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The Palermo Merz Equatorial Telescope

An Instrument, a Manuscript, Some Drawings

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Abstract

A manuscript by Georg and Sigmund Merz dated 1862 and containing instructions for assembling the equatorial telescope acquired by the Palermo Observatory is conserved in the archives of the Museo Astronomico e Copernicano in Rome. It is a rare document that reveals "tricks of the trade" and technical knowledge not usually included in textbooks or treatises. It was sent to the Palermo Observatory as an aid to the installation of the telescope, which made a signal contribution to the development of solar physics in Italy in the 19th century. Based on the study of unpublished sources (consisting of texts and drawings), the history of the instrument has been retraced. This paper presents a detailed description of the Merz manuscript (including a complete transcript) and some technical drawings recently discovered in the archives of the Palermo Observatory.

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1 Introduction

The Palermo Observatory was established at the end of 18th century as part of the reform of the educational system of the Kingdom of the Two Sicilies undertaken by the Bourbon Government based on Enlightenment principles.[1] Its first director, the mathematician~~, astronomer~~ and Theatine priest Giuseppe Piazzi (1746–1826), equipped the new observatory with the best astronomical instruments available at the time, fabricated by instrument makers such as Jesse Ramsden (1735–1800), who built for him the famous 5-foot vertical circle.[2] However, on the list of instruments originally acquired for the observatory there was no equatorial instrument. This would later be greatly regretted by Piazzi, although he sought to remedy the lack in 1803 by purchasing a small equatorial telescope[3] made by Troughton, after obtaining approval from King Ferdinand to convert into cash the royal medal awarded to him for his scientific achievements.

Piazzi's successors made little effort to modernize the equipment at the Palermo Observatory and by the middle of 19th century it had become quite obsolete. However, thanks to various unexpected political developments, the observatory was granted the opportunity to replace its equipment and to acquire a large equatorial telescope.

2 A Merz Telescope for the Palermo Observatory

The initial decision to acquire a 9-inch refractor for the Palermo Observatory was taken in Vienna in 1851. Domenico Ragona (1820–1892) (Fig. 1), formerly

1 On the establishment of the Palermo Observatory, see Giorgia Foderà Serio, "On the history of the Palermo Astronomical Observatory," in *Physics of Solar and Stellar Coronae*, edited by Jeffrey F. Linsky, Salvatore Serio (Dordrecht: Kluwer, 1993), pp. 21–33.

2 On the Ramsden Circle, see for instance: Ileana Chinnici, Giorgia Foderà Serio, Paolo Brenni, "The Ramsden's Circle at the Palermo Astronomical Observatory," *Bulletin of the Scientific Instrument Society*, 2001, *71*:2–10. This instrument made it possible for Piazzi to carry out important research; he discovered the first asteroid, Ceres, in 1801 and published two editions of his famous star catalogue in 1803 and 1814.

3 Unfortunately, this instrument is no longer extant.

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FIGURE 1 *Portrait of Domenico Ragona* (*oil on canvas by Salvatore Rubino, 1903; Museo della Specola, INAF-Osservatorio Astronomico di Palermo*)

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first assistant at the observatory, had been appointed as temporary director in 1850 following the removal of Gaetano Cacciatore (1814–1889) for ~~his~~ anti-Bourbon activity.[4] At the time the two politicians in the kingdom with the most influence over the administration of the island were the Prince of Satriano and Lieutenant of Sicily, Carlo Filangieri (1784–1867), and his political rival Giovanni Cassisi (1788–1865), Ministerial Secretary of State for Sicilian Affairs in Naples. The Prince of Satriano "first conceived the idea"[5] of sending Ragona to study astronomy at Berlin Observatory under the supervision of its director, Johann Franz Encke (1791–1865).[6] In this he was following the example of the Prince of Caramanico and Viceroy of Sicily, Francesco D'Aquino (1738–1795), who had sent Piazzi to study astronomy in France and England about sixty years earlier; it was there that Piazzi acquired the instruments destined for the new observatory. Clearly the Bourbon government was prepared once again to invest in the modernization of the Palermo Observatory in order to make it a top-ranking astronomical institution.

Ragona left Palermo for Berlin in the spring of 1851, stopping along the way for two months in Vienna where he held "long and assiduous conversations" with the director of the Vienna observatory, Karl Ludwig von Littrow (1811–1877) "about the current state of the Palermo Observatory and the work that might be carried out there."[7] Ragona also sought advice about the instruments required for a modern observatory. Littrow convinced him that a large refractor was needed and Ragona therefore commissioned a 9-inch dialytic refractor from the Viennese optical instrument maker Simon Plössl (1794–1868).[8] When he

4 Gaetano was the son of Niccolò Cacciatore (1770–1841), who served as Piazzi's assistant and then succeeded him as director of the observatory. Gaetano was appointed director after his father's death, but in 1848 he was removed from this post due to his involvement in a series of rebellions against Bourbon rule.

5 "[...] l'eccellentissimo Principe [di Satriano] concepì la prima idea [del mio viaggio scientifico]." Domenico Ragona, "Osservazioni al Cerchio Meridiano," *Giornale astronomico e meteorologico del R. Osservatorio di Palermo*, 1859, *III*:289–336, p. 291.

6 Alexander von Humboldt may have played a key role in deciding which instruments to acquire for the Palermo observatory, for he seems to have been one of the principal scientific advisors to the Bourbon Government ~~(see below)~~. To confirm this it would be necessary to study the network of ties connecting Satriano and Cassisi with other intellectuals in Italy and abroad, an issue that lies beyond this scope of this paper.

7 "[ebbi] lunghe ed assidue conferenze [...] sullo stato in cui ritrovavasi la Specola di Palermo, e sui lavori che vi si potevano intraprendere." Ragona, "Osservazioni al Cerchio Meridiano" (cit. note 5), p. 290.

8 Ragona, "Osservazioni al Cerchio Meridiano" (cit. note 5), p. 290. A dyalitic refractor corrects the chromatic aberration of starlight by means of a lens mounted near the midpoint along the

was in Berlin, however, the Italian changed his mind; after inspecting the equipment at the Berlin Observatory and discussing the matter with Encke, he decided that a large refractor telescope alone would not suffice and that a meridian circle was necessary in order to be able to accurately measure the position of the stars.[9]

Ragona therefore contacted the instrument makers Pistor and Martins of Berlin and they offered to manufacture two instruments – a meridian circle and a refractor with a 7-inch aperture, which was the largest that they were capable of producing – at a reduced price. To obtain the king's permission to acquire two instruments instead of one, Ragona solicited letters of support from prominent scientists and politicians, including the renowned polymath and author of the treatise *Kosmos*, Alexander von Humboldt (1769–1859); Count Luigi Grifeo, Plenipotentiary Minister in Berlin; and the astronomer Encke. The role played by Humboldt appears to have been decisive; in a footnote to the obituary that he wrote when the baron passed away,[10] Ragona acknowledges his debt to the great scientist.[11]

The proposal to acquire a meridian circle was approved by the government, but the reduction in the refractor size from the 9-inch aperture suggested by Littrow to the 7-inch aperture available from Pistor and Martins met with

length of the tube. On the dialytic refractors made by Plössl, see Henry C. King, *The History of the Telescope* (London: Griffin & Co., 1955), p. 191.

9 "These two instruments, in fact, go hand in hand and while the refractor may offer the advantage of fixing the coordinates of stars wherever located in the sky, it has the disadvantage of not determining the positions as exactly and accurately as those measured by means of the meridian circle [Questi due strumenti difatti si danno la mano a vicenda, e se il refrattore ha il vantaggio di poter fissare le coordinate degli astri qualunque sia il punto del cielo in cui si ritrovano, ha l'inconveniente di non dare posizioni così esatte e precise come quelle che si ottengono col Cerchio Meridiano]." Ragona, "Osservazioni al Cerchio Meridiano" (cit. note 5), p. 290. At the Palermo Observatory, the meridian circle was intended to replace the celebrated Ramsden Circle, which was designed to make astrometric observations but whose intrinsic limitations were already recognized in Piazzi's time.

10 See Domenico Ragona, "Alessandro Humboldt," *Giornale astronomico e meteorologico del r. Osservatorio di Palermo*, 1859, *III*:51bis–60bis, pp. 59bis–60bis.

11 Other sources confirm Humboldt's contribution: "In Berlin [Ragona] had the honour of enjoying the affection and esteem of the most celebrated Baron Alexander Humboldt, through whose powerful influence Ragona obtained a Merz's refractor of great dimensions and one of Pistor and Martin's meridian-circles, instruments which now adorn the Observatory of Palermo." George Washington Moon, *Men and Women of the Time* (London: George Routledge and Sons, 1891), p. 738.

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firm opposition from the Minister for Sicilian Affairs, Cassisi. "[He] pointed out that the refractor in St. Petersburg, the one in Vienna and also the one in Berlin were constructed in Munich, and even if [Palermo's] instrument is commissioned in [Berlin], the lenses should be bought in Munich."[12] This position reflected Cassisi's political agenda; he considered it paramount to obtain "instruments comparable to those of the main observatories in Europe, both in size and quality,"[13] because "the purpose of the King's admirable actions in favor of the Palermo Observatory was to restore its ancient renown."[14] In so doing, the government of the Kingdom of Sicily, much shaken by revolutionary events, hoped to augment its prestige and gain a reputation as a modern and forward-looking nation, the equal of other European countries, and thus refute accusations of its reactionary rule.

The letter conveying Cassisi's decree does not mention the name of the instrument maker Merz; the minister simply instructs Ragona to inform his supervisor Encke that "the refractor must necessarily be made in Munich"[15] and to learn which instrument maker ought to have been contacted in the first place.[16] Cassisi had clearly been informed of the existence of a firm in Munich that had supplied the observatories in St. Petersburg, Vienna and Berlin with high-quality refractory lenses, but did not know its name.[17] Afterwards Ragona also claimed to have requested the king's consent to acquire "a meridian circle by Pistor and Martins and a 9-inch aperture refractor by Merz and Son"[18] for

12 "[…] reso consapevole di questa determinazione fece osservare che in Monaco erano stati costruiti i refrattori di Pietroburgo, Vienna e Berlino stesso, e che quando anche in questa cultissima città se ne avesse voluto commettere la costruzione, le lenti si avrebbero dovuto acquistare in Monaco […]." Letter from the Deputazione dei Regi Studi to the Director of the Palermo Royal Observatory, Palermo, 13 May 1854 (Archivio Storico dell'INAF-Osservatorio Astronomico di Palermo, Palermo, Dossier Corrispondenza Ufficiale in Entrata 4, Folder 3).

13 "[…] che con un piccolo aumento alla somma già autorizzata si potrebbero avere si per grande dimensione nel rifrattore che per buona costruzione strumenti eguali a quelli delle primarie specole d'Europa." Letter from the Deputazione dei Regi Studi (cit. note 12).

14 Ibid., "[…] lo scopo degli ammirevoli Sovrani provvedimenti dati per l'Osservatorio astronomico di Palermo, è stato quello di fargli riacquistare l'antica rinomanza […]."

15 Ibid., "[…] il rifrattore indispensabilmente deve costruirsi in Monaco […]."

16 It also specified that the instrument should be commissioned via the papal nuncio for Bavaria, the Sicilian Mgr. Antonino De Luca (1805–1883).

17 This could have been the astronomer Leopoldo Del Re (1804–1872), who was director of the Naples Royal Observatory at the time or, as is more likely, the influential Baron von Humboldt.

18 See Domenico Ragona, "Rapporto al Sig. Presidente della Deputazione dei R. Studii sui

the Palermo Observatory. Whoever prompted this order, Cassisi's preference was unmistakable and his decision irrevocable. Pistor and Martins declared that they were prepared to build a larger refractor themselves or, if their client preferred, to order the necessary optical pieces from Merz, and were willing to subject the instrument to approval by Encke before delivery, but this offer was refused as they "could not number having built even one refractor to be used in astronomical observatories."[19] By comparison, the purchase of a 9-inch refractor like the one at the Berlin Observatory directly from Merz, "whose very high quality was already proven by long experience," appeared to guarantee the "certainty of a successful result."[20]

A refractor was therefore ordered from the Merz firm in Munich and after Ragona's return to Palermo in 1854, its production was monitored by the Italian *chargé d'affaires* in Bavaria and future Plenipotentiary Minister, Count Guglielmo Ludolf (1818–1908), "who attended to all the circumstances related to the construction of this precious instrument with admirable zeal and application."[21]

3 The Construction and Delivery of the Instrument

Encke as well seems to have played an important role in the Palermo Observatory – Merz transaction. His contribution was acknowledged by Ragona, who declared that the Palermo refractor "will turn out to be even better than the ones already made [by Merz] [...] due in part to the improvements proposed [...] by the distinguished prof. Encke in Berlin, at our enlightened Royal Government's particular invitation."[22] He went on to say that "the most remarkable pieces, beside the optical parts, will be the handlebar devices, [and] those

lavori eseguiti nel 1° semestre del 1859 nel R. Osservatorio di Palermo, e sulla latitudine del medesimo," *Giornale astronomico e meteorologico del R. Osservatorio di Palermo*, 1859, *III*:209–232, p. 230, in note 1.

19 "[...] non potevano citare un solo refrattore costruito per uso di Osservatori Astronomici." Ragona, "Osservazioni al Cerchio Meridiano" (cit. note 5), p. 296.

20 "[...] essendo già comprovato da lunga esperienza il pregio moltissimo [del rifrattore di Berlino] [...] [l'Osservatorio di Palermo sarebbe stato] sicuro di un felice risultamento." Ragona, "Osservazioni al Cerchio Meridiano" (cit. note 5), p. 295.

21 "[...] che con ammirevole solerzia ed impegno curò tutte le circostanze relative alla costruzione di questo prezioso strumento." Ragona, "Osservazioni al Cerchio Meridiano" (cit. note 5), p. 296.

22 "Questo rifrattore riuscirà migliore di quanti altri si sono eseguiti finora dalla cennata officina [...] pei miglioramenti proposti [...] dietro speciale invito del nostro illuminato

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for reducing the effects of temperature variation, smoothing over friction and counterbalancing exactly the various parts of the instrument and other things [...]."[23] It is possible that these were some of the improvements suggested by Encke.

In 1857 Ragona announced the "imminent delivery" of the refractor and provided a brief description of the instrument:

> The refractor will have a 9 French inch-aperture [...] and a 13 ⅓ French foot-focal length. It will be equipped with a seeker of 29 French inch-aperture [...], five astronomical eye-pieces, magnifying 142, 212, 320, 480 and 760 times, a repeating position micrometer with eight eye-pieces magnifying from 94 to 1000 times, two circular micrometers, several position lamps of novel construction (with a rotating ring), etc. The mount will be made in brass with an hours circle 14 French inches in diameter [...] whose *nonii* allow to read intervals of 2 arc seconds, a declination circle 20 French inches in diameter [...] whose *nonii* allow to read intervals of 4 arc seconds and with a spinning pendulum clock properly placed to avoid clanking, and easy to attach and detach from the instrument.[24]

Ragona's announcement was premature, as in the summer of 1858 the instrument was still in the Merz workshop in Bavaria. The Sicilian astronomer

Real Governo, dallo illustre astronomo Berlinese prof. Encke." Ragona, "Breve notizia sul refrattore che si attende da Monaco per la Specola di Palermo," *Giornale astronomico e meteorologico del R. Osservatorio di Palermo*, 1857, *II*:268–270, p. 269.

23 "[...] gli oggetti di molto pregio nello strumento, indipendentemente dalla parte ottica, saranno i meccanismi annessi ai manubri, quelli per evitare gli effetti delle variazioni della temperatura, per rendere minimo l'attrito, per ottenere l'esatto contrapeso delle varie parti dello strumento, ed altre cose [...]." Ragona, "Breve notizia sul rifrattore" (cit. note 22), pp. 269–270.

24 "L'apertura del refrattore sarà di 9 pollici francesi [...] e la lunghezza focale di 13 ⅓ piedi fran[cesi] [...]. Saranno annessi al refrattore un ricercatore di 29 poll[ici] franc[esi] [...] cinque oculari astronomici amplificanti 142, 212, 320, 480 e 760 volte, un micrometro ripetitore di posizione con otto oculari amplificanti da 94 a 1000 volte, due micrometri circolari, varie lampadi di posizione di nuova costruzione (anello rotatorio) ecc. ecc. La montatura sarà in ottone con un circolo orario di 14 poll[ici] fran[cesi] di diametro [...] di cui i nonï danno i 2 secondi di tempo, un circolo di declinazione di 20 poll[ici] fran[cesi] di diametro [...] di cui i nonï danno i 4 secondi in arco, e sarà munita di un orologio con pendolo centrifugo, disposto in modo da non produrre strepito, e che semplicemente si congiunga o si stacchi dallo strumento." Ragona, "Breve notizia sul rifrattore" (cit. note 22), pp. 268–269.

obtained permission for a two-months' leave of absence "to go to Munich and obtain information regarding some distinctive features of the refractor whose construction is in progress at the Merz brothers' [workshop]."[25] He spent the last two months of the year in the Bavarian city and, as he wrote in a report, "Not flinching at any impediment or obstacle," he faced "the extraordinary harshness of the climate in Munich in the heart of winter, to the most severe detriment of [his] health."[26] This must have been a genuine tribulation for a man accustomed to the mild Sicilian climate. In the end, however, Ragona's stay in Munich proved extremely fruitful for he took advantage of the opportunity to learn much from the famous optician, afterwards expressing "[his] deepest thanks to Mr. Merz, who helped me with his suggestions and knowledge [in a manner that was] even more than friendly, brotherly."[27]

In February 1859 the refractor finally arrived at the Palermo Observatory "in excellent condition, without any damage to the most delicate parts of the instrument, thanks to its perfect packaging,"[28] and in July the construction of a suitable room to house the refractor began.[29] This may appear to be quite late considering the delivery date of the instrument, but in March 1857 the meridian circle by Pistor and Martins had just been set up at the observatory[30] and Ragona was kept busy adjusting, regulating and using the instrument; in fact, the first account of the meridian circle was published by him in 1859.[31]

25 "[…] onde portarsi in Monaco per prender notizia di talune particolarità relative al rifrattore che colà si sta costruendo dai fratelli Merz […]." Letter from the Deputazione dei Regi Studi to the Director of Palermo Royal Observatory, Palermo, 30 July 1858 (Archivio Storico dell'INAF-Osservatorio Astronomico di Palermo, Palermo, Dossier Corrispondenza Ufficiale in Entrata 4, Folder 7).

26 "Non indietreggiai innanzi a qualunque impedimento ed ostacolo, e affrontai la straordinaria rigidezza del clima di Monaco nel cuore dell'inverno, con discapito gravissimo della mia sanità […]." Ragona, "Rapporto al Sig. Presidente della Deputazione dei R. Studii" (cit. note 18), p. 230.

27 Ibid. "[…] colgo questa occasione per esprimere i miei più sentiti ringraziamenti al signor Merz, che più da fratello che da amico mi giovò coi suoi consigli e col suo sapere."

28 "[…] in ottimo stato, e senzacché si fossero in alcun modo deteriorate le più delicate parti dello strumento per conseguenza del perfetto imballaggio fattovisi." Letter from the Deputazione dei Regi Studi to the Director of Palermo Royal Observatory, Palermo, 25 February 1859 (Archivio Storico dell'INAF-Osservatorio Astronomico di Palermo, Palermo, Dossier Corrispondenza Ufficiale in Entrata 4, Folder 8).

29 See Domenico Ragona, "Avvertenza," *Giornale astronomico e meteorologico del R. Osservatorio di Palermo*, 1859, *III*:[1].

30 See Ragona, "Rapporto al Sig. Presidente della Deputazione dei R. Studii" (cit. note 18).

31 See Ragona, "Osservazioni al Cerchio Meridiano" (cit. note 5). He announced that a more

4 The "Long Sleep" of the Telescope in Palermo

In the same year Ragona announced publicly that the fourteen cases containing the refractor were safely in storage at the observatory[32] and that a detailed account of the work being undertaken to assemble and mount the refractor would be published "shortly" in the fourth volume of the *Giornale Astronomico e Meteorologico*.[33] In fact this volume never saw the light; the arrival of ~~Giuseppe Garibaldi and his~~ Expedition of the Thousand to conquer the Kingdom of the Two Sicilies in the spring of 1860 changed the course of history. The rule of the Bourbons was overturned, leading to the fall of the kingdom and the transformation of the political landscape of Sicily. The process of unifying the peninsula advanced and the creation of the Kingdom of Italy was proclaimed in 1861.[34]

Thus in July 1860, after a 12-year absence, Gaetano Cacciatore was recalled to take up the university chair in astronomy and the directorship of the observatory. Ragona saw the future of his project to modernize the observatory threatened and published an eloquent though unsuccessful protest, proposing that the two posts be kept separate and that he should be allowed to continue as director of the latter.[35]

The anxiety expressed by Ragona was justified; as time passed Cacciatore showed himself to be lacking in the capacity to head an important research institution, as well as the expertise to complete the setting of the meridian circle, let alone the installation of the refractor still lying in storage. Political and scientific circles in Palermo were aware of this situation, but attempts to find an acceptable solution proved unsuccessful[36] until 1863, when the

detailed description of the Meridian Circle would be given in a separate publication; unfortunately, this never appeared.

32 Ragona also underlined that all expenses for both instruments were covered by the Royal Treasury of Sicily with a contribution from the Royal General Administration. Ragona, "Rapporto al Sig. Presidente della Deputazione dei R. Studii" (cit. note 18), p. 232.

33 See Ragona, "Avvertenza" (cit. note 29). This journal was published biannually beginning in 1855; it was edited by Ragona, who probably intended to turn it into an annual publication.

34 The political unification of Italy initially excluded Rome, which was annexed later, in 1870.

35 On the political events surrounding the Palermo Observatory, see Ileana Chinnici, "Personaggi e vicende dell'Osservatorio Astronomico di Palermo attraverso l'Unità d'Italia," *Giornale di Astronomia*, 2011, *37*:2–9, p. 3.

36 Cacciatore was prepared to give up the directorship of the observatory, but only if he were to be appointed Rector of Palermo University, a condition obviously considered unacceptable. See Chinnici, "Personaggi e vicende dell'Osservatorio Astronomico di Palermo" (cit. note 35), p. 4.

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mathematician Federico Napoli (1819–1883) undertook to raise the issue with the Minister of Public Education of the new Italian government, Michele Amari (1806–1889), who was originally from Palermo. He wrote that the Palermo Observatory, "demanded [his] help," as it had the prospect of becoming "the leading Observatory in Italy and a leading one in Europe," but that "the large Merz refractor still lay in its cases, as it is lacking someone capable of handling it."[37] In fact, Amari was already aware of the situation and a few months earlier had consulted Giovanni Virginio Schiaparelli (1835–1910), the director of the Brera Observatory in Milan and now principal advisor to the government on astronomical matters. Schiaparelli agreed with Napoli that Palermo could become the *leading observatory in Italy* because of its excellent instruments, but that these were not being used to their full potential and a knowledgeable and competent director was necessary to run the institution.[38]

At Napoli's urging, Amari decided to send Schiaparelli to Palermo to draw up a report on the observatory. At the same time, Napoli proposed a possible way out of the impasse: "[...] to save this major and unfortunate institution [the Palermo Observatory], it is a condition *sine qua non* to appoint an assistant to act as director."[39] Acting on this suggestion, in a shrewd diplomatic move Amari and Schiaparelli found a suitable 'assistant' – the young director of the modest Modena Observatory, Pietro Tacchini (1838–1905)[40] (Fig. 2), who was appointed "adjoint astronomer" at the Palermo Observatory. He was replaced in Moden by Ragona, who thus found a respectable position far from his rival in Palermo.

37 "[...] vi ha l'Osservatorio di Palermo che reclama un vostro ajuto; diverrà il primo Osservatorio d'Italia ed uno dei primi di Europa [...] ma il grande Refrattore di Merz rimane ancora nelle casse perché manca un uomo che sappia maneggiarlo." (F. Napoli to M. Amari, 28 July 1863) in Chinnici, "Personaggi e vicende dell'Osservatorio Astronomico di Palermo" (cit. note 35), p. 4.

38 See Chinnici, "Personaggi e vicende dell'Osservatorio Astronomico di Palermo" (cit. note 35), p. 4.

39 "[...] sul modo di salvare questo grande e disgraziato stabilimento; è mestieri come condizione sine qua non, che venga nominato un assistente che possa fare da Direttore [...]." (F. Napoli to M. Amari, 28 August 1863) in Chinnici, "Personaggi e vicende dell'Osservatorio Astronomico di Palermo" (cit. note 35), p. 4.

40 For a biographical note on Tacchini, see Ileana Chinnici, "Pietro Tacchini (1838–1905), a key figure in the post-Unitarian Italian astronomy," *Memorie della Società Astronomica Italiana. Supplementi*, 2006, *9*:28–34.

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FIGURE 2 *Portrait of Pietro Tacchini* (*photographer unknown, ca. 1880; reproduced with the permission of the Observatoire de Paris*)

5 A Visit by the Astronomer Otto von Struve of St. Petersburg

During the first week of October 1863, the astronomer Otto Wilhelm von Struve (1819–1905), director of the Pulkovo Observatory in St. Petersburg, visited Palermo as part of his tour of the most important observatories in Italy. He had begun his career as an assistant to his father, the astronomer Friedrich Georg Wilhelm von Struve (1793–1864), who served as director of the university observatory in Dorpat (now Tartu, Estonia), before being appointed to set up the Pulkovo Observatory in 1839. In Dorpat Struve Sr. conducted a massive survey of double stars using a large Fraunhofer refractor;[41] in Pulkovo he continued with this research using a splendid 15-inch refractor made by Merz & Mahler. His son Otto participated in the project, and therefore it is not surprising to find in the report that he wrote after his trip,[42] the observation that the Palermo Observatory was in possession of "a 9-inch aperture refractor from Munich, like the one in Dorpat" that was still packed away in its original crates, even though the rotating dome of the new telescope room and the pillar for the instrument were ready.[43] Inspired by the many potential applications of this magnificent instrument, Otto W. Struve proposed to Cacciatore[44] that they collaborate on a project in which the Merz telescope would be employed to survey double stars[45] in the austral hemisphere, in order to amplify the Pulkovo catalogue:

41 See Friedrich Georg Wilhelm von Struve, *Catalogus novus stellarum duplicium et multiplicium maxima ex parte in Specula Universitatis Caesareae Dorpatensis per magnum telescopium achromaticum Fraunhoferi detectarum* (Dorpati: Typis J.C. Schuemanni, 1827). Struve published additional catalogues of double stars in 1837 and 1852; see Joseph S. Tenn, "Keepers of the Double Stars," *Journal of Astronomical History and Heritage*, 2013, *16* (*1*):81–93, pp. 83–84.

42 See Simone Bianchi et al., "Les Observatoires astronomiques en Italie. An 1863 report by Otto Wilhelm Struve" in this volume.

43 "[…] un réfracteur de Munich, avec une ouverture de 9 pouces, comme celui de Dorpat, s'y trouve également. Ce dernier instrument n'a pas encore été ôté des boites, dans lesquelles il a été transporté de Munich, mais la tour mobile et le pilier en marbre qui devra le porter, sont déjà achevés." Bianchi et al. "Les Observatoires astronomiques en Italie" (cit. note 42). The construction of the room for the telescope was initiated by Ragona, while the pillar was probably made after Cacciatore's reinstatement.

44 Struve also proposed to Cacciatore that they might revise and update Piazzi's star catalogue and offered the collaboration of Pulkovo Observatory. See Bianchi et al., "Les Observatoires astronomiques en Italie" (cit. note 42).

45 See Otto Wilhelm von Struve, *Catalogue de 514 Étoiles Doubles et Multiples découvertes sur l'hémisphère céleste boréal par la grande lunette de l'Observatoire Central de Poulkova,*

> [...] one of the first tasks to carry out should be the extension, from the equator to the 30th degree parallel of austral declination, of the sky survey made at Pulkovo in the years 1840–1843 for the boreal hemisphere. Undoubtedly, this kind of work will lead to the discovery of an additional large number of double star systems.[46]

Struve's judgment of the Palermo Observatory was quite positive; he states in his report that:

> [...] among all the Italian Observatories, that in Palermo is probably the one which most easily could be put in a condition that, with the hope of a large success, could participate in the works of modern astronomy. For this purpose, it is already equipped with the required instruments.[47]

During his trip Struve also had the opportunity to meet Tacchini in Modena before the latter's departure for Palermo; the Italian astronomer invited Struve to his home and they had long conversations about the Palermo Observatory.[48]

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et Catalogue de 256 Étoiles Doubles Principales où la distance des composantes est de 32 secondes à 2 minutes et qui se trouvent sur l'hémisphère boréal (St. Petersburg: Academy of Sciences, 1843).

46 "[...] un des premier travaux à entreprendre devait être une extension depuis l'équateur jusqu'au parallèle de 30° de déclinaison australe, de la [révision?] de la voute céleste que nous avons exécuté à Poulkovo en 1840–1843 pour l'hémisphère boréal. Il n'y a pas de doute qu'un pareil travail conduirait [encore?] à la découverte d'un très grand nombre de systèmes binaires d'étoiles." Bianchi et al., "Les Observatoires astronomiques en Italie" (cit. note 42).

47 "[...] de tous les observatoires d'Italie, celui de Palerme est probablement celui qui le plus facilement pourra être mis en tel état qu'avec l'espoir d'un plus grand succès il pourra participer dans les travaux de l'astronomie moderne. Pour ce but il est déjà pourvu de tous les instruments nécessaires." Bianchi et al., "Les Observatoires astronomiques en Italie" (cit. note 42).

48 On that occasion Struve invited his young colleague to come to Pulkovo Observatory for a period of training, as noted in a letter from Tacchini to Schiaparelli: "He told me about Palermo Observatory and the works to do there; [...] once installed the equatorial, he has recommended to me to carry out a survey of the austral sky up to 30° [of latitude] for observing double stars. Moreover [...] he has invited me to spend some time at Pulkovo Observatory [...] (Egli mi parlò dell'Osservatorio di Palermo e sui lavori da farsi; egli insiste sulla convenienza di esaminare le divisioni del circolo adoperato da Piazzi; e collocato che sia l'equatoriale mi raccomandò una revisione del cielo australe sino ai 30° per le stelle doppie. Egli inoltre [...] m'invitò a passare qualche tempo a Pulkova [...])." Letter from Tacchini to Schiaparelli, Modena, 30 October 1863 (Archives Domus Galilaeana,

Tacchini made an excellent impression on Struve, who wrote: "[…] I am convinced that, through his zeal and knowledge, he is indeed in a condition to restore to Palermo Observatory a honorable name in science."[49]

The Merz telescope in Palermo would never be used to look for double stars, but Struve's optimistic predictions regarding the observatory and Tacchini's ~~suitability to serve as its director~~ would be borne out, as we will see below.

6 The Installation and Use of the Refractor

Tacchini arrived in Palermo in November 1863 with a clear directive from Schiaparelli: "The first thing to do in Palermo is to set up the Refractor."[50] For this purpose the latter astronomer had left with Cacciatore the drawings of the Pulkovo refractor[51] so that "with these instructions and a few studies on the several parts of the instrument, the enterprise will easily succeed."[52]

Tacchini moved forward decisively with the observatory's activities, expanding the library, setting the meridian circle, and starting to edit regular publications from 1865. However, he ran into difficulties with Cacciatore over the refractor as the latter proved dilatory in obtaining the necessary funds, to the severe disappointment of Tacchini. In May 1864 the latter wrote to Schiaparelli:

Pisa, Fondo Schiaparelli). Tacchini did not obtain the necessary funding from the Italian Government to travel abroad (see below), but later had the opportunity to visit Pulkovo Observatory on the occasion of the Italian scientific expedition to observe the total solar eclipse of 1887, which was visible from Russia. See Pietro Tacchini, *Eclissi totali di sole* (Roma: Eredi Botta, 1888), p. 210.

49 "[…] j'ai gagné la conviction qu'avec son zèle et ses connaissances il sera bien en état de reconquérir à l'observatoire de Palerme un nom honorable dans la science." Bianchi et al., "Les Observatoires astronomiques en Italie" (cit. note 42).

50 "Penso che la prima cosa da farsi a Palermo sia mettere in ordine il Rifrattore […]." Letter from Schiaparelli to Tacchini, 10 September 1863, in Chinnici, "Personaggi e vicende dell'Osservatorio Astronomico di Palermo" (cit. note 35), p. 6.

51 See Friedrich G. Wilhelm Struve, *Description de l'Observatoire astronomique Central de Poulkova*, 2 vols., vol. II: 1845 (Saint Petersbourg: Imprimerie de l'Academie Imperiale des Sciences, 1845), plates XXXIV–XXXV (A, B). A recent examination of the copy of this work in the Brera Observatory library showed that these illustrations were particularly worn, thus confirming that they were handled repeatedly.

52 "[…] con questa norma e con un poco di studio sui varii pezzi dell'istrumento non sarà difficile venire a capo dell'impresa." Letter from Schiaparelli to Tacchini, Milan, 10 September 1863, in Chinnici, "Personaggi e vicende dell'Osservatorio Astronomico di Palermo" (cit. note 35), p. 6.

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> The refractor could be installed immediately, but it would be better to delay this for a few weeks, because the Director has exhausted the money that had been earmarked, and I believe he has also already paid in advance out of his own pocket [the expenses] for [18]65; thus he is waiting for additional funds from Turin [authors' note: that is, from the new government, since Turin was the capital of Italy at the time]. In the meantime, a wooden base has been constructed in a room, and I have temporarily placed the first mounting plate, the large bed and all pieces relating to the clockwork, thus eliminating in advance all the difficulties that we would have met during the actual installation. At the same time, all the elements have been cleaned and the instrument appears to be well preserved, except for some small losses of paint in various points; it has been constructed in a special way and I think that, once mounted, it will prove to be magnificent.[53]

In the meantime, Tacchini was scrupulously studying scientific *memoirs* regarding the use of the refractor,[54] in particular the reports by Joseph von Fraunhofer (1787–1826), who had passed on his experience as an optical lens maker to Georg Merz (1793–1867) (Fig. 3) who was later associated with his son Sigmund Merz (1824–1908). Tacchini also asked the Italian government for permission to travel abroad and visit observatories with large instruments such as the one in Pulkovo, but his request was turned down, primarily for financial reasons.[55] He

53 "Col rifrattore siamo al punto che si potrebbe subito collocare; ma converrà differire qualche settimana, giacchè il Direttore non avendo più denari dell'assegno, e credo già abbia poi anticipati del suo anche quelli pel [18]65, così aspetta un assegno straordinario da Torino. Intanto si fece una base di legno in una stanza, ed ho collocato in provisorio la prima piastra, il letto grande e tutto ciò che spetta al movimento orario, elim[in]ando così preventivamente quelle difficoltà che egualmente avremmo incontrato nell'atto della vera collocazione. In pari tempo si sono puliti tutti i pezzi, e questo si è conservato bene, meno piccole cose, che si riducono però a perdita di vernice in qualche punto; è lavorato in un modo particolare e montato ritengo debba riescire una galanteria." Letter from Tacchini to Schiaparelli, Palermo, 19 May 1864 (Pisa, Archives of Domus Galilaeana, Dossier Schiaparelli).

54 See the worksheets by Tacchini with notes, translations and drawings, conserved in the Archivio Storico dell'INAF-Osservatorio Astronomico di Roma.

55 See the letter from Schiaparelli to Tacchini, 10 September 1863 in Chinnici, "Personaggi e vicende dell'Osservatorio Astronomico di Palermo" (cit. note 35), p. 6. ~~Before leaving for Palermo, Tacchini met Struve in Modena; the famous astronomer gave Taccini many suggestions regarding his directorship and future work at the Palermo Observatory and invited him to visit the Pulkowa Observatory. See the letter from Tacchini to Schiaparelli, Modena, 30 October 1863 (cit. note 44).~~

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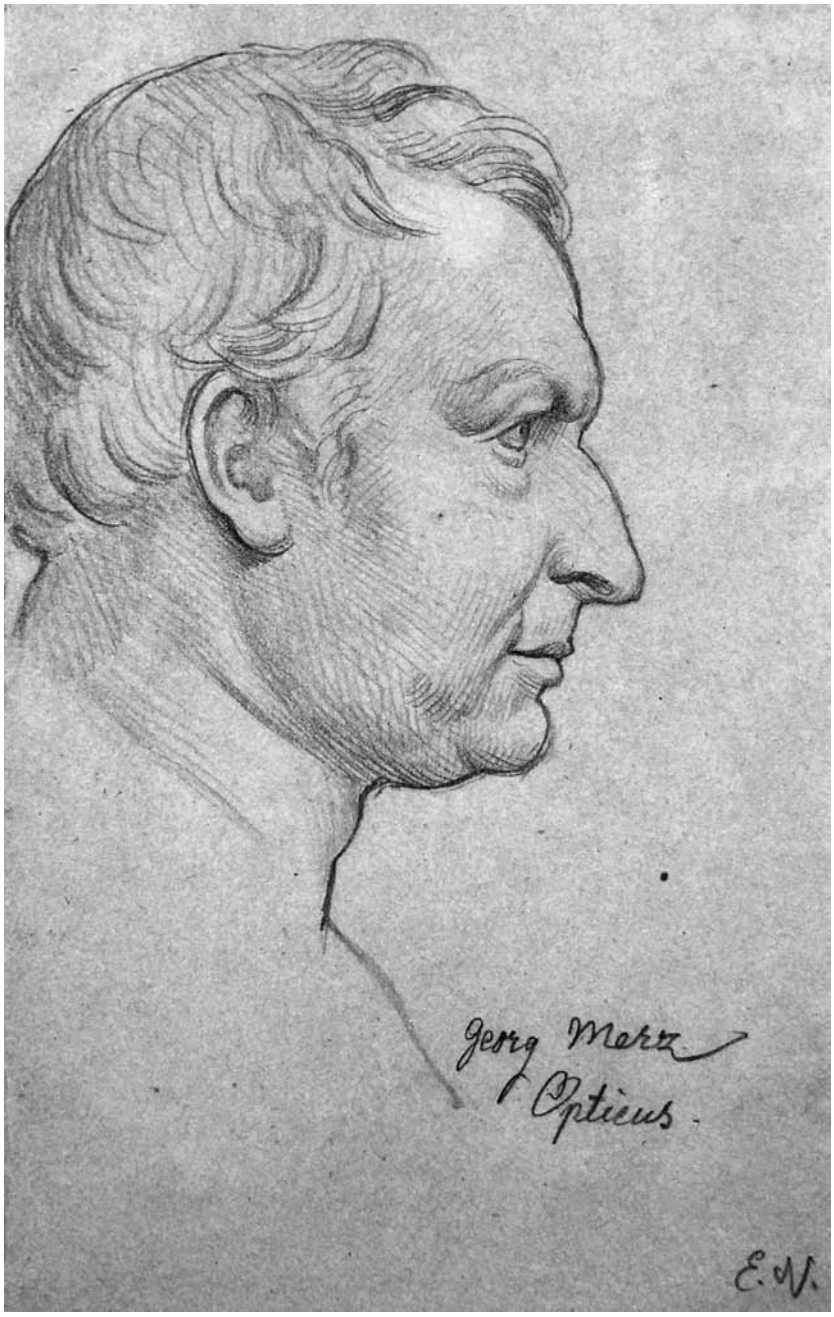

FIGURE 3 *Portrait of Georg Merz (pencil drawing by Eugen N. Neureuther [1806–1882]; image provided courtesy of PD Dr.-Ing. Timo Mappes, www.musoptin.com)*

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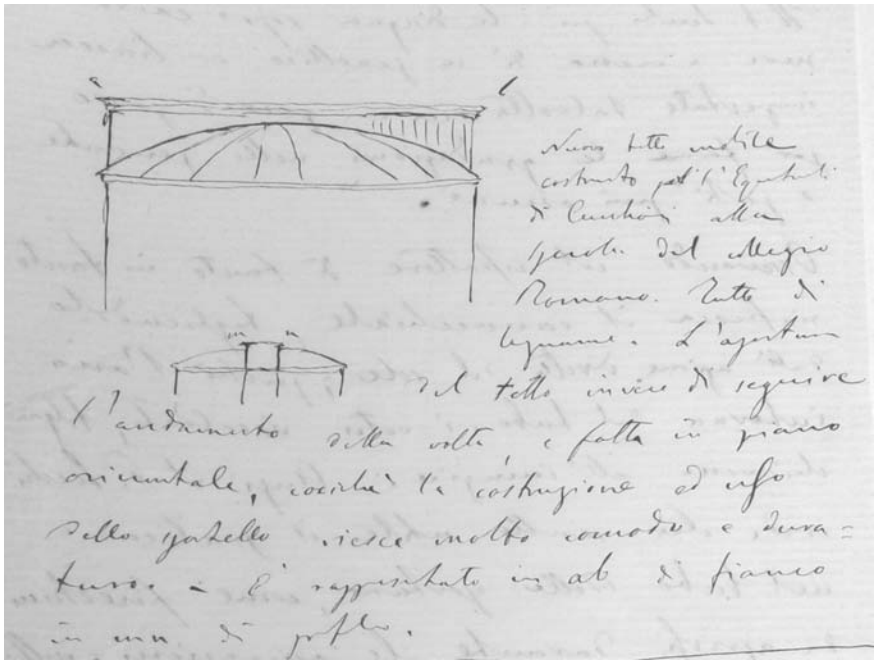

FIGURE 4 *Sketch by Tacchini of the dome built for the Cauchoix telescope at the Collegio Romano Observatory, which probably served as the model for the dome of the Palermo Merz equatorial* (*Archives of the* INAF*-Osservatorio Astronomico di Roma*)

did manage to visit the Collegio Romano Observatory, where a Merz telescope quite similar to the Palermo refractor was in operation. In fact, conserved in the archives of INAF – Osservatorio di Roma are worksheets with drawings by Tacchini of instrument parts, domes, pillars, observing chairs, etc. in use at the Collegio Romano Observatory (Fig. 4), These are accompanied by what appear to be notes made during discussions with the director Angelo Secchi (1818–1878) as they include suggestions and advice that were most certainly furnished by the renowned Jesuit astronomer. Thus Secchi as well made an important contribution to the advancement of astronomical studies in Palermo by sharing his expertise with Tacchini. Having used a Merz telescope for a decade, he was thoroughly familiar with both its capacities and its limitations, and therefore was the best possible advisor for Tacchini. The latter seems to have taken full advantage of his suggestions; for example, the cylindrical shape of the dome for the observation room was modeled on those constructed for the telescopes at the Collegio Romano, probably on Secchi's advice.

Thanks to his engineering background and his ~~previous experience~~, Tacchini successfully set up the large refractor in the spring of 1865, as Cacciatore wrote

in the observatory's new journal, the *Bullettino Meteorologico del Reale Osservatorio di Palermo*:

> I am delighted to announce the final installation of the large Merz equatorial, the stupendous device owned by the Observatory since 1859. This not being the place to provide a complete and apposite description of the outstanding instrument by the Merz workshop in Munich, suffice it to say that it is now fully in use and ready to be employed in the service of science [...].
>
> The objective-lens of this spectacular instrument measures 10 English inches in total diameter while, taking into consideration the portion underlying the mounting circle, its free aperture is 9.665 inches, that is 0.246 meters, and its focal length is 4.42 meters.
>
> This large equatorial, to be regarded as a first-class instrument, has the same size as that installed in 1854 at the Collegio Romano, and both are the largest telescopes extant in Italy at present.
>
> The studies that have just been initiated and the few observations so far allowed by a persistently cloudy sky, show clearly that the illustrious maker has not disproven either himself or the high reputation gained worldwide as the prince of modern makers.
>
> The micrometer, whose accuracy leaves nothing to be desired, is provided with 8 positive eye-pieces, from 90 to 1000 in magnification, and with 5 negative ones from 142 to 760. Moreover, there is an eye-piece with a double circular micrometer. Besides the above-mentioned eye-pieces, I have added an extra one built to measure by Messrs Troughton & Simms in London, aimed at observing the Sun under the most favorable conditions, a reflection eye-piece recommended by Fr. Secchi's authoritative praise.
>
> Beautiful in its external parts, elegant in its lines, graceful in its balanced colors and in the combination of its various metals, this wonderful instrument is as much a pleasure to look at as it is precious to use for making observations, thanks to its smooth and easy movements and especially to its powerful and clear lenses.
>
> Its installation has been expeditious, devoid of any inconvenience or the need for the work of craftsmen and mechanics, so that just two of us, merely helped by the Keeper and a few extra hands, have succeeded in properly placing it.
>
> I have the pleasure, on the occasion of mentioning for the first time the setting of this magnificent instrument, to pay tribute in praise and admiration to my Illustrious companion and friend Mr. Tacchini, regard-

> ing whom it is difficult to state what I admired most: the solidity of his cognition and knowledge or his sharp, intelligent and pragmatic industriousness during the important work of arrangement and placement.[56]

The instrument was mounted on a fine marble pillar composed of four pieces joined with iron hooks[57] and housed in a circular room with a cylindrical

56 "Godemi l'animo di potere annunziare la definitiva collocazione del grande Equatoriale di Merz, stupenda macchina della quale era in possesso l'Osservatorio sin dall'anno 1859. Non essendo questo il luogo di una apposita e completa descrizione di questo insigne lavoro delle officine Merz a Monaco, bastami per ora l'accennare che esso oramai trovasi nel suo pieno esercizio, e pronto a rendere alla scienza eminenti servigii [...]. Il diametro assoluto dell'Obbiettivo di questo colossale strumento è di 10 pollici inglesi, e tenendo conto della parte che sta sottoposta al cerchio d'incassatura, la sua apertura libera è di $9^{poll.}$, 665 ovvero di 0^{m}, 246, e la lunghezza focale uguale a 4^{m}, 42. Questo grande equatoriale che è da annoverarsi tra gli strumenti di primo ordine è pari in dimensioni a quello dell'Osservatorio del Collegio Romano collocato sin dal 1854, e sono i più grandi che al presente sianvi in Italia. Gli studi che già ne abbiamo intrapresi, e le poche osservazioni che a motivo di un cielo ostinatamente coperto ci è stato dato di fare, danno chiaro a vedere che l'illustre artefice in questa costruzione non venne meno a se stesso, né all'alta fama che nei due mondi l'ha proclamato principe degli artisti moderni. Il micrometro, la di cui precisione nulla lascia a desiderare, è fornito di 8 oculari positivi a cominciar da 90 insino a 1000 d'ingrandimento, e di 5 negativi da 142 a 760. Oltre questi vi ha un oculare con micrometro circolare doppio. Ai sopradetti oculari ho voluto aggiungerne un altro che ho fatto elaborare dai Signori Troughton & Simms in Londra, allo scopo di potere osservare l'immagine del Sole nelle condizioni più favorevoli, oculare a riflessione raccomandato dagli autorevoli encomi dell'Illustre P.re Secchi. Bello nelle parti esteriori, elegante nelle forme, vago nella composizione delle tinte e nella combinazione dei vari metalli questo stupendo strumento se riesce piacevole e grato alla vista è poi prezioso nell'esercizio e nelle osservazioni per la dolcezza e facilità dei movimenti, e quel che più monta per la forza e precisione delle lenti. La collocazione è proceduta sollecitamente, senza incontrare inconvenienti di sorta, o avvertire il bisogno di artefici o meccanici, di modo che solo in due e col solo aiuto del Custode e di poche braccia ausiliari in breve tempo l'abbiamo messo al suo posto. Mi è pertanto grato nella opportunità che per la prima volta toccami a far cenno della collocazione del magnifico strumento, rendere un tributo di lode e di ammirazione allo Egregio mio Compagno ed amico Signor Tacchini, di cui nell'importante e delicato lavoro di riordinamento e di collocazione non so se abbia dovuto più ammirare o la solidità delle cognizioni e del sapere, ovvero l'avveduta ed intelligente pratica operosità." Gaetano Cacciatore, "Annunzi," *Bullettino Meteorologico del R. Osservatorio di Palermo*, 1865, *I*:11–12, p. 11.

57 "[...] il pilastro in marmo è in 4 pezzi riuniti con chiavi di ferro." Letter from Tacchini to Schiaparelli (cit. note 44). The choice of a marble pillar appears to be unusual, as other Merz telescopes at the time were mounted on pillars made of granite or of wood with

dome, as is shown by surviving photographs of the Royal Palace of Palermo. An inaugural ceremony was held, of which we have a vivid account provided many years later by Paolo Palazzotto, keeper of the Observatory. As he noted, it was a glittering event:

> [...] on April 30th of that year [1865], in the evening, the Observatory was greatly celebrating the Large Refractor inauguration, attended by a representative of the Government, civil and military authorities and 400 guests from high society.
>
> The opening address was read by the late Director Cacciatore, deservedly praising Prof. Tacchini – deservedly I say, since [he succeeded], contrary to Prof. Ragona's claims in booklets published in Berlin that just himself and no other one could install that large instrument! [...] After the inauguration, a splendid reception was offered to the guests with assorted ices in profusion.[58]

It may appear surprising that 400 guests were invited to what was a scientific event, but Cacciatore was a respected figure in Palermo for his past anti-Bourbon activism, and the ceremony had a certain political significance; the *New Deal* of the refurbished observatory coincided admirably with the *New Deal* of a unified Italy. This symbolism was underlined by the fact that the Palermo Observatory was (and is still) located in the tower of the Bourbon Royal Palace.

The Merz refractor was primarily used by Tacchini for solar observations that contributed to the development of solar physics. At first it provided detailed views of photospheric features such as sunspots (Fig. 5), faculae and granulation, leading to more detailed descriptions and a greater understanding of these

metal clamps. Tacchini himself was dubious about this pillar and asked Schiaparelli if an inspection was necessary; it is unclear if such an inspection was ever carried out.

58 "[...] la sera del 30 aprile di quell'anno [1865] l'Osservatorio era in grandissima festa per l'inaugurazione del Grande Refrattore con l'intervento del rappresentante del Governo, Autorità Civili e Militari e 400 invitati della migliore societa'. Il discorso inaugurale fu letto dal compianto Direttore Cacciatore eloggiando [sic] meritatamente il Prof. Tacchini, dico meritatamente dapoiche', contrariamente a tutto ciò che il Prof. Ragona con appositi opuscoli pubblicati in Berlino asseriva che egli solo e nessun'altro poteva collocare a posto il grande strumento! [...] Dopo l'inaugurazione agl'invitati fu servito splenditamente un trattamento con gelati a profusione." P. Palazzotto to F. Angelitti, [Palermo], 14 April 1905, Archivio Storico dell'INAF-Osservatorio Astronomico di Palermo, Palermo, Dossier Corrispondenza Ufficiale in Entrata 30, Folder 4.

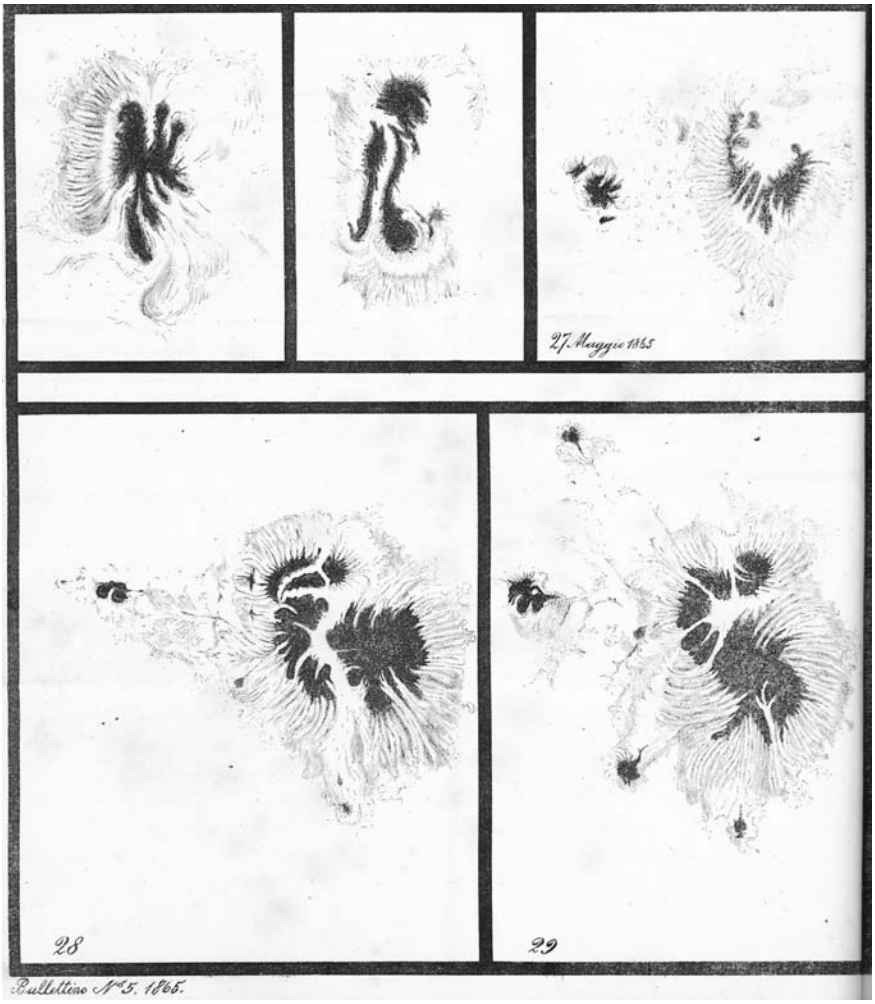

FIGURE 5 *Drawings of sunspots observed by Tacchini in 1865 using the newly installed Merz equatorial at the Palermo Observatory (from Pietro Tacchini, "Il Sole veduto col grande Refrattore di Merz,"* Bullettino meteorologico del R. Osservatorio di Palermo, *1865,* I-5:*1–3*)

phenomena. Because of its first-rate optics, the Merz refractor also came to be used for the routine observation of celestial objects and ~~extended~~ phenomena such as comets, planets, ~~and~~ moons. In 1871 a direct vision spectroscope made by Tauber based on a design by Zöllner was added which ~~augmented the instrument's performance even further.~~ Tacchini's detailed observations of the solar chromosphere, documented in drawings that constitute some of the best 19th-century illustrations of these features (Fig. 6), led him to formulate one

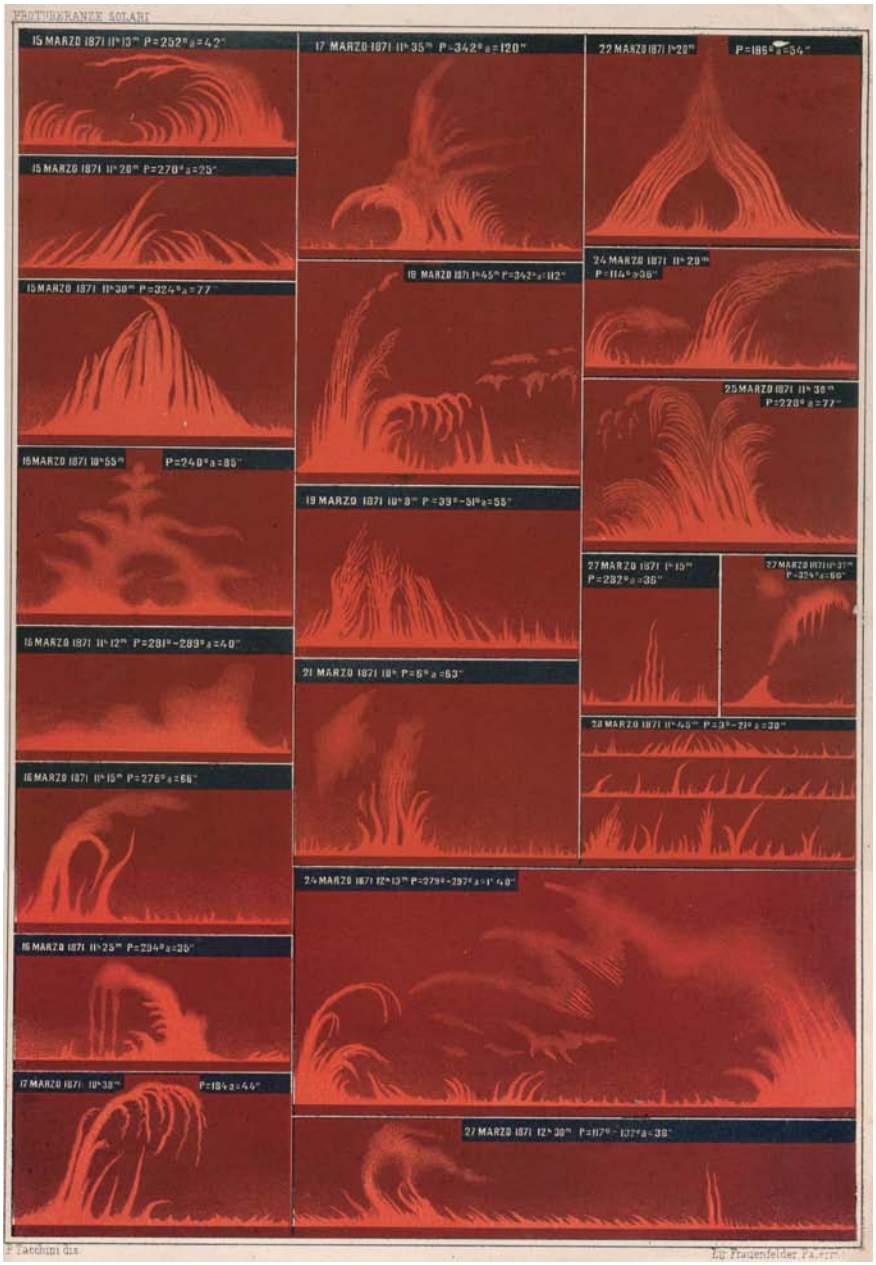

FIGURE 6 *~~Spectrographic~~ images of solar prominences observed by Tacchini in 1871 using a Tauber direct-vision spectroscope attached to the Merz equatorial* (*lithographs reproduced from Pietro Tacchini, "Fisica solare,"* Bullettino meteorologico del R. Osservatorio di Palermo, *1871,* VII-5:*49–62;* VII-6:*69–78;* VII-7:*85–99;* VII-8:*111–113;* VII-9:*121–132*)

of the first classifications of solar prominences (*thread-like*, *cloudy-like* and *beam-like*).[59]

This propitious combination of a skillful observer and a high-quality instrument did not pass unnoticed by Secchi, who was working with ~~an~~ identical refractor and realized that he and Tacchini could join forces in a very constructive collaboration. In October 1871 the two astronomers established a scientific society – the "Società degli Spettroscopisti Italiani" – whose objective was to monitor ~~significant~~ solar ~~phenomena such as limb darkening using sophisticated instrumentation~~ and whose *Memorie* may be considered the first astrophysical journal ~~whose primary focus was solar physics.~~[60]

The subsequent histories of the Merz refractors in Rome and Palermo were quite different. ~~The~~ telescope at the Collegio Romano Observatory was dismantled and ~~in 1923~~ transferred to the newly built Rome Observatory at Monte Mario (Fig. 7), where it was destroyed during a fire in 1958. Only the granite pillar on which it stood has survived, and stands abandoned today in the crumbling premises of the Collegio Romano Observatory.[61] The Palermo telescope was still in active use in the 1950s, when it was sent to the Salvadori workshop in Florence to be reconditioned. During this "modernization" process[62] the original design was altered and the resulting hybrid instrument was used until the 1980s~~; it was finally retired from service,~~ restored in 2001,[63] ~~and~~ is now on display at the Palermo Observatory ~~in its original setting~~.[64]

59 See Pietro Tacchini, "Fisica solare" (part 3), *Bullettino Meteorologico del R. Osservatorio di Palermo*, 1871, *VII*:85–99, pp. 93–94.

60 On this scientific society and its publication *Memorie*, see Ileana Chinnici, "The Società degli Spettroscopisti Italiani: birth and evolution," *Annals of Science*, 2008, *65*:393–438.

61 See Renzo Lay, "Il Nuovo Osservatorio del Collegio Romano," in *Angelo Secchi. L'avventura scientifica del Collegio Romano*, edited by Aldo Altamore, Sabino Maffeo (Foligno: Edizioni Quater, 2012), pp. 91–107; 100.

62 A similar "modernization" and restyling was carried out on the Pistor and Martins' Meridian Circle; both decisions (to renovate existing instruments rather than to replace them) can be explained by the parlous financial conditions of Palermo Observatory in those years. See Giorgio Foderà Serio, Ileana Chinnici, *L'Osservatorio astronomico di Palermo* (Palermo: Flaccovio, 1997), p. 29.

63 See Paolo Brenni, Ileana Chinnici, Giorgia Foderà Serio, "The restoration of three large telescopes of the Palermo Astronomical Observatory," *Bulletin of the Scientific Instrument Society*, 2001, *71*:11–16.

64 A restoration of the marble pillar was carried out in 2012, which required the telescope to be dismounted. Before it was reassembled, the instrument was cleaned and some slight repairs were made. A project to repair the moving mechanisms so that the telescope may be used for educational purposes is currently under evaluation.

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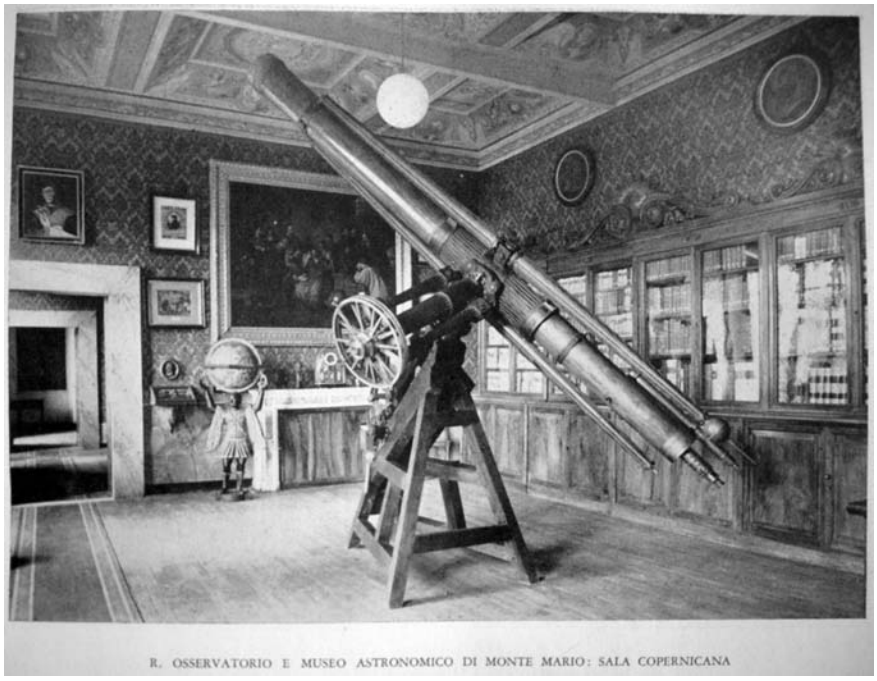

FIGURE 7 *Photograph of the Merz equatorial ~~at the Collegio Romano~~, taken when it was on temporary display in the Copernicus Hall of the Museo Astronomico e Copernicano, which is housed in the Rome Observatory on Monte Mario (from Giuseppe Armellini, "Il R. Osservatorio e Museo Astronomico di M. Mario,"* Capitolium*, 1938,* XIII:*611–620, p. 615*)

7 The Assembly Instructions Provided by Merz

Conserved in the Museo Astronomico e Copernicano in Rome is a manuscript consisting of 32 pages measuring about 224×283 mm, signed and dated on the last sheet *G. & S. Merz, Munich 6 juin 1862*. It is bound together with three letters written on sheets of different sizes, and has a cover measuring about 221×328 mm on which is written "Sigismondo Merz" and a list of the letters.[65] The text of the manuscript, which is written in French, covers the

65 For the sake of completeness, a brief description of the letters bound with the manuscript is provided here: three letters from Merz to Tacchini, dated respectively 22 February 1874 (written to accompany a printed catalogue of Merz instruments); 10 June 1875 (regarding a refractor commissioned for Calcutta Observatory; see Ileana Chinnici, "An 'Italian' Observatory in India: The history of the Calcutta Observatory," *Studies in History of Medicine and Science*, 1995/96, *XIV*:91–115); and 3 April 1878 (about a refractor commissioned for Cata-

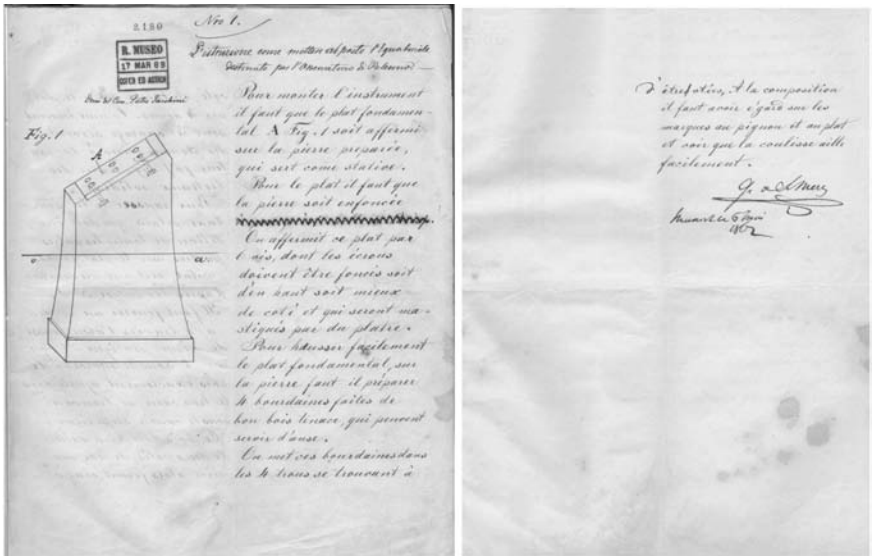

FIGURE 8 *The first and last pages of the manuscript by Georg and Sigmund Merz, ~~in which it can be clearly seen that the manuscript~~, the title in Italian, and the signature (~~G. & S. Merz~~) ~~were all~~ written by different hands (Archives of INAF-Osservatorio Astronomico di Rom*

right-hand side of every sheet – *recto* and *verso* – except the last, whose *verso* is blank. The left-hand side of each sheet is taken up by drawings (totaling 18 in number) that illustrate the text. A complete transcription is provided in an appendix to this paper. On the first page (Fig. 8) there also appear two annotations written in Italian by a single hand which is different from that of the manuscript's author; the first note consists of a title, "Instructions for setting up the Equatorial destined for the Palermo Observatory", while the second states that the document was a gift from Pietro Tacchini, who also served as the director of the Museo Astronomico e Copernicano from 1879 to 1902 and greatly expanded its collections.[66] While the signature and some of the annotated corrections can be ascribed to Sigmund Merz, the body of the text was written by a different hand, suggesting that the instructions were prepared

nia Observatory; see Carlo Blanco, "Tacchini and Astrophysics at Catania," *Memorie della Società Astronomica Italiana – Supplementi*, 2006, *9*:35–42) and one letter from Merz to Gaetano Cacciatore, dated 9 August 1881 (concerning a micrometer for the Merz refractor in Palermo).

66 See Marinella Calisi, *Guida alla visita del Museo Astronomico e Copernicano di Roma* (Roma: Osservatorio Astronomico di Roma, 1991), p. 10.

by an employee and then revised by the instrument maker. It may be noted that the author had a good working knowledge of French, but that it was clearly not his native language.

This manuscript is of great importance, because it originated directly from the instrument makers' workshop. It is rare to find such documents in a historical archive, and let alone in a museum library. Tacchini's decision to donate the Merz manuscript to the Museo Astronomico e Copernicano (conceived to be the most important museum of astronomy in Italy) therefore reflects the historical significance that he assigned to this document.

The assembly instructions for the Merz refractor in Palermo shed considerable light on the technical details of this type of instrument. It is fascinating to note that – unbeknownst to the technicians themselves at the time – the recent restoration of the Fraunhofer telescope in Dorpat,[67] which was never subjected to radical modification, demanded the same operations as those described in the Merz manuscript. The only difference was that, to facilitate the operation, a hoist was used to move the heaviest pieces. In fact, from a mechanical point of view the Merz refractor is a relatively simple apparatus and a clever technician working in an observatory would probably not have encountered any major problem in understanding how its parts were assembled. However, Merz's instructions indicated the precise order in which the operations were to be carried out in order to assemble the telescope without loss of time or damage to its parts. The document also revealed a few "tricks" in terms of technical information of a kind that is rarely provided in textbooks or treatises on astronomical instruments, but which is all the more helpful because it ~~has been gathered by the makers of the instruments themselves or by the astronomers and technicians who utilized them.~~

In their manuscript Georg and Sigmund Merz not only describe how to put together the refractor, but give careful instructions on how to lubricate each piece. They advise technicians to protect the more fragile pieces with a cloth to avoid damage during assemblage, and explain how to equilibrate the tube by proper placement of the counterweights. The authors in many cases point out pieces that have been marked with letters, numbers, dots or lines. The use of such markings was a common practise, as been ascertained from the recent cleaning and restoration of other high precision instruments dating to the 19th century. In fact, before the standardization and mass production of instruments, what appear to be identical pieces (such as screws and bolts)

67 See Paolo Brenni, "The Fraunhofer's Refractor of Tartu (Dorpat) and its Restoration," *Bulletin of the Scientific Instrument Society*, 2012, *113*:2–7.

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were in fact not interchangeable and the assemblage of a complex apparatus required many fine adjustments. For example, each individual screw would fit perfectly into only one aperture. The switching of two screws could impair the proper assemblage of the various parts of an instrument; therefore, every element had to be marked in order to avoid going through a process of trial and error with much waste of time in order to reach the correct ~~solution.~~

Since the Merz telescope was delivered in 1859, it is clear that the manuscript, which is dated 1862, was prepared and sent subsequently. In 1862 Ragona had already left Palermo but Tacchini had not yet arrived; therefore Gaetano Cacciatore, the director of the observatory at the time, was probably the recipient of this document, which appears to have been sent by Merz in response to a specific request.

The manuscript was almost certainly used by Tacchini to assemble the refractor and to do the necessary adjustments, an operation that the Merzes greatly facilitated by the care they took in packaging and marking the various parts. This fact was noted by Secchi in 1854 when he was setting up the Merz refractor at the Collegio Romano Observatory:

> For that operation, the maker's presence was unnecessary, since the parts were so well worked and placed in the 13 cases that none were either damaged or broken; moreover, they had been so accurately marked that just five hours were sufficient to arrange everything.[68]

It is possible that, in addition to the outstanding quality of their optics, the ease with which their instruments could be assembled was a contributing factor to the success of Merz refractors in the 19th century.

8 Some Drawings of the Palermo Refractor

The description provided by Palazzotto in 1905 is a reliable, first-hand account of the installation of the Merz refractor in Palermo; in one passage he refers to drawings made ~~by Tacchini~~ at the time which illustrated every part of the

68 "Per tale operazione non fu d'uopo far venire l'artista, essendo i pezzi così ben lavorati e ben disposti nelle 13 casse che lo contenevano, che nessuno si trovò danneggiato né guasto; e inoltre per la gran cura con cui tutti erano stati contrassegnati, cinque sole ore di tempo bastarono per metter tutto a posto." Quoted in Lay, "Il Nuovo Osservatorio del Collegio Romano" (cit. note 52), pp. 99–100.

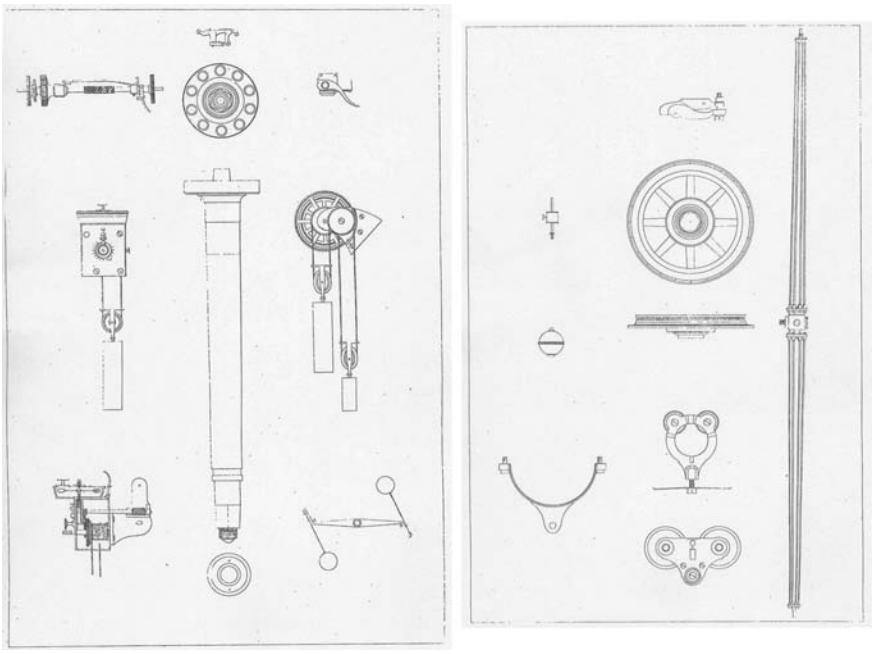

FIGURE 9 *Lithographs of pieces of the disassembled telescope, probably drawn by Tacchini in 1865 (Archives of INAF-Osservatorio Astronomico di Palermo); see the annexed legenda*

disassembled telescope: "I clearly remember [...] that, during the completion of the Refractor rooms and dome, each part of the instrument was drawn in masterly fashion by Prof. Tacchini and handled by me numberless times [...]."[69]

Some lithographed plates of drawings (Fig. 9) showing parts of the Merz telescope have recently been discovered at the Palermo Observatory in a cabinet amongst other charts and printed illustrations. While sorting the documents, three lithographed sheets (consisting of two different plates and one duplicate) illustrating the parts of an unknown instrument similar to a Merz refractor were spotted. These were compared to the drawings in the Merz manuscript and it was concluded that they could represent parts of the disassembled ~~Mertz~~ telescope in Palermo. On the sheets we find some pieces that do not appear,

69 "Ben ricordo [...] che ogni singolo pezzo di quello strumento, mentre si terminavano e stanze e cupolo del Refrattore, veniva maestralmente disegnato dal Prof. Tacchini e da me maneggiato le mille e cento volte [...]." From P. Palazzotto to F. Angelitti, 14 April 1905 (cit. note 49).

and others that have been drawn in far more accurate detail, than in ~~the Merz manuscript~~. The drawings show a few of the individual parts of the telescope depicted in the manuscript. Conversely, not all the parts illustrated in the manuscript appear on the lithographed sheets. Therefore the two sets of documents complement each other.

***Plate* (*Left*)**

First column (from top to bottom a, b, c, ...):

a) endless screw and pinion designed to transmit the movement from the clock to the polar axle
b) box containing the clockwork mechanism
c) section drawing of the clockwork mechanism

Second column:

a) unidentified part of the telescope
b) polar axle head
c) polar axle
d) ring fixing the polar axle

Third column:

a) lever acting on the endless screw
b) endless rope system designed to maintain the power that drives the clockwork while raising the weight
c) rotating arm of the clockwork mechanism, consisting of a bar, two springs and two spheroidal weights

***Plate* (*Right*)**

First column (from top to bottom a, b, c, ...):

a) example of a counterweight
b) example of another type of counterweight
c) one of the half-collars holding the tube

Second column (from top to bottom):

a) lever acting on the roller
b) view of the polar circle (face-on)

c) view of the polar circle (edge on)
d) example of a frictionless roller for the axle
e) example of another type of frictionless roller for the axle

Third column:

Anti-flection beam for the tube (two wooden cones reinforced with iron bars)

There are no legends on the sheets, suggesting that they could represent preliminary drafts for a work that was under preparation; the drawings bear no numbers (whereas those on the manuscript are numbered) and probably a third lithographed sheet containing other drawings has been lost. The sheets do not match the dimensions of the *Bullettino* and this is consistent with Cacciatore's statement in 1865 that the *Bullettino* was not the most appropriate publication in which to present a detailed description of the Palermo refractor. A letter written in 1864 by Tacchini to Schiaparelli is revealing: "Since the Director intends to publish a short description [of the Refractor], with some drawings and photographs, I have started to prepare a few small things in advance."[70] Even if, for unknown reasons, these drawings were never published, this passing reference clearly confirms that Tacchini was their author.

The authenticity and significance of these unpublished documents – both the manuscript and the drawings – is therefore proven.

9 Concluding Remarks and Future Perspectives

The assembly instructions and the drawings of the Merz refractor at the Palermo Observatory are of genuine historic interest. The former exemplifies a type of technical documentation that was never intended for publication; indeed, it was considered unimportant and would often be thrown away after it had served its purpose. Only in recent years has the so-called "grey literature" – consisting of trade catalogues, price lists, advertisements, assembly instructions, leaflets describing the use of instruments, technical drawings and notes – attracted the notice of historians of instruments as potentially valuable sources of information.

70 "Siccome il Direttore intende pubblicare una succinta descrizione [del Rifrattore] con qualche disegno e fotografia, così ho già incominciato a preparare qualche cosetta in precedenza." Letter from Tacchini to Schiaparelli (cit. note 44).

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For example, the Merz manuscript allows us to compare the technical features of the Palermo refractor with other similar instruments manufactured by Fraunhofer and by Merz. A comparison between the drawings in Palermo by Tacchini and the lithographed plates of the Pulkovo telescope shows that the clockwork of the instrument in Palermo was identical to the driving mechanism of the Dorpat and Pulkovo refractors. This evidence is of even greater scholarly interest if we consider that the Palermo refractor was modified in the 1950s and therefore several of its original elements, such as the clockwork mechanism, the declination circle, the device with rollers for the polar axle, the counterweight used for the declination axle, the original breaking collars, etc. were not only removed but disposed of. Moreover, to the best of our knowledge there are very few photographs showing the Palermo refractor before its renovation. The best one (Fig. 10), discovered in 2011 by Chinnici in the collections of the Science Museum of London, had been sent to the English capital on the occasion of the International Exhibition held in 1876 in South Kensington; another, less clear photograph is conserved at the Palermo Observatory and probably dates to ~~an earlier~~ period. The data that can be gleaned from these original sources should contribute greatly to our understanding of the early features of the instrument and its use.

Finally, the rediscovered documents certainly cast fresh light on the technical characteristics of the refractor and the details of its construction, and provide information regarding the methods used in the mid-19th century to assemble large, high-precision instruments.

These instructions and drawings, together with the photographs and direct comparison with similar surviving refractors, could also enable us to reconstruct some of the missing original pieces. Certainly the "de-modernizing" the instrument and the reconstruction of all the pieces that were eliminated during the 1950s is out of the question. Such an undertaking would be absolutely anti-historical as well as extremely expensive. Like it or not, the modifications undergone by the instrument during the second half of the 20th century now form part of its history, even though it is regrettable that such a fine instrument was partially transformed in the interests of a presumed modernization. On the other hand, it ~~may~~ be ~~possible to add~~ a mid-19th century clockwork mechanism and incorporate it into the refractor without greatly modifying the instrument, and in a way that would be completely reversible. Such an addition would greatly enhance the educational value of the telescope, as well as providing a vivid illustration of the technology that was used in the mid-19th century to compensate for the apparent movement of the stars.

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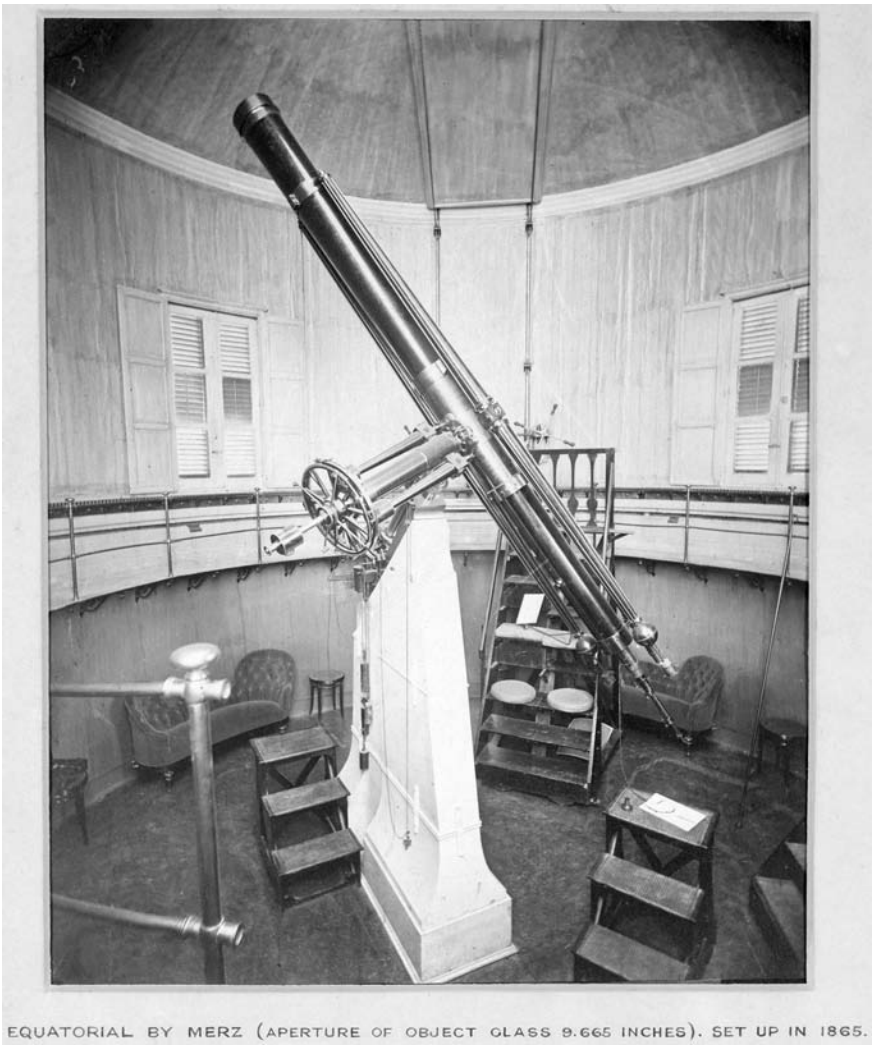

FIGURE 10 ~~a)~~ *One of the few surviving photographs of the Merz telescope at the Palermo Observatory, taken not later than 1876; the Tauber direct-vision spectroscope attached to the focus of the telescope is clearly visible* (*image reproduced courtesy of the Science Museum of London*)

Appendix. A Manuscript by Merz: Instructions for Installing the Equatorial Telescope of the Palermo Observatory (*Diplomatic Transcription, without Orthographic Corrections; // = Page Break*)

N.ro 1

■ added period as below, ok

(*The first page bears the stamp*: R. MUSEO 17 MAR 88 COPER ED ASTRO)

L'istruzione come mettere al posto l'Equatoriale destinato per l'Osservatorio di Palermo (*annotation by another hand*)

Dono del Com. Pietro Tacchini (*by the same hand as the annotated title in Italian*)

Pour monter l'instrument il faut que le plat fondamental A Fig. 1 soit affermi sur la pierre préparée, qui sert comme stative.

Pour le plat il faut que la pierre soit enfoncée (*deleted:* à peu près échelle de Paris).

On affermit ce plat par 6 vis, dont les écrous doivent être foncés soit d'en haut soit mieux de coté et qui seront mastiqués par du platre.[71]

Pour hausser facilement le plat fondamental, sur la pierre faut-il préparer 4 bourdaines faites de bon bois tenace, qui peuvent servir d'anse.

On met ces bourdaines dans les 4 trous se trouvant à // coté, et laisse porter le plat par 4 hommes. Comme échafaud pour cette ouvrage servent des planches mises à la hauteur (a) Fig. 1 sur des treteaux solides.

Pour hausser le lit pour l'axe polaire, qui doit être delivré de toutes les autres parties, sur le plat fondamental, sert une preparation d'après l'esquisse N°. 2.[72]

Il faut fourrer un rondin (a) à travers l'archet, aussi de même pratique-t-on un (b) sous le morceau (č) de bois exactement ajusté dans le trou carré, se trouvant sous le canon superieur.

Ce bois doit bien saillir de deux cotés, de cette manière alors feront cinq à // six ouvriers commodement cet ouvrage. Les deux rondins (a b) seront bien à envelopper de toile molle tant qu'ils posent sur la surface metalique. Pour ce travail on éloigne les deux vis de correction en haut, pour avoir place pour un rondin aussi fort que possible. On attache le lit de l'axe polaire par les vis mises en haut et à coté, mais avec prévoyance, afin que la pièce massive ne se pliera pas par en tirant trop les vis. Quand le lit se trouve sur la pierre il faut placer la broche du cercle horaire Fig. 3.

71 As the screws in the marble pillar were plastered over, the iron bed (base) of the telescope (*plat fondamental*) could not be removed during recent restoration work.

72 The heavy brass bed of the polar axle was removed with a hoist.

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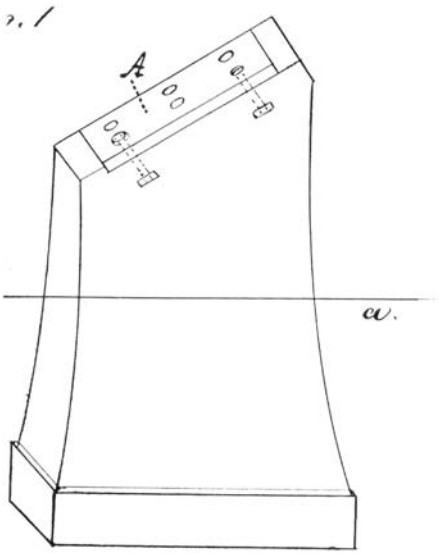

FIGURE 1 Figure captions are mandatory, remove figure nummbers from images?

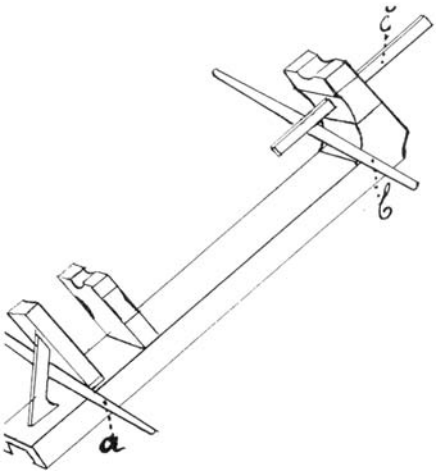

FIGURE 2 remove 2 from image?

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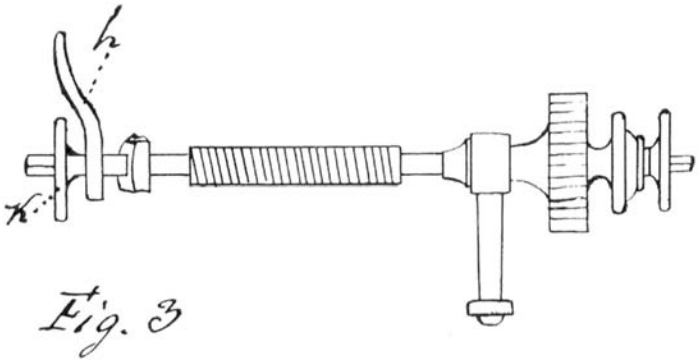

FIGURE 3 remove Fig. 3 from image?

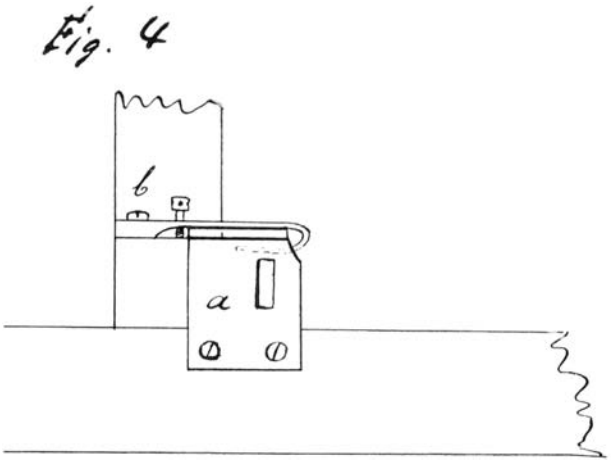

FIGURE 4 remove Fig. 4 from image?

D'abord il faut tant que possible purifier la broche, // éloigner la tête, le levier et les pièces métalliques et brosser les pas de la vis avec une brosse huilée.

Aussi on brossera bien les pas du cercle horaire au moyen d'une brosse raide trempée en huile. De manière suivante il faut enfoncer la broche: On éloigne du lit de l'axe polaire la pièce (a) Fig. 4 se trouvant en ouest, de même que le ressort (b), met le Conus dans le trou respectif du coté oriental du lit et l'attache par la vis se trouvant au Conus. La pièce metallique du coté désignée par le mot « en haut » doit être tellement ajustée que le coté convex se tournera au dehors et le coté designé avec //

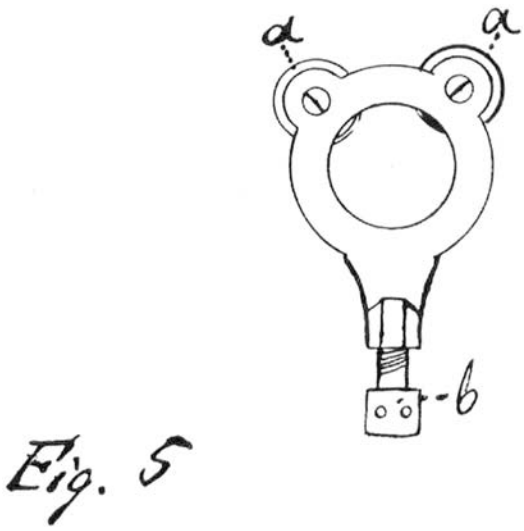

FIGURE 5 remove Fig. 5 from image?

N.ro 2

«en haut» se mettera en haut. Alors on rattachera avec des vis la pièce qu'on a au commencement ôtée et de même on affermit le ressort (b Fig. 4), aussi on met le levier (h Fig. 3) et la tête (k). Par le ressort (b) on modère la pression du grand ressort, et par là on règle l'engrenure de la broche dans le cercle horaire. Les pas de la broche doivent maintenant rester retirés, jus que tout l'instrument soit monté.[73]

A présent on joigne le cercle horaire avec son axe.

L'axe la plus grosse et la plus courte est l'axe horaire. Mais d'abord on met provisoirement le roulage (Fig. 5) à l'axe. Les roulettes (a) aussi la vis (b) y doivent être retirées. Les // têtes de vis se tourneront vers la partie la plus grosse de l'axe. L'axe elle-même doit être garantie contre endommagement causé par l'embrocher du roulage par une enveloppe de toile fine. On pousse le roulage si loin comme Fig. 6 montre jusqu'à ce qu'il ne tombera plus par lui-même.

A présent il est temps de mettre le cercle horaire à l'axe. On y fait bien de poser l'axe horaire verticalement afin que le prisme à six surfaces se tourne en

73 The system comprising the endless screw and the toothed rim of the polar circle was one of the weakest points of the refractor. Awkward manipulation, wear and friction could easily damage it.

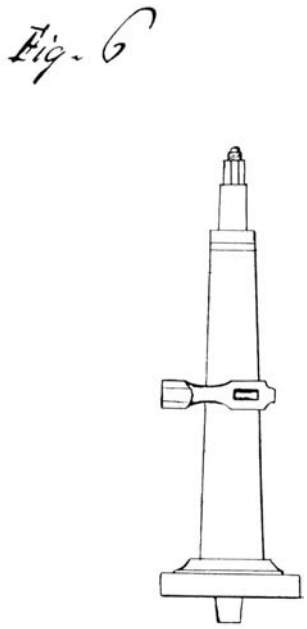

FIGURE 6 ■ ~~remove Fig. 6 from image?~~

haut. Le prisme, celui du cercle et celui de l'axe sont les plus soigneusement à huiler mais bien à essuyer, afin qu'il y a seulement l'huile dans // les porreaux. Il faut approcher le cercle avec grande prevoyance, et après le marque qui se trouve à une surface du prisme et consiste d'un point enfoncé. Si l'on met mal le cercle, celui-ci serait bien en danger. Alors on place le port-de microscopes et met l'ecrou, d'abord on la serre jusqu'à la marque, mais alors on la désserre et serre seulement à un tel point que le port-de microscopes ne la deserre pas à son tournoiement. L'axe sera tenue suspendue au dessus du lit d'abord dans la direction de l'axe du monde comme la Fig. 7 montre. Les canons, doivent être bien engraissés de suif et de l'huile fine pendant // (*deleted:* que) (*addition by another hand:* que l'axe reste à sec pour que) la poussière ne peut pas s'attacher à l'axe et entrer comme-ça dans le canon.

Un ouvrier vigoureux et prevoyant saisit le cercle par les deux mains, pendant un autre lui tient l'axe suspendue par les deux bras jusqu'à la pose dans les canons mais sans toucher la partie de l'axe qui se tournera alors dans le canon.[74]

74 This operation was particularly delicate and had to be carried out carefully in order to avoid damage to the circle and its divided scale.

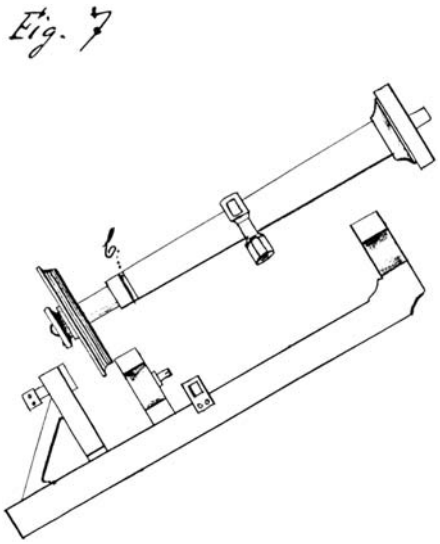

FIGURE 7 remove Fig. 7 from image?

En même temps saisissent deux autres ouvriers l'axe à la tête, l'extremité superieure et à la cheville saillante et soignent alors simultanement l'entrée de l'axe dans le canon supérieur. Quand l'axe est posée, alors en seront montés les couvercles après les avoir nettoyés //

N.ro 3

et engraissés. Du couvercle en bas on ôtera les verniers. Ceux-ci ne seront alors ajustés que quand l'instrument est tout à fait monté. Alors on peut detacher le roulage de l'axe et mêttre avec précaution dans la rainure (b) Fig. 7 qui est sa place à la partie basse de l'axe. Les roulettes seront ajustées, de même on pose le ressort (f) et serre la vis (b) Fig. 8. Aussi on doit mettre entre l'axe et le plat (c) Fig. 9. du parchemin trempé en huile comme doublure, pour empecher un frottement par la pression de l'instrument et pour former un reservoir d'huile.[75] Aprésent on approche le roulage pour la partie superieure de // l'axe mais avec grande precaution et bien doucement, jusqu'à ce que les roulettes, qui doivent être aussi bien nettoyées, touchent à l'axe.[76] L'un tient à

75 A steel ball was probably inserted between the end of the axle and the regulating screw when the refractor was "updated" in the 1950s.

76 The two rollers help to decrease the weight (and hence the friction) of the axle on the collar of the bed. In the Dorpat refractor, which was made earlier, the rollers were lifted by means of a lever with a counterweight and not, as here, by the action of a screw on a lever.

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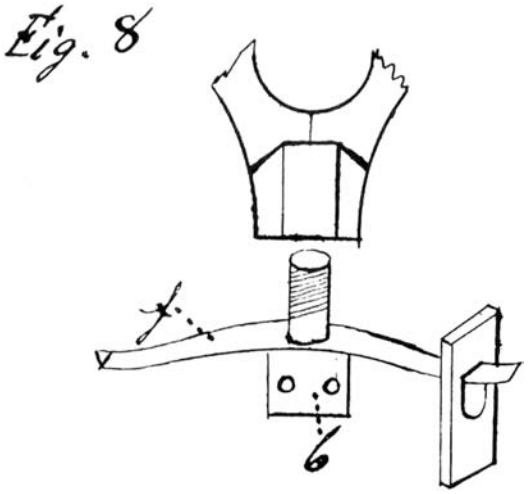
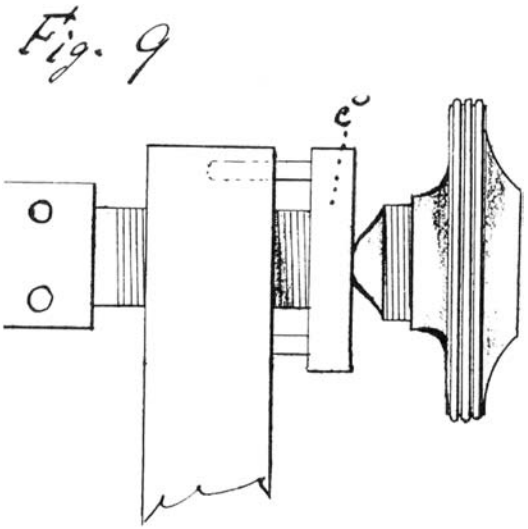


FIGURE 8 ~~remove Fig. 8 from image?~~



~~FIGURE 9~~ ~~remove Fig. 9 from image?~~

présent la pièce approchée (a) Fig. 10. pendant un autre la serre, et un troisième fait passer le levier par le trou carré au bas du canon superier et l'on affermit par la cheville conique de fer. Il serait bien de mettre un ruban fin de fil entre les rouleaux et l'axe pour être assuré contre tout dédomagement. Ce ruban peut être retiré bien facilement. A présent on prendra le canon de declinaison, mais

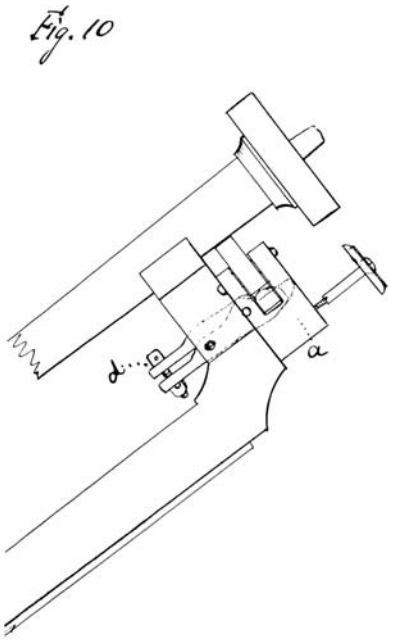


FIGURE 10 remove Fig. 10 from image?

il est à remarquer // que les deux balanciers qui sont à chaque coté et qui sont mobiles ne soient pas abandonés à eux-mêmes et c'est pourquoi qu'ils doivent être tenus paralleles au canon, et aussi de telle manière posés.[77] Ces balanciers seront alors otés du canon, ce qui se fait par l'enlevement de deux écrous et par (*deleted:* rentirer) (*annotation by another hand:* retirer) de chevilles coniques sur les quelles ils se reposent. De même on doit ôter de la pièce d'arret le port-de verniers et à présent on doit ajuster la pièce d'arret du canon de telle manière que le bras plus long (a) Fig. 11. a la direction (*addition by another hand:* vers cette partie,) qui doit être vissée sur la tète de l'axe horaire. Cette pièce d'arret doit être solidement fixée au moyen d'un coup de marteau. Avant de // la fixer par de coup de marteau (*deleted:* Avant de la fixer par de coup de marteau) il faut regarder la marque enfoncée au canon et à la pièce d'ârrét. Aussi il ne faut pas frapper avec le marteau sans y mettre un morceau de bois, qu'on pose sur la pièce d'arret près (x) Fig. 11. et sur laquelle on applique les coups de marteau. Les 4 vis pour la serrer se trouvent dans le canon et sont aussi marquées. Alors on pose le canon sur la tête de l'axe.

77 The two counterweights of the declination axle were eliminated during the "modernization" of the instrument.

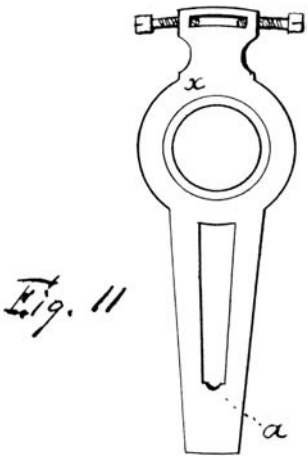


FIGURE 11 remove Fig. 11 from image

Pour ce travail il est bon de hausser l'echafaudage à peu près d'un pied.

Canon, axe et vis sont bien marqués. Les vis avec des points enfoncés dans le canon et dans l'axe, les plats touchants aussi //

N.ro 4

par un point enfoncé, celui-ci doit être avant montér le canon regarder en haut, ou le canon se penchera en bas, comme la Fig. 12 le répresente. Les vis sont marquées par des points comme numeros courants aussi les trous respectifs. Alors on visse l'axe de declinaison sur le lit du télescope. Cette operation doit se faire sur l'echaffaudage même du coté occidentale; qui doit avoir au moins une largeur de 7 a 8 pieds, pour lever seulement le lit du télescope avec l'axe pour l'entrée suivante de l'axe dans le canon et pour ne pas être obligé la porter plus loin à une autre place.

Voilà aussi les plats touchants de l'axe et de lit marqués d'un point enfoncé. Les vis sont // marquées avec des chiffres romaines pour ne pas les confondre avec celles de l'axe horaire.

Quand l'axe de declinaison est montée alors le roulage en cercle dont les roulettes doivent être ôtées serait appliqué à la rainure qui est sa place à la tête de l'axe.

Il y doit être tenu par quel qu'un, jusqu'à ce qu'un autre ait posé les roulettes. La rainure et les roulettes doivent être bien nettoyées, les axes et les roulettes bien engraissées par l'huile. Les roulettes et les axes ne doivent pas être changés, elles sont bien marquées. Les tétes de vis qui fixent les roulettes ainsi que les deux chevilles au roulage doivent regarder en haut. L'anneau de ressort qui

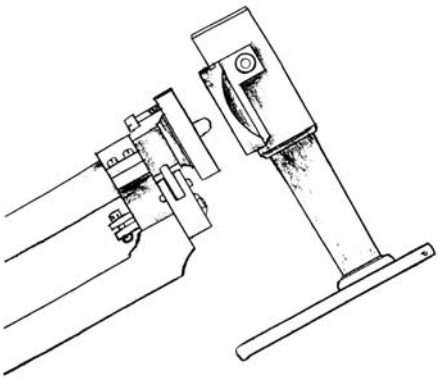


FIGURE 12 ■ ~~remove Fig. 12 from image?~~

se trouve à l'axe et qui sera alors // remis à l'axe doit être bien nettoyé et bien huilé. L'une des surfaces est concave et doit reposer sur la tête de l'axe. Avant de mettre l'axe dans le canon on posera le canon horizontalement pour une (*deleted:* blus) plus commode manipulation.

Le canon doit être soutenu par une planche solide ou par un baton de bois comme dans la Fig. 13 (a) pour pouvoir rester dans cette position.[78] Aussi doit-on les deux balanciers coniques appliquer et faire tenir au canon où l'on a besoin 2 hommes jusqu'à ce que l'axe est completement introduite. Les balanciers pour empecher un changement sont marqués de telle manière que les chevilles coniques et le petits toneaux // qui se trouvent dans les cubus des balanciers sont marqués par 1 et 2. Peu avant l'introduction l'axe et le canon sont bien à nettoyer et les canons bien à engraisser d'huile et de suif.

Un engraissement trop precoce a le desavantage que la poussière s'y attache facilement, ce qui est bien nuisible au canon. A l'introduction, à laquelle on a besoin 5 hommes dont 3 tiennent le lit du telescope (B) Fig. 13 le quatrième tient l'axe (A) à l'aide du cinquième, suspendue dans le canon jusqu'à ce qu'il puisse attraper l'axe de l'autre coté par la pièce d'allonge, après il abandonne à son compagnon à coté du lit le tenir de l'axe visse la pièce d'allonge avec //

78 When disassembling (or reassembling) the instrument it is necessary to be take great care during this step as the entire system is unbalanced. If the axles are not fixed (for example, with strong nylon belts) a sudden rotation could cause great damage.

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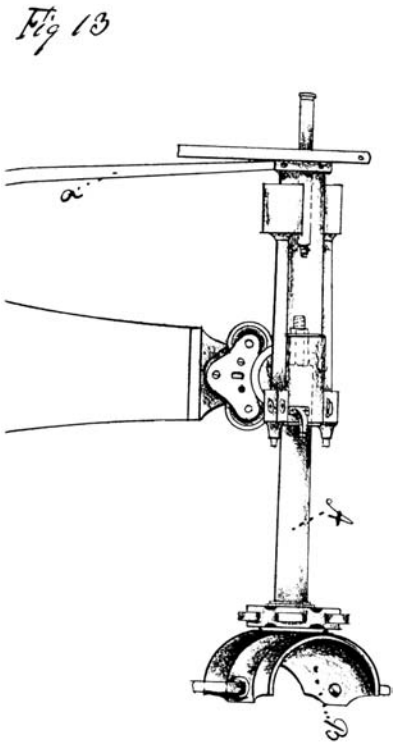

FIGURE 13 ■ ~~remove Fig. 13 from image?~~

N.ro 5

précaution dans l'axe et dirige à présent avec le secours de cette pièce d'allonge l'axe de telle manière, qu'elle peut se faire entrer en suspent sans nuir le canon. Plus loin il faut avoir égard que le nez au canon se met entre les deux chevilles qui se trouvent au roulage en cercle et que ceux qui tiennent les balanciers prennent garde d'introduire leurs chevilles aux trous du roulage en cercle. Alors on ôte la pièce d'allonge. A présent vient le port-de verniers, qui ne peut pas être mal posé, parce que la cheville d'acier au bras (*deleted:* court) (*addition by another hand:* de correction doit venir dans le creux du bras court) du pièce d'arret. Quant à 4 vis pour visser le port-de verniers les vis et leurs petits platines sont marquées. Ces vis sont bien à serrer et après à désserer // et alors, seulement à résserér qu'un mouvement par la vis de correction est possible.

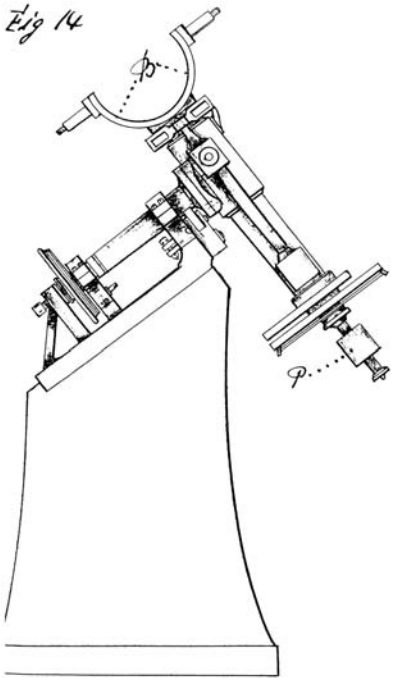

FIGURE 14 ■ ~~remove Fig. 14 from image?~~

A présent seront mis le cercle d'arret et le cercle de declinaison.[79] Les prismes à six surfaces doivent être soigneusement nettoyés et le prisme en acier de telle manière huilé comme au cercle horaire. Le cercle est marqué au prisme par des points enfoncés et de même aussi les surfaces respectives du prisme de l'axe. Entre le canon et le cercle d'arret vient encore le petit ressort d'anneau. Celui-ci tient seulement par l'huile. La partie facettée de l'anneau regarde le canon. Après le cercle de déclinaison sera monté le port-de microscopes et l'écrou se visse alors. On le visse selon les signes comme à l'axe horaire mais après // on le desserre un peu et l'on resserre seulement si loin, qu'un tournoiement du port-de microscopes ne le peut plus dévisser. A présent on visse la pièce d'allonge pour l'axe de declinaison. Alors on portera le canon de declinaison après qu'on a ôté le soutien dans la situation comme Fig. 14 pour pouvoir mettre le télescope dans son lit (B) qui de cette manière peut être mis tout à fait horizontal. Quand le canon est dans cette situation on approchera

79 Unfortunately, the original declination circle was eliminated and disposed of during the "modernization" of the refractor.

aussi le grand poids (P) cilindrique dont la place est à la pièce d'allonge de l'axe de déclinaison.

Pour mettre le télescope dans son lit il est à observer que l'echaffaudage doit être transferré dans la direction de l'est à ouest, // raportant à la longueur de la lunette. Cet echaffaudage doit avoir du coté de l'objectif du moins neuf pieds. La partie d'oculaire de la lunette vient à être posée dans le lit ou se trouvent les vis de correction. Quand la lunette est mise alors on ferme le lit par les deux demi-anneaux. Ces demi-anneaux ou couvercles sont marqués comme ils vont ensemble avec 1 et 2 points et les vis courrament aussi (*deleted:* aussi) avec des points. Dans cette situation seront aussi élevé les deux grands balanciers pour le télescope sur leurs chevilles au lit de télescope qui d'un côte finissent dans l'anneau du coté de l'objectif et qui sont destinés à recevoir à leur autre bout des poids à balles. Quand à ces balanciers faut il d'abord regarder, si les barres //

N.ro 6

de fer ne sont pas devenues trop lâches, et si elles ne doivent pas [*être*] attirées un peu par les clefs ajoutés.[80] Les chevilles au lit du télescope et les petits tonneaux qui se trouvent dans le cubus sent marqués de points. Quand ils sont sur leurs chevilles, alors il faut que chacun soit tenu dans une direction parallèle à la lunette jusqu'à ce que l'anneau à la partie de l'objectif est enchainé pour les recevoir. Ici sont marqué les chevilles cylindriques au bout des balanciers, et en effet que l'un soit marqué avec un point, et de même respondant aussi l'anneau avec un point. La marque à l'anneau est sur son nez, et cette marque doit regarder vers l'oculair, si l'anneau doit être dans la // juste situation. Les deux-demi parties de l'anneau sont comme elles vont ensembles, marquées, à la saillie de plats touchants. Le télescope doit à présent être soutenu du coté de l'objectif parce qu'il y a là un peu un surpoids, quand on visse les grands poids balles. Ceux balanciers du coté de l'oculaire sont marqués respondant, et à la verité à deux pièces correspondantes. En même temps doit être mis l'objectif, sans quoi reste encore une fois un surpoids trop grand à la partie de l'oculaire. Mais comme par l'objectif ce coté reçoit le surpoids, il faut encore que les petits poids cylindriques soient mis aux batons de poids à balles, aussi on mettra le chercheur avec son statif. Le[*s*] 4 vis comme // leurs trous sont marqués par des numeros. Aprésent on attache l'arrêt au cercle d'arrêt pour la déclinaison. La

80 In other refractors (Dorpat, Pulkovo, Harvard) made by the same firm, the beams supporting the counterweights of the anti-flection system of the telescopic tube consisted of elongated brass cones rather than of long wooden cones reinforced by a series of longitudinal iron bars as in the Palermo telescope.

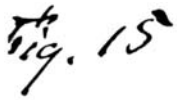

FIGURE 15 ■ ~~remove Fig. 15 from image?~~

pièce de supplément Fig. 15 y doit être poussée de côté dans la rainure. Quand l'entier est ainsi composé dans ses masses (*deleted:* ses) principales alors il faut que les ressorts des pièces à deux roulettes que ce trouvent à l'axe horair soit en haut soit en bas soient rectificiés pour transporter ainsi la préssion dans les coussinets de l'axe sur les rouettes. Cela arrive en bandant les ressorts de cette manière que si l'on serre la vis (d) Fig. 10 elle doit être tournée si long temps, jusqu'à ce que l'huile commence a sortir en haut // du coussinet superieur.

Mais àprésent il faut moderer un peu la tension, que l'axe repose assurée en bas du coussinet et non pas sur le couvercle. Quant au coussinet de la partie inferieure de l'axe horaire il faut serrer la vis (*deleted:* (A) *Fig. 9 de*) b Fig. 8 [*de*] telle manière jusqu'à ce que l'huile commence (*addition by another hand*: à sortir sous) l'axe en bas du coussinet, après cela on est sur que l'axe repose à présent aussi en bas du coussinet et non pas en haut sur le couvercle. Alors doit-on mettre tout l'instrument de telle manière, que la lunette est située horizontalement en ouest parce qu'alors un petit surpoids dans la déclaison de la lunette peut être fait inefficace sans dommage en serrant //

N.ro 7

la vis d'arret de la déclinaison, pendant l'engrenage de la vis sans fin horaire n'est pas à conseiller, avant que toutes les parties de la machine parallactique soient exactement rectificés, la vis ainsi que les pas de cercle horaire pourraient facilement prendre dommage.[81] Aprésent vient l'ajuster l'horloge. Les vis pour l'attachement se trouvent déjà au lit de l'axe horaire. D'abord on ajuste la cage d'horloge A Fig. 17.[82] A la poulie qui porte la broche conductrice, se

81 See note 3.

82 Unfortunately, when the telescope was "modernized" in the 1950s the original clockwork

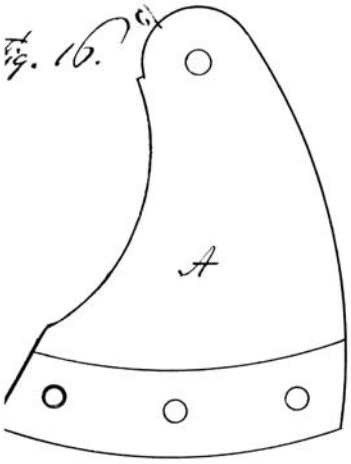

FIGURE 16 remove Fig. 16 from image

trouve en haut un conus (K), qu'on a seulement besoin à mettre dans le trou correspondant au lit de l'axe horaire. On visse à ce conus l'ecrou se trouvant // au conus même. O[n] y fait bien c'est à dire il est necéssaire de maintenir dans le trou l'ecrou déjà avant l'introduire le conus dans le trou destiné, pour attirer en vissant le conus par l'ecrou même. L'autre atachement seul se fait par la vis (N) Fig. 18. avec le plat suplémental, qui ajuste dans la fente de la poulie. Sous la cage d'horloge se trouve la vis à correction horizontale du pendule ou du balancier. Aprésent peut devenir embroché le rouage de transport qui transporte le mouvement de la broche conductrice de l'horloge sur le cercle horaire par la tête dentée. On visse en avant de celui-là la poulie A Fig. 16. // Mais avant d'embrocher cette poulie il faut mettre le cordon sans fin sur le rouleau muni des points se trouvant à la plus grande roue dentée. Quand la poulie est affermise on mettra le contre-coup de cordon sur le rouleau aussi muni des points se trouvant à la poulie. Pour ouvrir le couvercle de la boite en cuivre y se trouve un levier de bois particulier à l'aide duquel on peut elever le couvercle quand on pousse le levier par l'ouverture et si l'on pratiquera une préssion sur le couvercle même. Mais il faut avoir de la prevoyance pour cette affaire parce-que la petite broche du balancier pourrait // être facilement cassée. A présent est encore à ajuster le lévier qui sert à separer la tête dentée de la vis sans fin pour arreter l'instrument ou pour le faire marcher par moyen d'horloge

(very similar to the mechanism of the Dorpat refractor) was eliminated and substituted by a small electric motor.

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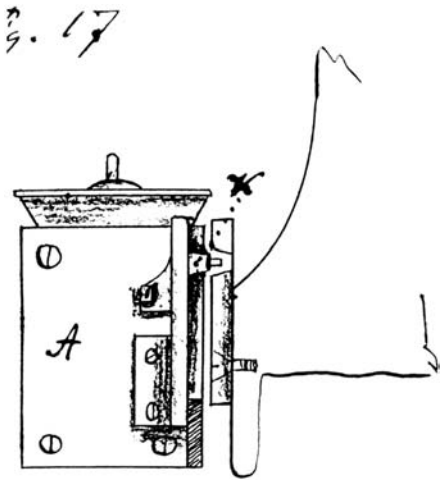

FIGURE 17 remove Fig. 17 from image?

en ayant serré la tête dentée. Pour cela on a seulement besoin de pousser et de visser le levier avec son plat pied, (*deleted*: de l'axe) (*addition by another hand*: de travers sur le lit de l'axe) horaire on vissera en ouest tout sur le levier qui suspend l'engrenage de la vis sans fin un rouleau avec un plat pied-uni. Sur ce rouleau va le cordon pour l'arreter l'instrument. Le rouleau pour faire marcher l'instrument trouve sa place en haut au lit de l'axe horaire du côté d'est. Les verniers pour la //

N.ro 8

added period, ok?

déclinaison et ceux pour le cercle horaire peuvent àprésent être ajustés, aussi les clefs d'Huighens qui sont pourvus de trois verges, dont l'une appartient à la vis de déclinaison. Pour la vis sans fin du cercle horaire il y a deux verges, parce-que l'observateur placé au sud a besoin d'une plus courte verge que quand il serait placé au nord. Aussi s'y trouve un clef avec verge pour la vis d'arret de la déclinaison.

Aprésent tout l'instrument est monté et achevé jus qu'à la rectification. L'appareil micrometrique sera vissé selon la nécessité de l'observation. Quand on l'emploie les poids cylindriques se trouvant aux // poids à balles doivent être ôtés. Pour prendre dehors la vis sans fin (la broche du cercle horaire) au moyen d'un nettoyement on n'a pas d'autre chose à faire que d'oter en est toutes les pièces dont la broche est munie ainsi que la broche soit toút libre, aussi on enleve en ouest la tête et le levier et la broche peut être prise du coté (*deleted*: d'est en) (*addition by another hand:* d'est en) vissant. Pendant toute cette operation il faut employer beaucoup de précaution. Pour munir l'appareil

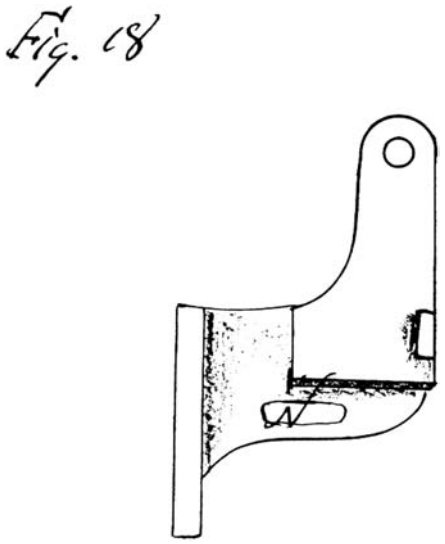

FIGURE 18 ~~remove Fig. 18 from image?~~

micrometrique de fils nouveaux il faut ôter la tête de vis de rappel et les (*deleted*: 2 petit ~~inoceau~~ de metal) (*addition by another hand*: petites vis, qui serrent le petit morceau de metal) après cela, si les deux tringles sont encore éloignées la coulisse principale avec l'index et la coulisse de l'oculaire peuvent (*hereafter, by another hand*) d'être otées, A la composition il faut avoir égard sur les marques au pignon et au plat et voir que la coulisse aille facilement.

G. & S. Merz
Munich, le 6 juin 1862