in the circuitry is that playing two or more strings on the same circuit (either the bass or treble) simultaneously results in an overall decrease in volume since the energy in the circuit is then divided between them. It is possible that the division of the strings into two circuits was an attempt to minimise this problem.

The on-off, back and forth motion produced by the Lorentz Force and the break wheel creates a sound not dissimilar to a cross between a traditionally played Neapolitan-style mandolin (but with a much more rapid repetition and softer attack) and the scraping of a plectrum along an electric guitar string, in the manner of a rock guitarist. The break wheel adds a fair amount of noise to the sound, both from the clicking and sparking of the contact blade against the wheel and the noise from the clockwork mechanism. If an electric motor, especially of the type available in the 1890s, were substituted for the clockwork mechanism (Breed suggests this possibility in his patent), it would likely only replace one kind of added noise with another. It should also be noted that, even under optimal conditions, the constantly varying temperature of the strings due to the flow of the electricity through them makes a constant pitch difficult to maintain, creating a slow, semi-measured, almost vibrato-like effect.

From the foregoing, one should not assume that the science behind Breed's design is unsound. The reason that Breed's design was not commercially successful was probably not poor science but the inability of the nascent electrical technology of the day to fully exploit his ideas.

Given all its problems, one has to wonder what Breed was trying to achieve with his design. Unlike later attempts at guitar electrification, Breed's design was not aimed at making a louder instrument. Nowhere in the patent does he claim that his design produces greater volume. In fact, it is doubtful that Breed was able to make his instrument anywhere near as loud as a conventional guitar. What Breed had developed was a stringed instrument that was capable of sustaining notes indefinitely while being fingered, a kind of electromagnetic hurdy-gurdy[13].

13 A hurdy-gurdy is a "mechanically bowed chordophone with three basic elements: a set of melody and drone (or bourdon) strings, a resin-coated

Although generally not appreciated as such, George Breed's guitar – represents an important step towards the electric guitar. While not amplified, Breed's design uses the Lorentz force like a modern electric guitar, only in reverse; Breed uses the Lorentz force to drive the string while Beauchamp's design uses the Lorentz force created by the vibrating string to create the electric guitar's signal. The ultimate significance of Breed's guitar inheres less in its functionality as a musical instrument than its importance both as the earliest known application of electricity to a fretted stringed instrument and in foreshadowing the electrical technology that would be applied, although in a very different manner, to stringed instruments, especially the guitar, forty years later.

DRIVING FORCES BEHIND THE ELECTRIC GUITAR

The one thing that all the preceding instruments discussed have in common is that they lack the one feature that most today would consider the defining characteristic of electric musical instrument; that is the employment of electromagnetic technology (*i.e.* an electrically-powered amplifier and loudspeaker) for the amplification (as opposed to mechanical activation) of the instrument. In other words, for many people the entire point of an electrical musical instrument is that it is able to be louder than a non-electric one. This may be obvious, but it still needs to be pointed out that to create an electric musical instrument in the modern sense, three things are necessary: 1) a sound source to be amplified, 2) a means of a amplifying the sound source (pickup and amplifier), and 3) a method of acoustic reproduction of the amplified sound source (speaker). This change in the essential conception of electric musical instruments begins around the turn of the 20th century and was driven mostly by the invention and spread of telephone technology. Indeed, it will be shown that telephone technology would

wooden wheel which when made to rotate by a crank acts as a bow, and a keyboard with tangents that bear on the melody string or strings when depressed." Francis Baines et al., "Hurdy-gurdy", Grove Music Online, Oxford Music Online, OUP, accessed September 21, 2013.

continue to be the main driving force electric musical instruments until the late 1920s. It should also be noted that in contrast to more modern times, during this nascent period "amplified" was not synonymous with "louder". Indeed, due to the low power of many early amplifiers, it could be questioned whether some of these early amplified instruments were even as loud as their fully acoustic counterparts.

In order to understand the context of the invention of the electric guitar, the nature of the inventing process itself must first be examined. The popular concept of invention and the inventor in most people's minds is someone in the mould of Thomas Edison; the often eccentric genius creating contraptions from scratch in answer to a pressing need of society. Most, if not all, of the popular writers on the history of the electric guitar have stated that a need for greater volume, especially to compete with louder brass and percussion instruments in the dance orchestras of the early 20th century, was the primary impetus for the development of the electric guitar. While it is true that it was soon recognised and advertised that increased volume was a benefit available to players of the instrument, examination of the historical record does not bear out the suggestion that making the instrument louder was the primary motivation behind its invention. This is not as contradictory as it first might appear; although everyone is familiar with the expression "necessity is the mother of invention", it is actually very common that an invention precedes its practical application (Diamond, 2005, p. 242-244). One of the best-known modern examples of this is the ever-so-slightly tacky glue used on post-it notes. Created in 1968 by Dr Spencer Silver, a senior scientist at 3M's corporate research lab, it was originally developed to be a super-strong adhesive and was a complete failure for its original intended use. Dr Silver spent several years trying to find a practical application for his invention and it was not until 1974 that Arthur Fry, a 3M colleague of Dr Silver's, came up with the idea for the post-it note, (its first use being to mark the pages in a hymnal). It was not until 1980 that they were commercially mass-marketed.[14] In the

14 http://www.post-it.com/wps/portal/3M/en_US/Post_It/Global/About/History/, retrieved December 27, 2012.

case of the development of the electric guitar, the historical assertion that it was due to an increased need for a volume can be easily and empirically disproved.

The contention is typically made that, in the quest for greater volume, the sound box of the guitar was gradually increased in size until it became physically impractical to play. Then in turn, inventors turned to mechanical amplification to increase the volume of the instrument, before turning to electrical amplification, which became the final and most widely used solution to this "problem" (Evans, 1977; Wright, 1995).[15] However, a critical examination of these assertions shows that they are wrong or, at best, extremely misleading. There are a number of factors that determine the volume of a stringed instrument; string material, construction, instrument tessitura, playing technique, et cetera, and none of these can be considered in isolation. Regarding the first contention, after a certain, rather small, size, making the sound box of a stringed instrument bigger does not make it louder; no one would argue that a double bass is significantly louder than the much smaller violin, or that of a *bajo sexto* (a Mexican 12 string/6 course baritone guitar) is louder than a Neapolitan-style mandolin. What increasing the sound box of an instrument does do is change its timbre; it increases the lower frequencies of the instrument, which need more acoustic energy to sound comparable in volume to higher frequencies. This has the effect of making the instrument sound deeper and fuller, but has only a slight effect, if any, on the overall volume produced. A noteworthy example of this phenomenon is found in the "dreadnought" style guitar, developed and made famous by the C. F. Martin Company; the large sound box of the instrument was specifically designed to provide a deep-sounding accompaniment for singing, rather than a loud instrument for solo playing (Evans, 1977, p. 246). It should be noted that this phenomenon holds true regarding higher versus lower frequencies when electronically amplified; lower frequencies need much more powerful amplification to be heard at the same apparent volume as higher frequencies. This is

15 Richard R. Smith, *The History of Rickenbacker Guitars* [1st ed.], Fullerton, Centerstream, 1987.

why large public address systems used in rock/pop music concerts have much more powerful amplifiers for the bass speakers than for the high-frequency horns.

This is not to suggest, however, that increased volume was not a concern and goal of electrical experimenters and manufacturers of the time; contemporary magazine articles mention both recent advancements in sound reproduction and the need/desire for ever-greater sound clarity and volume in radios and phonograph players.[16] However, it is noteworthy that the same complaints are not made concerning stringed instruments; although the banjo was one of the first stringed instruments to be amplified (as will be discussed below), previously no one seemed to be complaining that banjos could not be heard over other instruments. It is clear, then, that before the 1930s, the quest for greater volume in stringed instruments was driven by novelty and electrical experimentation (both of which can be considered zeitgeists of the 1920s especially) rather than a perceived lack in the volume-producing capabilities of stringed instruments by musicians themselves.

EXPERIMENTERS OF THE 1920S

For the greater part, early electric stringed instruments were the province of experimenters, not working musicians. This was often reflected in their designs, which were commonly radical and minimalist – both ergonomically and aesthetically – compared to conventional musical instruments. Later electric string designs, especially those intended for commercial manufacture, were typically based more on traditional instruments – most likely to help in the appeal to musicians.[17] The vast majority of these early experimental amplified stringed instruments were

16 "Electric Amplifier Developed for Fretted Instruments," *The Crescendo*, January 1929, p. 20.

17 It is almost axiomatic that musicians tend to be notoriously conservative when it comes to their taste in, and choice of, instruments. Witness that the vast majority of violins are based on a handful of models by three or four historical makers and a similar majority of electric guitars can trace their lineage two models made by the Gibson and Fender companies.

3. Joseph J. McCrann's, "Radio Violin", *Popular Science*, Oct. 1922

based not on fretted stringed instruments, like the guitar, mandolin and banjo, but rather on violin family instruments, most often the violin and cello. However, these instruments often only bear a passing resemblance to their acoustic namesakes.

For example, the October 1922 edition of *Popular Science* magazine depicts Joseph J. McCrann of Lowell, Massachusetts, playing his newly invented "radio violin[18]" (**fig. 3**). A cursory examination of the instrument however, reveals it to have very little in common with its relatives made by Stradivari. Physically, the instrument consists of little more than a stick of wood – possibly a cut-down broomstick – with the addition of a pickup and a ukulele key as a tuning peg. The pickup appears to be repurposed from phonograph and seems also to function as the instrument's bridge. The brief article in *Popular Science* states that McCrann "transmits music by radio" but this is not to say that he was broadcasting this instrument by radio waves in the way that we would understand this today. Rather, it simply means that McCrann was using radio technology, that is to say the amplification stage of a radio, to reproduce the sounds of his instrument. McCrann's instrument is, in essence, an amplified diddley bow[19] played with a violin bow. It should be noted that this picture seems to have confused more than one later researcher who was unfamiliar with the confusion and conflation of the terms "radio" and "amplified" by both journalists and the general public during this nascent period (Candelaria and Kingman, 2012, p. 12).

The cover of *Radio News* magazine for April 1927 depicts a violin player on stage playing an amplified violin through an amplifier and speaker to a huge audience (**fig. 4**). However, the actual setup depicted in the magazine is much more humble, a violin with a carbon-button pickup and a horn-type radio speaker. In the first paragraph of the article, the author explains his motivation for the creation of his amplified "giant-tone" violin:

18 "A Radio Violin," *Popular Science*, October 1922.

19 A diddley bow is a one-stringed instrument, common to the American South, which is typically played Hawaiian-style with a glass jar in the left hand and a plectrum in the right hand. American musician Bo Diddley took his stage name from the instrument.

4. Cover of *Radio News*, April 1927

> A dance orchestra leader, who also plays a violin, asked the writer recently if the violin music could be amplified electrically, so that it could be heard all over a large dance hall above the music of a piano and the loud wind instruments. He thought this would be a profitable novelty and would, as well improve the quality the dance music by making the director's instrument dominate all the others[20].

At first it may seem that this contradicts the assertion made previously that it was not lack of volume driving the development of the electric guitar. However, it is clear from the passage that it was the novelty of the concept – as well as the notion of being able to more easily dominate the band – that was the real impetus behind the idea[21]. The article also seems to suggest that the apparatus works because the violin is already capable of producing a significant volume. The carbon-button pickup was mounted on a long thin bolt (which possibly acted as a metal reed) that was attached to the violin's treble *f* hole – the author of the article noting that drilling a hole in the top of the instrument would make a better mounting, but that the instrument's owner was hesitant to have this done. The pickup mounting on the giant-tone violin left the carbon-button floating about an inch and a half to two inches above the soundboard. This positioning would have made it somewhat inconvenient for both bowing and pizzicato playing.

As a group, these early electrical stringed instruments routinely ignored playing considerations in favour of electrical and technological ones. Almost certainly, this is due to the fact that the developers of these instruments were engineers and tinkerers, rather than traditional luthiers. It is significant that these early electric stringed instruments were much more likely to appear in the pages of *Popular Science* than the *Music Trades Review*; this suggests that the main appeal of these instruments was their technological innovation and novelty rather than the actual music created by them. This being true for both the instrument's inventors and the public who read about them in magazines.

20 R. F. Starzl, "The Giant-Tone Radio Violin", *Radio News*, April 1927.

21 The article also seems to suggest that the apparatus works because the violin is already capable of producing a significant volume.

This is not to say that all the developments in electric stringed instruments during the 1920s were by amateurs. The first commercially available electrically amplified stringed instrument was the "Electro" made by the Stromberg-Voisinet company around 1928/1929. While some have asserted that these were the first electric guitars (Wright, 1995, p. 89), the Stromberg-Voisinet Electro does not meet the definition of an electric guitar in the way that is usually understood. While the pickup on these instruments was electromagnetic, they did not use the electromagnetic technology in the same fashion (that is, using the string as the armature) as George Beauchamp's design. The instruments were prominently featured in a full-page advertisement within the section featuring the Stromberg-Voisinet company's products in the 1929 Chicago Musical Instruments (CMI) catalogue (**fig. 5**). The catalogue advertisement shows the Electro's amplifier along with four different models of Electro amplified instruments; a guitar, a tenor guitar, a tenor banjo and a long-scale plectrum (four-stringed) banjo.[22] The new line of Stromberg-Voisinet Electro instruments appears to have been fairly well publicised; half-page articles on the instruments appeared in *The Music Trades* issues in both the October 20 and November 17, 1928 while the November 24, 1928 issue of the *Music Trade Review*, gives the Electro a prominent position in its "Musical Merchandise" section.[23] The January 1929 issue of *The Crescendo* also has a short article on the Electro.[24] It should be noted that all three of these articles use much the same language, which makes it almost certain that they were written from the same source – most likely a press release given out by Stromberg-Voisinet. The October 20, 1928, *The Music Trades*

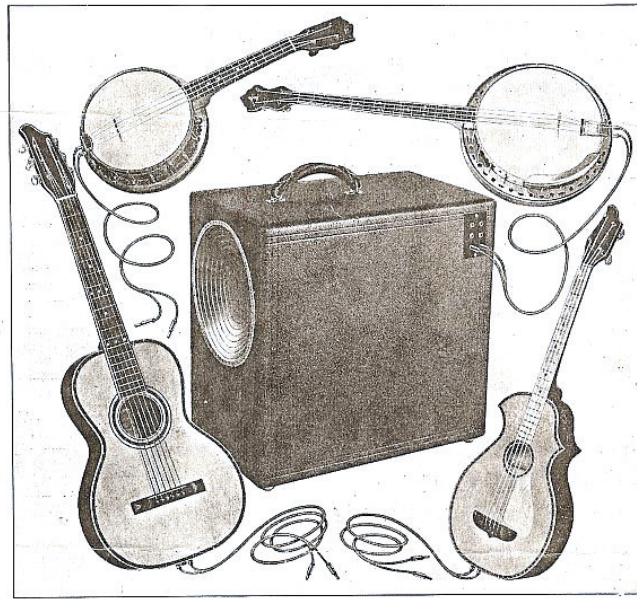
22 The tenor banjo and the plectrum banjo are often confused; the plectrum banjo is essentially a five-string banjo with the short fifth string removed while the tenor banjo, which also has four strings, has a string length that is much shorter than the plectrum banjo, to facilitate the playing of chords.

23 "New Sales Avenue Opened with Tone Amplifier for Stringed Instruments", The Music Trades, October 20, 1928; "Draw Banjo Volume from Tinkling Guitar", The Music Trades, November 17, 1928. "Electric Amplifier for Stringed Instruments", *Music Trade Review*, November 24, 1928.

24 See supra f.n. 17.

STROMBERG ELECTRO INSTRUMENTS

Electrically Amplified Guitars, Tenor Guitars, Banjos and Mandolins



The tone in these instruments is amplified many times, through a magnetic pickup built into the instrument which takes the vibrations direct from the sounding board, and passes it through a two-stage amplifier. Every tone is brought out distinctly and evenly, with a volume that will fill even a large hall. This outfit makes possible the use of these instruments in places where their lack of volume has made their use hitherto impossible. Two or three instruments may be used simultaneously if desired.

Operated from light socket, alternating current. No batteries required.

Price of Amplifier only, no instruments included	$165.00
Electro Guitar, Spanish or Hawaiian Style, fitted with Stromberg pickup	40.00
Tenor Guitar, fitted with Stromberg pickup	40.00
Mandolin, fitted with Stromberg pickup	40.00
Tenor Banjo, fitted with Stromberg pickup	50.00

(NOTE: If only direct current is available, your local electrical dealer can supply a converter for changing direct current to alternating.)

5. Stromberg-Voisinet "Electro" instruments and amplifier as depicted in the Chicago Musical Instruments wholesale catalogue, 1929

article states that the instruments were developed by Stromberg-Voisinet company secretary H. C. Kuhrmeyer and were currently in production. The article further states that a prototype guitar and amplifier were being demonstrated in the Chicago banjo shop of Milton G. Wolf[25] and that the instruments had been used by Guy Lombardo's Orchestra at the Granada Cafe and with "singular success" by Brunswick recording artists "The Vagabonds[26]".

By the middle of 1929, the Stromberg-Voisinet Electro had essentially disappeared from the market; no further mentions of it are found in advertising or trade publications. It is very possible that, due to the lead time for the publication of wholesaler/jobber catalogues, the Stromberg-Voisinet Electro was no longer actively being made or promoted by the time the advertisement for the instrument appeared in the Chicago Musical Instruments wholesale catalogue in the spring of 1929.

CONCLUSION

For an instrument that is little more than eighty-five years old, the electric guitar has more than its share of mythology and misconceptions, the foremost of which is that it's history only goes back eighty-five years. Electric musical instruments have a much longer history than is generally recognised, with the earliest example (the previously mentioned *Denis d'or* of Václav Prokop Diviš) dating from the 1740s. However, it is important to remember that these early electric instruments employed electricity as part of the operational mechanism rather than a means of amplification.

The second most common myth-conception concerning the electric guitar is that musicians' desire for increased volume was the driving force behind the development of the instrument. However, the historical record indicates that whilst increased volume was recognised as a benefit once the electric guitar had been invented, novelty, rather than loudness, appears to have been the primary factor motivating its invention; the earliest

25 Milton G. Wolf was a noted the banjo player of the 1920s who was featured in the 1926 promotional catalogue for Vega banjos.

26 The Music Trades, October 20, 1928.

attempts at inventing the electric guitar were not by professional musicians but rather by experimenters.

Although is it difficult to see from a contemporary vantage point, the rise of the electric guitar was not inevitable, but rather the sometimes random result of many twists and turns of technology mixed with a healthy dose of musical fashion. However strange they may seem, all of the instruments discussed here can be seen as premonitions and early incarnations – the hidden history – of what was to become a defining icon, and sound of the 20th century, the electric guitar.

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KEYWORDS

Electric guitar, George Beauchamp, Adolph Rickenbacker, Electromagnetic pickup, Rickenbacker, Electro String Corporation, Denis d'or, Václav Prokop Diviš, Jean-Baptiste Delaborde, Clavecin électrique, George Breed, Lorentz Force, Joseph J. McCrann, Stromberg-Voisinet, H. C. Kuhrmeyer

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