THE COMPLAINT OF THE MARKNEUKIRCHEN BRASS-INSTRUMENT MAKERS ABOUT THE POOR QUALITY OF BRASS FROM THE RODEWISCH FOUNDRY, 1787-1795

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(Editor's Note: The following article is a revised version of a paper read at the International Natural Horn Festival, 10 September 1993, at the Folkwang College of Music, Essen.)

1. Introduction

For the manufacture of brasswind instruments such as trumpets and horns, the copper-zinc alloy brass has been employed for predominantly technical reasons from the Middle Ages to the present. Present-day brass is distinguished by a high level of metallurgic purity, that is to say, the absence of impurities. In contrast, brass produced prior to the middle of the nineteenth century exhibited a more or less high content of trace elements, such as lead, tin, silver, and sulphur, as a result of the manufacturing processes of the time.

In connection with the reproduction of historical brass instruments, the question arises as to whether and to what extent this objective difference in material influences the playing qualities of the instruments. Some express the opinion that the instrument makers of that time were aware of and made conscious use of the positive effects of trace elements. I have already contradicted this view in an earlier article.[1] I remarked there that instrument makers, as a rule, did not have free choice of material, but were forced to use the brass that was produced within the territory of the sovereign state (country or city) in which they lived or, if the occasion arose, that which was offered on the black market. This restricted source of supply was additionally limited by a nearly constant shortage of raw materials. Thus the purchase of brass was above all contingent on the availability and, not least, the price of sheet brass.

Based on a detailed account from the years 1787 to 1795, I would like to show the extent to which these two aspects could influence the purchase of brass. The case at hand has to do with a complaint by the brass-instrument makers in Markneukirchen in the Electorate of Saxony about the poor quality and comparatively high price of sheet brass from the foundry in Rodewisch-Niederauerbach, Saxony.

I first found references to these proceedings in a book on the history of Markneukirchen, published in 1925.[2] In the course of my research, Prof. Dr. Hans Otto Gericke of Magdeburg called my attention to relevant documents in the Staatsarchiv (State Archive) in Dresden. I would like to take this opportunity to express my heartfelt thanks to Prof.

Dr. Gericke for this information as well as for the very valuable additional source materials concerning the Rodewisch brass foundry that he placed at my disposal.

In May 1990 I had an opportunity to examine some important documents in the State Archive in Dresden. Preserved there is a bundle of manuscripts from the *Churfürstlich Sächsischen Landes-Oeconomie-Manufactur- und Commercien-Deputation* (Electoral Saxon State Economy-Manufacture- and Commerce Delegation [= State Trade Council]) in Dresden. Since the papers are not chronologically ordered and contain some unrelated correspondence, the State Archive placed the entire set of documents, in the form of photographs, at my disposal for detailed evaluation. For this, too, I should like to express my sincere thanks.

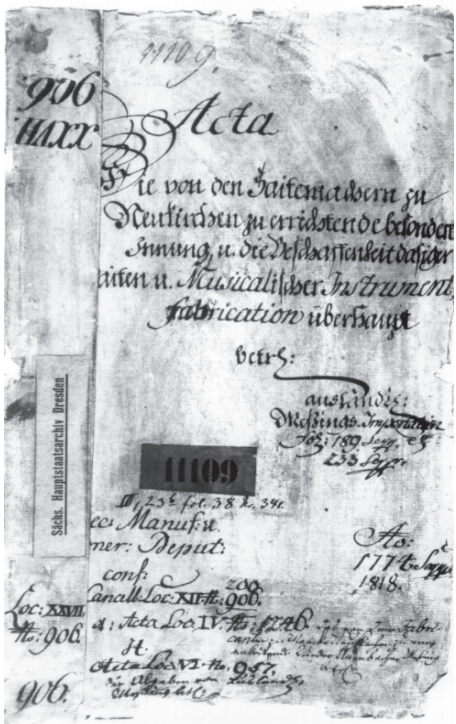


Figure 1: Title page of the ACTA, part 1: Documents pertaining to the special guild to be established by the string makers of Neukirchen, and the general state of the string and musical instrument manufacture there / foreign / brass importation. (Photo: Staatsarchiv Dresden)

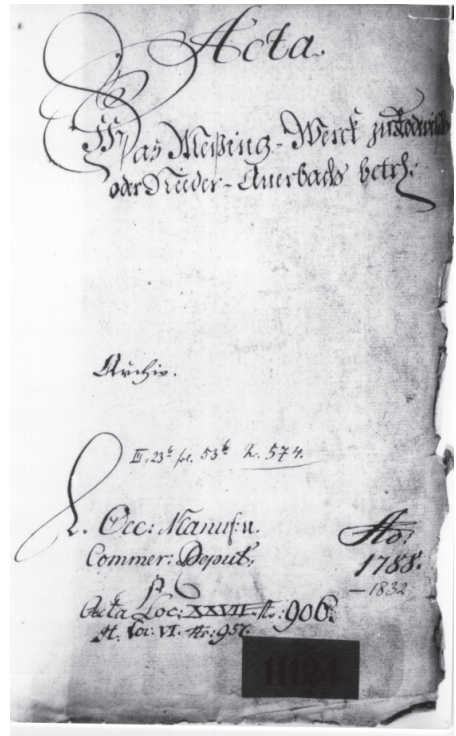


Figure 2: Title page of the ACTA, part 2: Documents pertaining to the brass works in Rodewisch or Nieder-Auerbach. (Photo: Staatsarchiv Dresden)

2. Disposition and content of the documents

The complete bundle of documents (henceforth ACTA) consists of two parts; their title pages are shown in Figures 1 and 2. Both groups of documents are for the most part indiscriminately bound together, and some have handwritten copies. They deal with the following subjects:

- A complaint by the Markneukirchen brass-instrument makers about the poor quality of the brass from Rodewisch (main part of the ACTA).
- A complaint by the violin and (string-) bass makers in Markneukirchen about problems with the supply of wood required for instrument making.
- A complaint by the string makers in Markneukirchen about problems with the supply of sheep gut required for making strings.
- A petition by an untrained but highly successful string maker in Markneukirchen for admission to the trade.
- A request by the brass-instrument makers in Klingenthal (approximately five kilometers from Markneukirchen) for permission to establish aguild.

After arranging the documents according to subject matter and chronology, it is possible to present a complete account of the complaint by the Markneukirchen brass-instrument makers and the course of the proceedings initiated by them from the first mention of the problem to its final settlement—a period of eight years. In the following narrative of the proceedings, the text—often very difficult to understand in the original and for the most part written in indirect speech (legal language)—has been put into direct speech and abridged, as far as the contents allow.

For a better understanding of the proceedings, a short description of the political and economic situation in the Electorate of Saxony at the end of the eighteenth century will be helpful.

3. The political and economic situation in Saxony at the end of the eighteenth century and its effect on the instrument makers in Markneukirchen

The Electorate of Saxony, located in the center of Europe and surrounded by the "great powers" of Prussia and Austria, among others (Figure 3), stood under the absolutist rule of Elector Friedrich August III during the period under consideration. He successfully strove to mend the damages suffered by his domain during the Seven Years' War between Prussia and Austria (1756-1763). Moreover, he energetically pursued the economic reforms already begun under Friedrich August I (August the Strong). In 1764 he founded the *Landes-Oeconomie-Manufactur- und Commercien-Deputation* (hereafter, State Trade Council) and in 1782 *the Geheime Finanz-Collegium* (hereafter, Committee of the Treasury) as the central planning and guidance organs in Dresden[3]. Both authorities were subordinate to the state government, with the Elector at its head.

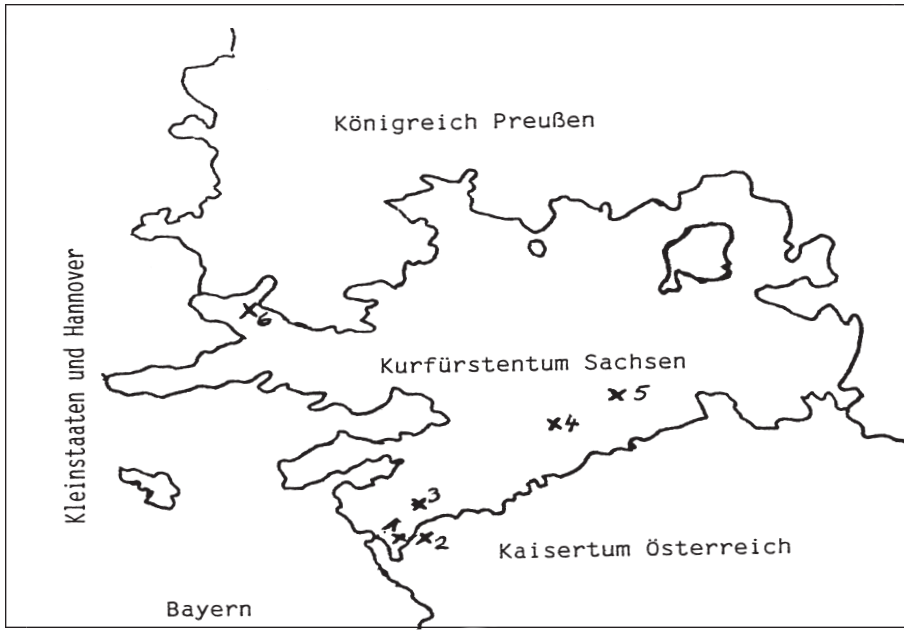


Figure 3:
The Electorate of Saxony (around 1800) and the locations of cities:
1 Markneukirchen, site of the instrument makers' homes and workshops.
2 Graslitz, site of the foreign brass foundry, 15 kilometers from Markneukirchen
3 Rodewisch-Niederauerbach, site of the domestic brass foundry, 45 kilometers from Markneukirchen.
4 Freiberg, seat of the Mining Regulatory Office and the School of Mining.
5 Dresden, residence of the Elector and the seat of the State Government.

In 1769 district and local authorities were appointed. Among their duties was the yearly compilation of reports for the state government in Dresden on the economic development in the administrative districts under their respective jurisdictions.[4] The goal of these organizational measures was the ability to facilitate planning and further the state's economic development, as well as to attain and maintain the greatest possible independence (a controlled economy). To this end, regulations intended to hinder or prevent imports were laid down (for example, the imposition of import duties) and, simultaneously, exports were supported. This economic policy, however, also favored the establishment and maintenance of monopolies.

All trades in Saxony, and consequently also the instrument makers in Markneukirchen, were affected by these measures and regulations. Thus, they were required, for example, to purchase the sheet brass necessary for the production of their instruments from the

brass foundry in Rodewisch-Niederauerbach (approximately forty-five kilometers from Markneukirchen). Since 1622 this foundry had held a monopoly, of unlimited duration, as the sole producer of brass in the Electorate of Saxony. It was successful in defending this monopoly against numerous attacks until well into the nineteenth century.[5] At the same time, the factory was protected by customs duties on brass imports from abroad.[6]

The Graslitz brass works in Bohemia, only fifteen kilometers from Markneukirchen but in the territory of the Austrian Empire, offered higher-quality brass at a lower base price. The brass-instrument makers in Markneukirchen, who had to pick up the required sheet brass from the factory themselves, therefore had very good reasons for wanting to use brass from the much closer foundry in Graslitz. All efforts in this direction, however, came to nothing because they were required to pay a duty of three Groschen per Taler of the product's value on the importation of "foreign" brass.[7]

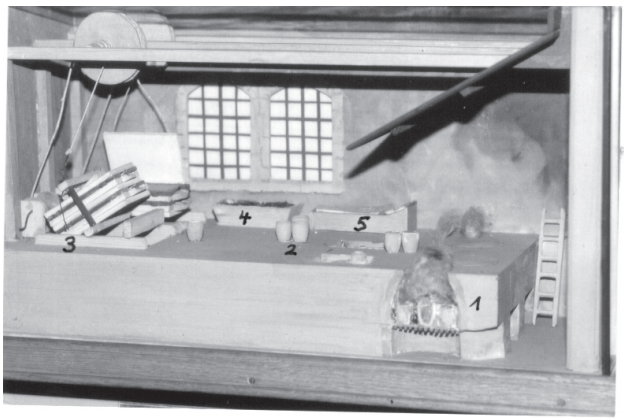


Figure 4:
Model of an eighteenth-century brass foundry (after Krünitz). Display in the Göltzsch Museum, Rodewisch, Saxony. (Photo by the author.)

1 Cementation furnace embedded in the floor of the foundry.
2 Crucibles.
3 Casting stones (forms), in casting position (front); laying (back).
4 Wooden 1 Cementation furnace embedded in the floor of the foundry box with coal.
5 Rest-place for the smelter.

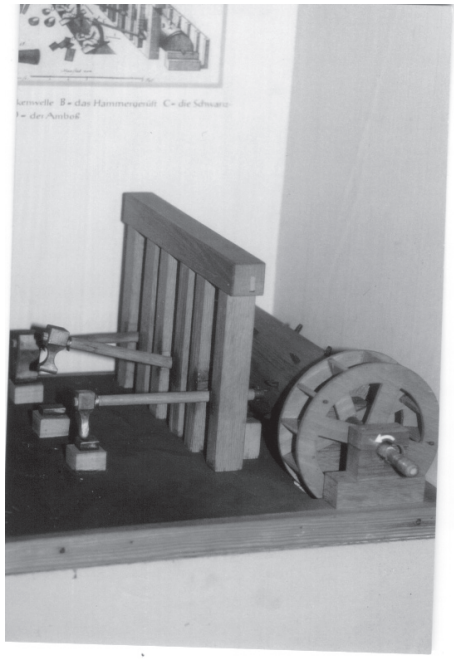


Figure 5:
Model of a brass hammer-works (after Krünitz). Display in the Göltzsch Museum, Rodewisch, Saxony. (Photo by the author.)

Figure 6:
Original crucibles from the brass foundry in Rodewisch-Niederauerbach (found after 1950 during road construction work). Display in the Göltzsch Museum, Rodewisch, Saxony. (Photo by the author.)

Figures 7:
Important dates and events in the histories of the Rodewisch and Graslitz brass foundries:

1593-1601	Conversion of an older iron foundry in Rodewisch to a brass foundry.
1603	Privilege for the exclusive production of brass in the Electorate of Saxony for a period of fifteen years granted by Elector Christian II.
1622	Privilege for the exclusive production of brass in the Electorate of Saxony granted to the Rodewisch foundry for an unlimited period by Elector Johann Georg I.
21 April 1677	Imposition of a customs duty of three Groschen pro Taler of value (corresponding to 12.5%!) on brass imports into Saxony; for transit shipments (to the Leipzig Fair, for example) the duty amounts to four Groschen pro hundredweight (corresponding to 0.5%).
ca. 1690	Brass production in Graslitz initiated by Count Nostiz.
1699	Count Nostiz suspends copper deliveries to Rodewisch.
27 April 1701	Confirmation of the customs regulations from the year 1677 (presumably as a result of the copper embargo imposed by Graslitz).
8 January 1705	Permission for the establishment of a rival brass foundry in Frauenstein, Erzgebirge, with the justification that the Rodewisch foundry cannot fulfill, in quantity and quality, the demand for brass in the Electorate of Saxony.
1 September 1705	Annulment of the above permission after energetic intervention by the owners of the Rodewisch brass works.
23 August 1745	Renewed confirmation of the customs regulations of 1677.
1788 - 1795	The period during which the complaint by the Markneukirchen instrument makers about the poor brass from the Rodewisch foundry and the request for duty-free import of Graslitz brass is processed. In February 1795 the request is granted for a period of six years.
ca. 1799	Suspension of brass production in Graslitz!
11 April 1802	Lifting of the customs regulations for brass imports following repeated complaints by the craftsmen and merchants in the Electorate of Saxony.
1812-13	Establishment of the first rolling-mill in Rodewisch (only a short, disappointing period of operation).
1816	Establishment of the second, more efficient rolling-mill.
	Introduction of metalic zinc in the production of brass.
1834	The production of sheet brass is completly converted to the rolling process, since "hammered sheets have become unmarketable."

(Sources: Gericke, *Die Geschichte des Messingwerkes Niederauerbach*; ACTA Dresden.)

4. The authorities and institutions involved in processing the complaint

The ACTA reveals the organizational problems that can result from an economic situation such as the one described above. As the schematic illustration in Figure 8 shows, there were eleven authorities, institutions, and interest groups, besides the instrument makers, participant to the proceedings. The final decision lay with the state government in Dresden, which was subordinate to the Elector, and thus with the Elector himself. The decision, however, was made only after all interested parties had expressed their points of view and their arguments weighed. In consideration of the means of transport and communication available then, it is obvious that this decision-making process was a long-drawn-out affair.

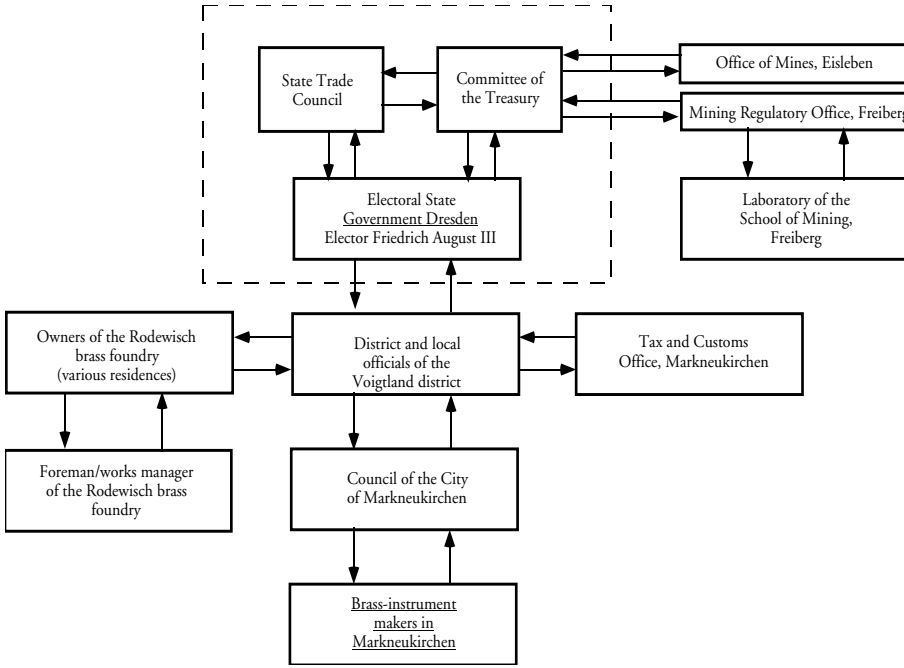


Figure 8:
Persons and authorities involved in the handling of the complaint:

5. The contents of the ACTA

5.1. The processing of the complaint from 1787 to February 1792

In 1787 the brass-instrument makers in Markneukirchen lodged a complaint with the city council about the poor quality of the sheet brass from the Rodewisch-Niederauerbach brass foundry (henceforth Rodewisch or Auerbach). They pointed out that the brass from the Graslitz foundry was of better quality and could be obtained in the required quantities at any time. It was, however, not possible for them to purchase the material since the brass works in Rodewisch held a monopoly, and the import of brass from abroad was forbidden. The instrument makers therefore requested permission to buy the sheet brass that they required in Graslitz.

The city council regarded the instrument makers' request in light of its potential for the furtherance of trade. Therefore it supported the request and forwarded it to the Voigtland district authorities. They, in turn, included the petition in their annual economic report for the year 1787, which was sent to the state government in Dresden at the beginning of 1788. The state government remitted the case to the State Trade Council for clarification of the questions raised.

In their initial reaction, the State Trade Council stated that to its knowledge the factory in Rodewisch did not have a "right to prohibit" (*Verbietungsrecht*) the importation of brass from abroad. Therefore, in a letter dated 20 August 1788 the district authorities were called upon to answer the following questions:

- Upon what authority is the cited "right to prohibit" based?
- What are the deficiencies of Rodewisch brass?
- Why is Graslitz brass better?
- How much brass is required by the instrument makers?

After clarification of the questions, the district authorities were requested to express their own opinion of the case.

The district officials forwarded the questions to the Markneukirchen city council and to the owners of the Rodewisch brass foundry and received the following answers from the former (presumably after renewed consultation with the instrument makers):

- Rodewisch brass is coppery, lead-like, and too strong (i.e. too thick). Moreover, cracks appear during annealing and hammering (i.e. forming).
- Graslitz brass is more purely smelted and can be more easily formed. Cracks do not appear during annealing and hammering. In addition, its color is much more pleasing.
- In comparison to Graslitz brass, that from Rodewisch is much heavier, so that with Graslitz brass one "receives five to six sheets more per hundredweight, and, as a result, [one] can also produce an additional four pairs of ordinary horns from such a hundredweight."

- The annual requirements lie between 16.5 and 20 hundredweights, depending of the state of the market.[8]

The answer from the owners of the Rodewisch brass foundry:

- On the strength of Electoral decrees from the years 1677, 1701, and 1745, a customs duty of three Groschen on every Taler of the product's value is to be paid on brass imported from abroad, and of four Groschen on every hundredweight of transit shipments (to the Leipzig Trade Fair, for example). The Rodewisch foundry has no general right to prohibit brass imports. The assertion to this effect by the Markneukirchen city council is thus "entirely contrary to the truth." They are, however, in possession of the *jure prohibendi* (in the present case, the exclusive privilege for the production of brass and the erection of brass foundries in Electoral Saxony).

To be sure, the factory-owners deferred the decision "to higher judgement," but they appended the following arguments "for the rejection of the unfounded reproach":

- For the production of brass in Rodewisch, only copper from the copper sales office in Eisleben is used. Copper ore from the Saxon mining fields of Eisleben and Mansfeld was processed in the oven at Mansfeld. The terms "Mansfeld copper" and "Eisleben copper" are synonymous. This is regulated by contracts "with highest confirmation" (i.e. state-guaranteed purchase and delivery contracts). In Graslitz, Bohemian copper is processed. The use of other sorts of copper in Rodewisch would have consequences for existing contracts.

- The export quota of the production in Rodewisch amounts to approximately fifty percent; consequently the quality of the material cannot be as poor as claimed by the Markneukirchen city council. On the contrary, Rodewisch brass is unequivocally superior in quality to the products from Salzburg, Kassel, Goslar, and Graslitz "The *Trommelmessing*[9] delivered" at the beginning of 1788 "to the Electoral Saxon Military is clear proof of its excellence."

- In addition, Rodewisch brass is employed with good results in Leipzig, "where indisputably more musical instruments are made than in Markneukirchen."

Because of the contradictory assertions by the two parties and the lack of detailed knowledge, the district authorities did not feel themselves to be in a position to proffer an opinion as demanded by Dresden. On the one hand, the dispensation from the customs duty could lead to a decrease in copper sales on the home market. On the other hand—also in the opinion of other "experts" and contrary to the assertions of the factory-owners—the Rodewisch brass displayed the stated deficiencies.

The district authorities doubted that an improvement in quality could be achieved through internal measures at the factory in Rodewisch. They saw the copper from Eisleben as the main problem. For this reason they left the decision concerning duty-free importation of Graslitz brass "to the wise discretion and the benevolent decision of His Electoral Excellency" (i.e. Elector Friedrich August III).

On 28 February 1789 the Committee of the Treasury informed the district authorities that they hesitated to grant the desired customs dispensation. The district authorities were ordered to

> admonish the owners of the brass foundry in Nieder-Auerbach to take pains to deliver to the makers of musical instruments in Markneukirchen the required brass in the same quality and at the same prices as that made in Graslitz in Bohemia, and not to give occasion for further complaints so that in the future there would not be any need for an easing of the import of foreign brass.

This warning obviously had no effect, for on 12 December 1791 the mayor of the city of Markneukirchen, in a letter accompanying the annual report of 1790-1791 by the district authorities, once again petitioned the state government in Dresden to "grant exceptional permission for the importation of the prohibited brass from Bohemia, because it is much better than that from Rodewisch, and also always available in the required quantities."[10]

The district authorities forwarded the Mayor's petition to the state government on 22 February 1792. They first recounted the course of the proceedings to date, and then appended the following additional arguments:

- The music-instrument industry in Markneukirchen has displayed a steady development and has become an important sector of the economy, producing increasing tax revenues. The district authorities therefore recommend supporting the instrument makers.
- If the renewed complaints by the brass-instrument makers are true, then this is proof that the owners of the Rodewisch brass foundry did not comply with the admonitions to improve the quality of material. Moreover, Rodewisch brass still costs fifty-eight Taler and that from Graslitz fifty-six Taler. The difference in thickness, which also had been a cause of complaint, is likewise still an issue.
- In addition, the instruments made of Graslitz brass apparently display a better "tone or sound," which "turns out much lighter and more refined."[11]

The district authorities procured specimens of Graslitz (sample A) and Rodewisch sheet brass (sample B), and included them with the letter. They requested that the samples be examined by experts, and a decision made accordingly.

In July 1792 the state government forwarded the case to the State Trade Council and the Committee of the Treasury. On 24 October 1792 the State Trade Council wrote to the Committee of the Treasury and requested that the enclosed specimens be examined, and that in accordance with the results a decision be made as to whether the duty-free import of Graslitz brass should be allowed "either immediately or *per modum restitutionis*."

In February 1793 the material samples were forwarded by way of the *Oberhüttenamt* (Mining Regulatory Office; i.e. the control board for mining and metallurgical engineering) in Freiberg to the School of Mining (the leading institute for research and instruction in mining and metallurgical engineering in Central Europe), also in Freiberg. The sheet thickness, surface properties, malleability, annealing characteristics, and composition of the samples were to be examined there.

In two separate reports from 21 and 22 February 1793, respectively, which included detailed descriptions of the processes employed, the Mining Regulatory Office was informed of the results.[12]

5.2 The material tests, the test results, and their evaluation from a modern point of view

5.2.1. The material tests and the test results

The tests were carried out by *Bergmechanicus* (mining engineer) G.F. Schubert and *Probierkundler* (testing expert) A.H. Klotzsch.[13] Schubert first cut both samples into equal pieces of 162 square lines and then weighed the samples. He determined a weight of 11/32 *quint* (0.23mm) for sample A and 1/2 *quint* (0.34mm) for sample B. Sample B was thus clearly heavier than sample A.[14]

Using the same samples, Schubert then tested their malleability and behavior during annealing. He reduced the thickness of the brass with a hundred uniform hammer strokes and then annealed the samples. He executed this cycle four times, and then determined the increase in surface area of the samples. In both cases it amounted to 150 square lines.[15]

The total surface area of the samples after working amounted to 312 square lines. The final thicknesses, calculated according to the formula given in note 14, came to 0.12mm for sample A and 0.17mm for sample B. The total reduction in thickness through working (cold-forming) was in both cases approximately forty-eight percent. Through hammering and annealing "several cracks" appeared in sample B, while sample A remained without cracks.

Following the scrape-cleaning of the samples (mechanical removal of the oxide layer that forms during the annealing process) and after the polishing of the surface, Schubert observed on sample B "somewhat more schistous spots than on A, which were already visible to the naked eye before examination, and even more so with the magnifying glass." Thus the assertions of the instrument makers concerning the surface of the brass were also confirmed.

Chemist Klotzsch first evaluated the color of the two brass samples, stating a "preference" for that from Graslitz over that from Rodewisch, "for the color of the Graslitz [brass] comes closer to that of pure gold; the color of the Rodewisch brass, on the other hand, is similar to gold that has become pale through mixing with silver." On this point too the assertions of the instrument makers were confirmed.

Klotzsch also determined a distinct difference in thickness between his samples. (He used a different method from Schubert, which does not allow conversion into millimeters.) From both samples Klotzsch cut a piece "3/4 inch in width by 7/4 inch in length," ascertaining the difference by weighing. Through "shortening" the heavier sample B by "a good 3/16 inch" he obtained pieces of equal weight.[16]

	A	B	C (supplementary sample)
Source of the sample	Graslitz	Rodewisch	Rodewisch
Description of the color	"like pure gold"	"like gold that has become pale through mixing with silver"	Not given
Brass thickeness at the outset	0.23mm	0.34mm	0.58mm
Description of malleabitility	No formation of cracks	Formation of cracks during hammering and annealing	"better ductility and, during annealing, fewer cracks" (in comaprison to B)
Test provisions: 100 unifrom hammer strokes and subsequent annealing = 1 cycle			
Number of cycles	4	4	5
Final thickness attained	0.12mm	0.17mm	0.27mm
Percentage of cold ductility	48%	48%	53%
Description of the surface (evaluation with the naked eye and with magnifying glass after scraping and polishing the surface)	no direct evalutation	"somewhat more impure; schistous points as on A"	"still black inclusions that should not be in good brass, which were not to be found in that of Graslitz"
Analysis			
Lead	not found	not found	not found
Sulphur	not found	not found	not found
Sulphur	not found	not found	not found
Zinc	remainder	remainder	not given

(Source: Acta Dresden)

Figure 9:
Characteristics of the brass samples A, B and C tested in Freiberg.

Since the Markneukirchen instrument makers supposedly suspected excessive amounts of lead and sulphur and/or excessive or unequally dispersed amounts of zinc, Klotzsch limited himself to the determination of these elements.[17] He employed samples the size of an "assay hundredweight" (*Probierzentner;* 1 Freiberger *Probierzentner* = 3.75g). He tested for lead and sulphur using a special chemical method. Even though he repeated the process, he found "neither lead nor sulphur" in the two samples.[18] Klotzsch determined the zinc content by placing previously weighed sample pieces "of both sorts in the most intense flame of a cupellation furnace, keeping them molten, only through the addition of borax, until a veil formed over the molten mass." (That is to say, he melted the copper and let the zinc evaporate.) He then weighed the remaining copper residue and ascertained a proportion of 74/100 in the Graslitz sample, and 75/100 in the Rodewisch sample. The Graslitz copper displayed "eine höhere Gare" (a more intensive redness), and the Rodewisch a more pale coloring. On the basis of the results of the analysis (no lead, no sulphur, and comparable zinc contents of twenty-six percent and twenty-five percent respectively), Klotzsch presumed that an uneven distribution of the zinc was responsible for the inferior malleability of the Rodewisch brass.

5.2.2. Evaluation of the test results from today's point of view

For easier comparison, the test results are listed in Figure 9 along with the results of a test carried out later on sample C (supplementary Rodewisch sample). Especially striking are the substantial differences in thickness. In principle it is entirely possible that Klotzsch cut the Rodewisch sample along the line y–y—that is, he reduced the width—to bring its weight down to that of the Graslitz sample. In this case the difference in thickness of thirty-two percent determined by Schubert compares to a difference in thickness of twenty-five percent determined by Klotzsch. Taking into consideration the technically unavoidable margin of error in the testing methods employed, these values at least lie within an acceptable range. This would then mean that the Rodewisch brass sample was approximately thirty percent thicker than that from Graslitz. If this difference was typical, the instrument makers had thirty percent less usable surface area for the production of their horns when using Rodewisch brass!

If one, however, can picture in one's mind the work necessary to cut the sample, depicted at actual size in note 16, by hand, it would seem much more likely that Klotzsch shortened the sample along the line x-x, and thus reduced the length of the sample. Klotzsch's use of the word "shortening" also supports this interpretation. The difference in thickness for the Graslitz brass calculated in this manner is then "only" 10.7 percent, deviating greatly from Schubert's thirty-two percent. This deviation can only be explained by considerable differences in thickness within the relatively small sample pieces. If we were to assume that the thickness of the Graslitz sample was largely constant, as the statements by the instrument makers seem to indicate, the brass thickness of the Rodewisch sample must then have varied considerably. On the basis of the present values, the thickness could have ranged between 0.26mm and 0.34mm. Such differences in thickness within a relatively small surface area of a few square centimeters must have presented the instrument makers with considerable

technical problems, especially in the production of instrument bells. It is therefore obvious that sheet brass produced by hammering would become unmarketable when, only a few years later, rolled brass, which was distinguished by a uniformity in thickness previously unknown, was introduced.[19]

Schubert expended the same amount of "forming power" on samples A and B (a total of 400 uniform hammer strokes). If the increase in surface area was the same (150 square lines) in both cases, the Rodewisch brass could not have been appreciably harder. With a greater hardness, the increase in surface area would have been less. When the instrument makers mention inferior malleability, this does not mean the same as "greater hardness."

That Klotzsch's analyses did not disclose any lead or sulphur is surprising, at least as concerns Rodewisch brass. The Eisleben copper employed in Rodewisch was "liquated" to extract the silver contained in the copper ore—that is, it was smelted in a special process with large amounts of lead.[20] It was technically not possible to remove the lead completely during the subsequent treatment. Consequently, with Eisleben copper one must always reckon with a small amount of lead (up to two percent). Moreover, the calamine required for the production of brass also contained lead.[21] Under these circumstances the Rodewisch brass at least could not have been completely lead-free. Yet if Klotzsch was unable to find any lead by means of the analytical process employed, it can be concluded that the lead content was very low, and that the Eisleben copper used was better than the authorities dealing with the case had claimed and were to continue to claim. In this context one must point out that, by and large, Eisleben/Mansfeld copper had a good reputation among the brass producers of that time.[22]

The determined zinc content of twenty-six percent and twenty-five respectively lie within the limits normal for eighteenth-century brass.

Klotzsch's surmise that the zinc in the Rodewisch brass was not uniformly dispersed is objectively false. With the smelting, casting, and shaping practices under consideration, as well as the given zinc content, and taking into account the physical principles in the forming of copper and zinc alloys, one has to assume in all events a homogeneous a-brass and a uniform zinc dispersion.[23] These physical principles were, however, not yet known. We should therefore posthumously forgive Mr. Klotzsch for his misinterpretation.

We can thus conclude that the two samples were not significantly different, and that the composition of the Rodewisch brass cannot have been the primary cause of the inferior malleability faulted by the instrument makers and confirmed by Schubert.

In his evaluation of the sample's surface, Schubert gives us a hint as to the possible—in my opinion, even probable—cause of the deficiency. He observes "schistous spots" on the Rodewisch brass, both in the original condition as well as after the four cycles of working, annealing, and subsequent scraping and polishing of the surface, and "black imperfections, which are not to be found in the Graslitz [sample]." When we consider that a "removal" of the surface takes place through oxidation of the surface during annealing, and especially through the subsequent scraping and polishing, these "spots and imperfections" are not just specific surface faults, but rather extend also to the deeper-lying core sections and presumably even throughout the entire cross-section of the brass sheet. This type of fault

occurs when the molten mass is insufficiently "degassed" and purified before casting. In order to avoid it, the molten mass must be thoroughly stirred with a special stirring rod (caliol), and the foam carefully removed from its surface.[24] If this procedure is not carried out properly, oxide particles can get into the casting, and the gases that are not set free (principally CO and CO_2) can form gas bubbles in the solidified brass bar. Both faults (oxide inclusions and gas holes) extend through the entire cross-section of the material and cause the formation of cracks during the working. The tendency to form cracks increases considerably the thinner the brass is hammered. The polished surface of a piece of brass having these faults displays more or less pronounced scurf (schist)[25] and dark spots, which under some circumstances can also be seen by the naked eye. Exactly this outward appearance was ascertained by Schubert.

To summarize, it must be stated that the deficiencies of the Rodewisch brass asserted by the Markneukirchen instrument makers (too thick in general, uneven thickness, poor malleability, and impure surface) were confirmed in full by the examinations conducted by the School of Mining. A critical analysis of the test results leads to the conclusion that the cause of the faults lay without exception in the production conditions at the Rodewisch foundry and not in the copper employed. Even more questionable therefore are the conclusions of the official authorities and private parties, who now come into play again.

5.3. The further disposition of the case, leading to the final decision in February 1795

In March 1793 the Mining Regulatory Office in Freiberg sent the two reports with the remaining pieces of the two samples and a cover letter to Dresden. The cover letter expressed the opinion that the ascertained deficiencies of the Rodewisch brass were a result "of the manufacturing process" in Rodewisch, and were to be avoided through a "more diligent smelting." Moreover, the Mining Regulatory Office recommended that they read the work *Traité de la Fonte des Mines* by Mr. Gengane.[26]

The Committee of the Treasury in Dresden sent the documents with the sample remainders, by way of the district and local authorities, to the owners of the Rodewisch brass works, and called upon them to state within six weeks whether they would be in a position to produce brass comparable to that of the competition, and to show proof of this with a new sample. If they could not do this, they would then be forced to accept the requested customs exemption.

The brass-works' owners at first declared themselves unable to express an opinion within the specified time limit. They pointed out that they lived far apart from another, and that they also had to consult the factor (technical works manager) in Rodewisch beforehand. They therefore asked for an extension of the deadline, which was granted them by Dresden.

The owners' statement must have arrived in Dresden in July 1793, for on 23 July the State Trade Council wrote to the state government, and related the brass-works owners' answer. The latter still continued to challenge the complaints with the following, in part irrelevant, arguments:

- The complaint by the instrument makers is already disproved in that the "most distinguished domestic and foreign mining and art experts evaluate Rodewisch brass very favorably."
- In spite of increasing competition, the works' brass exports are growing.
- If Rodewisch is unable to make delivery on time to foreign customers occasionally (during water shortages, for example, or because of the efforts to give precedence to deliveries for the domestic market), the latter prefer to completely shut down their production rather than take brass "from other brass works located much closer."
- Other instrument makers, especially those in Leipzig, have never complained about Rodewisch brass. Also the predecessors of the current instrument makers in Markneukirchen, and even the current makers themselves, never complained before. Furthermore, the Rodewisch foundry has constantly striven to further improve the quality of its material.

The owners addressed the test results submitted by the Freiberg School of Mining as follows:

- It is entirely incomprehensible that the Rodewisch brass should have a lesser degree of purity in comparison to that from Graslitz. Everyone who knows the production methods in both foundries is "convinced of the contrary." It is known that "often a fourth, indeed even more" of the brass produced in Graslitz "must be melted down again." The superiority of Rodewisch brass will be clearly proved by the enclosed sample C.
- It is true that the Graslitz brass is "of a more intensive red color," but that this is due to the copper employed there. The difference in color is, however, so minimal as to be negligible. And in view of its uniformity and the luster of its surface, the qualitative superiority of Rodewisch brass becomes especially obvious if one compares "not just small pieces, but rather whole sheets with another."
- It is also true that Rodewisch brass is somewhat harder. This is because of the Eisleben copper, which becomes harder and more brittle through the liquation process. If one wants to avoid this "really insignificant difference," it would then be necessary to employ Hungarian copper. This, however, would be "detrimental" to domestic copper sales as well as to the Rodewisch foundry. Moreover, the difference in hardness is so small that a change of raw material is completely unnecessary, and the working of the material in Markneukirchen into musical instruments is not hindered by it.
- Obviously, in normal industrial production one cannot always avoid variations in quality. For that reason, a proper evaluation is not possible on the basis of such small samples as in the present case. It is also "very probable that the instrument makers in Markneukirchen intentionally chose for the submitted

samples a piece of pure [brass] from Graslitz, and a piece of schistous [brass] from Niederauerbach."

- If one subjects the enclosed sample C to the same tests as A and B, it will become apparent that the Rodewisch brass differs from the Graslitz brass "in color and ductility only slightly or entirely imperceptibly"(!), yet demonstrates its qualitative superiority "all the more clearly in the other characteristics."
- In consideration of the above, the foundry's owners hope that the state government will retain "the highest word of command," including the customs regulations, "proclaimed for the benefit of the brass works." For the foundry "supports several hundred people, in part directly, in part indirectly," and brings "a substantial revenue into the land."
- They have now proved(!) that the "Neukirchen manufacturers have not had any disadvantage [through] the use of Niederauerbach brass. On the contrary, the requested free or eased importation of Graslitz brass would have highly detrimental results," for
- the instrument producers would then "charge a premium price" for their instruments because of the usage of Graslitz brass. This would then lead other instrument producers in Saxony to make the same demands. And then one must accordingly reckon with underhanded brass dealing.
- Moreover, the owners of the brass works in Graslitz will be able to point to the better quality, officially acknowledged even by Dresden, of their own product, and through this additionally endanger the sales of Rodewisch brass.
- Since in Austria one also has to pay a customs duty on brass imports, the owners of the brass works hope "confidently" that nothing will be changed in the existing regulations. It goes without saying that in the future they will "be most diligent as concerns their responsibility as well as their interest in the perfection of the brass factory," and take into "utmost consideration" the recommendations for improvement suggested by the Mining Regulatory Office in Freiberg during the production experiments that are to be carried out.[27]

In a letter dated 23 July 1793, the State Trade Council recommended that the state government have the sample that was chosen and sent by the factory owners themselves, sample C, tested, since the Council could not exclude the possibility that the instrument makers in Markneukirchen "intentionally" sought out a poor piece of Rodewisch brass. If, however, with sample C it should again turn out that the "Graslitz brass maintains some advantages over that from Niederauerbach in terms of lightness, ductility and color," it could then be assumed that the deficiencies could not be attributed to the production conditions in Rodewisch, but rather to the Eisleben copper processed there.

The above conclusion was both hasty and false in view of the facts. It demonstrated, however, that the State Trade Council was more inclined toward the point of view of the factory owners. The ascertained deficiencies also appeared to the Council to be unimportant since the instrument production in Markneukirchen continued to thrive. The Council

considered the instrument makers' complaints to be exaggerated. On the contrary, the doubts of the foundry's owners deserved "more attention," because a customs exemption for foreign brass could have an affect "also on other foreign products and articles such as iron and hardware." Also the customs duties on iron and hardware had, after all, the goal of fending off foreign products, in some cases superior in quality, from the Saxon market. Only through these customs duties could the prosperity of the Saxon economy be guaranteed.

The State Trade Council, however, deemed it necessary to "again seriously admonish" the foundry owners to provide the instrument makers in Markneukirchen with brass "in the best possible composition, for economic use, and at a just price." The State Trade Council then once again left it to the state government, "in most submissive obedience, to decide what that highest authority wishes, and to command us what is to be done."

Sample C was then sent by the same route, via the Mining Regulatory Office in Freiberg, to the School of Mining, and was again tested by Schubert and Klotzsch, using the same procedures. In his report of 7 September 1793, Schubert stated that with the same surface area of 162 square lines, the weight of sample C amounted to 7/8 quint; therefore the sample was approximately 3/8 quint heavier than the previous Rodewisch sample B.[28] Schubert again tested the malleability with cycles of a hundred hammer strokes and subsequent annealing. This time, however, he applied five cycles and achieved an increase in surface area of 186 square lines. He found that sample C had better ductility and "not as many cracks" as sample B. After scraping and polishing the surface, however, he found under the microscope "black defects that should not be in good sheet brass, and which were not found in that from Graslitz."[29]

In a letter of 12 September 1793, Klotzsch laconically stated that he has "treated" the sample "to the best of his ability," and was convinced "that absolutely no lead or sulphur is to be found in it." Both reports were again sent by the Mining Regulatory Office in Freiberg to Dresden with a cover letter. In it, the suggestion was made that Eisleben be admonished to produce "a purer and more ductile copper."[30] The Committee of the Treasury wrote on 12 September 1793 to the State Trade Council and reported that the comparative tests on sample C did not turn out "to the disadvantage" of the Rodewisch brass works.[31]

Concerning the suggestion that Eisleben be encouraged to produce better copper, the Committee of the Treasury replied that the mine management and the Office of Mines in Eisleben had rejected the suggestion. An improvement in the quality of copper involved higher costs and thus "an unnecessary extravagance," especially since the other copper consumers were satisfied with the quality provided. The Office of Mines therefore recommended that under the present circumstances the Rodewisch brass works employ non-liquated copper from the foundries "in Sangerhausen or from the Stanau foundry in the Neustadt district." The Committee of the Treasury was thus still of the opinion that a customs exemption for the import of foreign brass should not be granted. If, however, the State Trade Council should be of another opinion, the Committee of the Treasury would like to be informed of it.

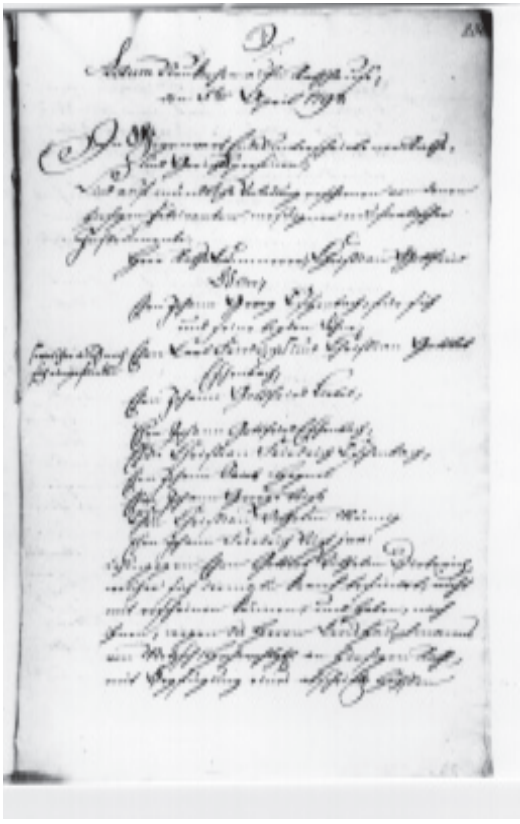


Figure 10:
First page of the protocol of the meeting on 5 April 1794 in the Markneukirchen town hall with the names of the instrument makers present, those who came late, and those absent. (Photo: Staatsarchiv Dresden)

Christian Gottfried Glier
Johann Georg Eschenbach (also representing his son, Karl Friedrich Eschenbach)
Christian Gottlob Eschenbach (son of Johann Georg Eschenbach)
Johann Gottfried Liebel
Johann Gottfried Eschenbach
Christian Friedrich Eschenbach
Johann Wilhelm Heynel
Johann Georg Voigt
Christian Wilhelm Mönnig
Johann Friedrich Voigt jr.
(Gottlob Wilhelm Dieterich absent because of illness)

Figure 11:
The brass-instrument makers present or mentioned at the "consultation" on 5 April 1794.

At this juncture the State Trade Council appears to have given serious consideration to a customs exemption, for in a letter dated 5 February 1794 the district and local authorities were requested to report, after careful investigation, the instrument makers' annual brass requirements. To this end, the district and local authorities consulted the *Land- und General-Accis-Einnahme* (Tax and Customs Office) in Markneukirchen and invited the instrument makers to a hearing in the town hall.

Consequently a meeting took place in the Markneukirchen town hall on 5 April 1794. In addition to the mayor and other "council and court persons," a total of ten brass-instrument makers were present (Figures 10 and 11). The instrument makers were first reminded of "their allegiance" and then asked to state their average yearly brass requirements. The instrument makers declared the requirements to be "approximately twenty hundredweights," whereby the requirements could "decrease or also increase," depending on the state of the market. At the same time, they pointed out that for several years they had "brought in little or no brass at all from Graslitz in Bohemia," because the previous foundry manager in Graslitz "died and some of the best factory workers have left." For this reason the quality of the Graslitz brass is presently even "much poorer than that from Rodewisch."[32] They ask for consideration of the fact that "in Rodewisch, a good six hours from here," they "are not always able to get good and sound brass in the gauges they require, and not always in the quantity they request." The brass from Rodewisch was still of uneven thickness, scaly, tended to form cracks, and was thicker than it should be.[33]

The instrument makers noted that these faults were not present in Graslitz brass five or six years earlier. They would now be satisfied if Rodewisch could offer them material of the quality that Rodewisch delivered to customers abroad and also to its own agency in Leipzig. If they then were to be charged the same price paid by the consumers in Leipzig, for example, they would "be all the more satisfied." The price in Rodewisch was at that time about one Groschen per hundredweight higher than the price in Leipzig and additional costs of eighteen to twenty Groschen per hundredweight accrued due to the great distance of transport. Moreover, "many times, when they did not receive the types of brass they requested, or even none at all, or at the most only a quarter or eighth of a hundredweight, they have also undertaken a fruitless, expensive journey."[34] The Markneukirchen instrument makers did, however, succeed in having an additional letter attached to the protocol of the meeting in which they requested the duty-free import of Graslitz brass in the event that Graslitz again became able to produce brass of the same quality as before.

On 11 April the district and local authorities reported the results of the inquiry to Dresden. According to them, the statements made by the instrument makers concerning the brass requirements agreed for the most part with the information from the Tax and Customs Office in Markneukirchen. The Tax and Customs Office drew up a table listing the use of domestic and foreign brass during the years 1788-1793 (Figure 12). The table shows that the average consumption amounted to 17 23/24 hundredweights per annum (840kg). The district and local authorities also forwarded to the state government the additional remarks made by the instrument makers and the cover letter.

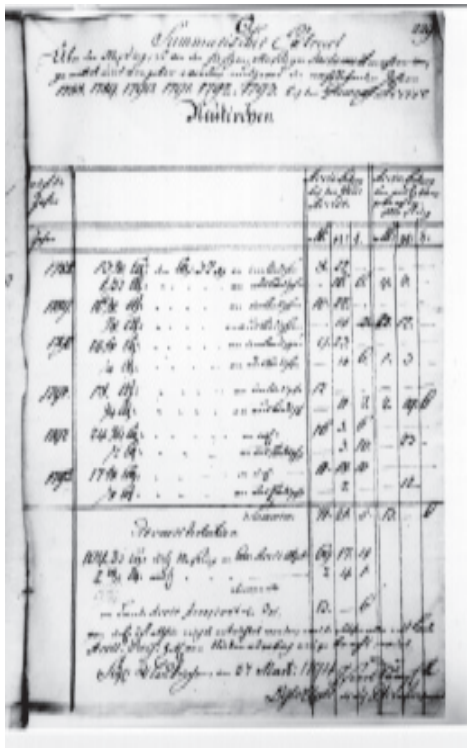


Figure 12:
Table from the "Land- und General-Accis Einnahme" (Tax and Customs Office) in Markneukirchen listing the use of domestic and foreign brass during the years 1788 to 1793.

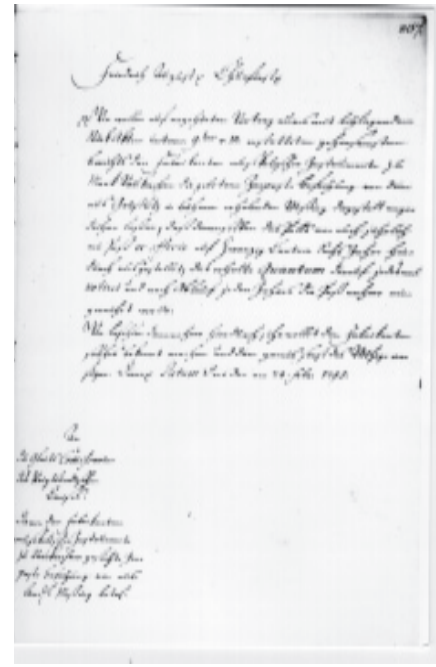


Figure 13:
Decree by the Elector Friedrich August III, dated 28 February 1795, granting the duty-free importation of twenty hundredweights of Graslitz brass per year for the period of six years. (Photo: Staatsarchiv Dresden)

Usage of domestic (Rodewisch) brass	= 104.22 hundredweights	
Usage of foreign (Graslitz) brass	= 3.53 hundredweights	
Total usage	= 107.75 hundredweights	= 17.96 hundredweights per year

(Photo: Staatsarchiv Dresden)

On 30 April 1794 the state government wrote to the Committee of the Treasury, recapitulating the correspondence of the previous months. They expressed doubt that the use of copper from Sangerhausen or from the Stanau foundry would be practicable in Rodewisch. The state government, though still opposed in principle to a customs exemption for brass imports, left the decision to the Committee of the Treasury, but desired to be kept informed.

The Committee of the Treasury, however, was obviously not capable of making this important decision, for after eight months the case was placed before the highest authority, Elector Friedrich August III. On 9 January 1795 the matter was orally submitted to the Elector (presumably by representatives of the State Trade Council and/or the Committee of the Treasury), and he finally had mercy on the Markneukirchen instrument makers. He allowed his state government, by decree dated 28 February 1795 (Figure 13),

> to grant the manufacturers of musical instruments in Markneukirchen the requested import exemption for the brass to be brought in from Graslitz, Bohemia, so that, for a period of six years, you annually issue them an official permit for twenty hundredweights. The quantity imported is to be noted on [the permit] each time, and, at the end of each year, the expired permit is to be surrendered.
>
> We thus hereby order that you inform the manufacturers of this and accordingly undertake the necessary measures.
> Dated Dresden, 28 Febr. 1795.[35]

Thus the case was finally decided after over seven years of proceedings. Even so it was not until September 1795 that the execution of the decree was clarified in all details and the district and local authorities as well as the Markneukirchen instrument makers informed of it. The ACTA ends here as far as the brass-instrument makers of Markneukirchen and their complaint about the poor quality of Rodewisch are concerned.

6. Conclusion

The entire process, from the first complaint by the instrument makers to the Council of the City of Markneukirchen through the granting of a permit for duty-free import of Graslitz brass, extended over a period of eight years. During this time vast quantities of paper were filled with writing; hosts of officials, lobbyists, technicians, and not least, office clerks were kept busy; and the patience of the instrument makers put to a very hard test. And in the end it did not even do them any good!

It is almost an irony of fate that the brass works in Graslitz never again recovered from the drop in quality mentioned at the April 1794 meeting in the Markneukirchen Town Hall. The problems in Graslitz continued, finally leading to the suspension of brass production in 1799.[36] With that, the owners of the Rodewisch brass works had one less serious competitor, and now even less reason to undertake special efforts to improve the quality of their brass. We can certainly imagine the consequences this could have had for the instrument makers in Markneukirchen. Perhaps it was a small consolation for them that only a short time later the "alarm-bells" were also to ring for the Rodewisch works. For in April 1802, after energetic and repeated complaints by other craftsmen and merchants in Saxony, the customs regulations for brass imports from abroad were lifted.[37] The dominant position of the Rodewisch brass foundry was thus ended and could not be regained even through

the improvements made in the production processes and the technical plant during the nineteenth century.[38]

When considering the case, the question arises as to whether this was merely an unfortunate isolated instance or whether the conditions described were symptomatic for the situation in Saxony or even in other Middle European regions such as Nuremberg, for example. My findings clearly indicate that such problems were common. The documents contained in the ACTA relating to the violin and bass makers as well as to the string makers in Markneukirchen reveal exactly the same kinds of difficulties:

- The craftsmen were required to purchase the necessary raw materials (wood and sheep gut) on the domestic market.
- The raw materials were not available in the required quality and/or quantities.
- A customs duty had to be paid on wood imports from abroad.
- Important decisions were hindered through antiquated government decrees, professional jealousy, and/or the provisions of guild statutes.

Figure 14:
Made of Graslitz or Rodewisch brass? Horn by Karl Friedrich Eschenbach, Markneukirchen, 1792. Object No. 776, Music Instrument Museum, Markneukirchen.
(Photo: Musikinstrumentenmuseum Markneukirchen)

Figure 15:
Most probably made of Rodewisch brass: Trumpet by Johann Georg Voigt, Markneukirchen, 1801. Object No. 982, Music Instrument Museum, Markneukirchen.
(Photo: Musikinstrumentenmuseum Markneukirchen)

During the "classical" period of brass-instrument production (the sixteenth through the eighteenth centuries), the conditions in the Free Imperial City of Nuremberg (like the larger Saxon state, an independent administrative and economic area with mercantile character) were comparable to those in Saxony. We must accept the idea that renowned instrument makers such as Schnitzer, Nagel, Haas, Ehe, Hainlein, and Kodisch did not have any special privileges beyond those of the other trades in Nuremberg. They were subject to exactly the same generally valid official decrees, regulations, and market conditions. Characteristic of this was

- that only the brass burners and brass hammerers were allowed to produce brass and sheet brass, and
- that the craftsmen could only employ domestic (i.e. Nuremberg) brass.
- In Nuremberg, brass imports from abroad were even forbidden!
- Material shortages were a chronic problem.
- The price of the material played a dominant role.[39]

Taking this into consideration, we have to assume that neither in Nuremberg nor in Markneukirchen did the instrument makers work in an idyll of freely creative handicraft, committed only to the ideals of art, but rather, in order to guarantee their source of income, they had to wage a continual struggle against external restrictions, which forced them to make many a painful compromise. In spite of this, many of them were in a position to produce good and sometimes even excellent musical instruments (Figures 14 and 15). For this, they deserve our respect and our appreciation.

Karl Hachenberg is an expert on metals and metallurgy. For more than forty-three years he worked in the steelmaking and aerospace industries, primarily in research laboratories. He retired in 1994 and has recently devoted much of his time to research related to brass used in historical instrument-making.

NOTES

[1] Karl Hachenberg, "Brass in Central European Instrument-Making from the 16th through the 18th Centuries," *Historic Brass Society Journal* 4 (1992): 229-252 (unabridged); *Instrumentenbau* 44, no. 9 (Sept. 1990): 17-24 (abridged German version).
[2] Erich Wild, *Geschichte von Markneukirchen* (Plauen i.V., 1925), pp. 238ff.
[3] Richard Dietrich, "Merkantillismus und Städtewesen in Kursachsen," *Städtewesen und Merkantilismus in Mitteleuropa* (Cologne: Bühlau Verlag, 1983), pp. 272ff.
[4] The aforementioned authorities (state government, State Trade Council, Committee of the Treasury, as well as the district and local officials) assume prominent roles in the course of the proceedings.
[5] Hans Otto Gericke, *Die Geschichte des Messingwerkes Niederauerbach i.V. vom Beginn*

des 17. Jh. bis 1927, preliminary study for a dissertation (Magdeburg, 1960), p. 15.
[6] Ibid., pp. 14-15.
[7] Ibid., pp. 14-15. Calculation of the customs duty:

1 Taler = 24 Groschen = 288 Pfennig
1 Groschen = 12 Pfennig
Base price for 1 hundredweight of Rodewisch brass = 58 Taler
Base price for 1 hundredweight of Graslitz brass = 56 Taler
Customs duty on 1 hundredweight of Graslitz brass = 56 X 3 Groschen
= 168 Gr. = 7 Taler
Gross price for 1 hundredweight of Graslitz brass = 63 Taler

The brass foundries in Rodewisch and Graslitz differed marginally in production capacity and in terms of the source of their raw materials. The works' physical plants were comparable and corresponded to the technical standard of that time (Figures 4, 5, and 6). The important dates in the histories of the factories can be seen in the compilation in Figure 7. The technique of brass production usual at that time is described in detail in the article mentioned above (see n. 1), so that we can dispense with a description here.
[8] 1 (commercial) hundredweight = 46.771kg.
[9] Apparently brass sheet of larger format produced especially for the military.
[10] The mayor obviously did not know that no such import restriction existed. He may, however, have considered the compulsory customs duty as a de facto ban.
[11] This is the first and only time in the entire correspondence that the influence of the two sorts of brass on the playing characteristics of the instruments is mentioned. This aspect can therefore hardly have been of central importance for the instrument makers. This point was presumably just an additional argument toward the attainment of their goal.
[12] Since the processes and the results achieved through them are of particular importance for the judgement of the quality of the samples, they will be discussed at length in the following section.
[13] At this time, a certain J.A. Klotzsch gave instruction in *Probierkunde* (techniques of material testing) at the School of Mining and wrote a book on the subject that was acknowledged by experts in the field. (See Margot Pfannstiel, *Die Tulpenkanzel: Bilder aus der Geschichte Freibergs und des Erzbergbaus* [Leipzig: Urania-Verlag, 1980], p. 134). We can therefore assume that the tests were properly executed, the procedures employed up-to-date, and the results valid.
[14] The thickness of the brass can be calculated using the following values:

1 Saxon inch =	12 Saxon lines	= 23.599mm
1 Saxon line		= 1.967mm
1 square line		= 3.868mm2
162 square lines	= 626.94mm2	= 6.269cm2
1 lot = 4 quint		= 14.6g
1 quint		= 3.65g
Sample A	= 11/32 quint	= 1.255g
Sample B	= 1/2quint	= 1.825g

Formula for calculating the thickness of the brass =

$$\text{weight/area}(cm^2) \times \text{density}(g/cm^3) = T\ (cm)$$

Density of brass with 25% zinc content = 8.65 g/cm3

T of A = 1.255/6.269 x 8.65 = 0.02314cm = 0.23mm

T of B = 1.825/6.269 x 8.65 = 0.0336cm = 0.34mm

Accordingly, the piece of brass from Graslitz displayed a thickness of 0.23mm and that from Rodewisch, 0.34mm. This corresponds to a difference in thickness of thirty-two percent. The assertions by the instrument makers concerning the greater thickness of the Rodewisch brass were thus confirmed.

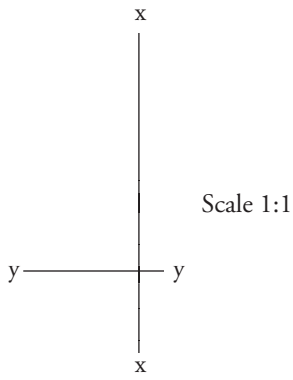
[15] The method of testing applied by Schubert in effect simulates the process employed in the manufacure of sheet brass in a hammer works.

[16] Since Klotzsch does not tell us which side of sample B he shortened, there are two possibilities for calculating the difference in thickness:

1 Saxon inch	=	23.599 mm
3/4 Saxon inch	=	17.7 mm
7/4 Saxon inch	=	41.3 mm

Sample size = original area = 17.7mm x 41.3mm = 731mm^2

Sample size after "shortening" along the lines x-x or y-y:



Shortening by 3/16 inch = -4.425mm

This results in Ax = 17.7mm x 36.875mm = 652.7mm2

or Ay = 13.275mm x 41.3mm = 548.2mm2

Based on the original surface area of 731mm2, this results in a surface-area difference = thickness difference of 10.7% for A_x and 25% for A_y. Both values clearly deviate from the

thirty-two percent that Schubert ascertained. In any case, however, Klotzsch too confirms that the Rodewisch brass is significantly thicker.

[17] Such a suspicion on the part of the instrument makers cannot be inferred from the ACTA.

[18] A description of the chemical analysis process employed for the determination of lead and sulphur is not given here because of the very specific subject matter. I did commission a specialized laboratory to replicate the process on appropriate test samples. In this way it could be confirmed that this process is suitable for the qualitative and, with minor reservations, also for the quantitative determination of lead and sulphur. Competently executed, the process could be expected to detect reliably a lead content of over 0.2%, for example.

[19] Hans Otto Gericke, *Die Lage der Arbeiter des ehemaligen Messingwerkes Niederauerbach/Vogtl. von 1600 bis zur Mitte des 19. Jahrhunderts* (Ph.D.diss., Karl Marx University, Leipzig, 1967), p. 184.

[20] Franz Kirnbauer, "Kupfererzbergbau und Kupfererzverhüttung im Mittelalter und in der Neuzeit bis um das Jahr 1900," *Kupfer in Natur, Technik, Kunst und Wirtschaft* (Hamburg: Norddeutsche Affinerie, 1966), pp. 51ff.

[21] Rud. Arthur Peltzer, *Geschichte der Messingindustrie und der künstlerischen Arbeiten in Messing* (Aachen, 1909), pp. 34ff.

[22] Ibid., pp. 106ff.

[23] Deutsches Kupfer Institut, *Kupfer-Zink-Legierungen* (Berlin: DKI, 1966), pp. 25ff.

[24] Bruno Jacob, *Messinghof und Kupferhammer (in Bettenhausen bei Kassel) unter landesherrlicher Verwaltung 1527 bis 1868* (Kassel, 1951), p. 106.

[25] Ibid., p. 107.

[26] Since Klotzsch addressed his report to "Mining-Councillor Mr. Gellert" in the Mining Regulatory Office, it can be assumed that Mining-Councillor Christlieb Ehregott Gellert was responsible for the contents of the cover letter (see Pfannstiel, *Die Tulpenkanzel*, pp. 122-124). C.E. Gellert (a brother of the well-known poet and professor of literature Christian Fürchtegott Gellert) was at that time the leading scientist in the field of mining and metallurgy in Freiberg and from 1762 Oberhüttenverwalter (chief mining official) there. He was therefore general director of all Electoral Saxon foundries, and thus also responsible for the foundry in Eisleben/Mansfeld. Gellert, without a doubt the most competent expert for the evaluation of the facts of this case, was absolutely correct in seeing the manufacturing conditions in Rodewisch as the cause of the deficiencies.

[27] The arguments of the Rodewisch brass-works' owners can be summarized as follows: The differences in quality (the difference in thickness, for example) ascertained by the impartial experts are ignored or dismissed as trifling, the customers were treated in a patronizing manner and depicted as querulous persons or swindlers, the material from the competition was criticized, their own products highly praised, the economic importance of their own enterprise stressed (jobs!), their own interests linked to those of the state, and non-committal promises made for the future.
(These arguments surely sound very familiar to today's public!)

[28] This corresponds to a brass thickness of 0.58mm.

[29] One can recalculate on the basis of Schubert's evidence:

Surface area after working = 348 square lines = 13.47cm2
Brass thickness after working = 0.27mm
Percentage of increase = 53%

Because of the massive initial thickness of sample C, and in spite of the high percentage of increase, the final thickness is considerably greater than the final thicknesses of samples A and B and even greater than the initial thickness of sample A. To be sure, Schubert ascertained "not as many cracks" this time, but this result definitely has to be seen in context with the clearly greater degree of thickness. It has to be assumed that with a further reduction in thickness to 0.17mm as with sample B, the number of cracks undoubtedly would have increased, since Schubert would have had to have applied at least three more cycles. Considering the material faults that Schubert again determined on the polished surface, an increase in the number of cracks would have been unavoidable.

It is therefore possible to conclude that sample C is not significantly better than the previous sample B. In any case, it displays the same serious structural fault. This is all the more remarkable since sample C was provided by the owners of the brass foundry themselves, and they certainly did not take just any piece of scrap. From this it can be deduced that samples B and C represented the general quality standard of Rodewisch brass, and that the complaints by the Markneukirchen instrument makers were in fact justified.

[30] This suggestion is unusual for two reasons: (1) the Mining Regulatory Office changed its opinion concerning the primary cause of the problem, taking up the point of view subscribed to in Dresden, and (2) Gellert, as general director of the Saxon foundries, must have known that no relief could be expected from those quarters.

[31] In consideration of the test results, this assessment is certainly very "pro-Rodewisch," and factually incorrect.

[32] This testimony by the instrument makers is a clear indication of the extent to which the quality of the brass is dependent on the specialized competence of a brass works' employees. Because of this turn of events in Graslitz, the instrument makers' only alternative to Rodewisch brass disappeared. They therefore concentrated their arguments on the aspects of price and expenses.

[33] Thus the instrument makers merely reiterated the deficiencies already stated previously.

[34] That is to say that the instrument makers needed twelve hours for the round trip, and sometimes did not even get any material, or only small amounts of 11.7 or 5.8kg in unsatisfactory quality and of too heavy gauge. And for that they also had to pay a higher price than their competitors in Leipzig.

If the instrument makers' assertion is true, that the brass delivered to customers in Leipzig and abroad was (generally) of better quality, then someone in Rodewisch must then have taken special care during the production of these deliveries or sorted the material according to quality. The former possibility would mean that Rodewisch was very much in a position to produce competitive quality material from Eisleben copper. In the case of the latter, the material not suitable for export would of necessity have been melted down

again or put into stock for sale at the factory. In either case, the brass sold in Rodewisch must have had a lower standard of quality.

In 1790 Rodewisch delivered 220 hundredweights of sheet brass to the warehouse in Leipzig, 230 hundredweights for *Messverkauf* (i.e. for sale at the Leipzig Trade Fair, and thus for export), and sold 490 hundredweights on site at the factory in Rodewisch. (*Ökonomisch-technologische Encyklopädie* [Berlin, 1802], s.v. "Messing," by J.G. Krünitz.) It is indeed remarkable that although more than fifty percent of the brass sheet production was sold in Rodewisch, the instrument makers were still not able to get suitable material in the required quantities.

[35] There could be two important reasons for the Elector's decision in favor of the Markneukirchen instrument makers: a) He had a strong sense of justice, which even led to him being known as "Friedrich August the Just"; b) In his capacity as Elector of Saxony, he was, like his predecessors, Arch-Marshal of the Holy Roman Empire, and thereby protector and chief arbiter of all disputes in the guild of the imperial, court, and field trumpeters and kettledrummers. He confirmed, as one of the last potentates, the old privileges of the trumpeters' and kettledrummers' guild again in 1769 and, moreover, was known as a patron of the trumpeters and kettledrummers.

Johann Ernst Altenburg quite appropriately dedicated his famous treatise *Versuch einer Anleitung zur heroisch-musikalischen Trompeter- und Pauker-Kunst* (Essay on anIntroduction to the Heroic and Musical Trumpeters' and Kettledrummers' Art) to this Elector, praising him many times in this work.

[36] Gericke, *Die Lage*, p. 160.

[37] Hans Otto Gericke, "Die erste Walzwerk in Sachsen," *Sächsische Heimatblätter* 2 (1966): 117-18.

[38] Gericke, *Die Geschichte*, pp. 16ff.

[39] August Jegel, *Alt-Nürnberger Handwerksrecht und seine Beziehung zu anderen* (Neustadt/Aich: Verlagsdruckerei Schmidt, 1965).