Although it seems unlikely by the nature of the assumptions involved, it should be explained. Most of Pingré's sources agree that a comet appeared around 25 January 1240 and was observed to be around the north pole. But one of the sources [16] recorded that this comet (or could it have been another?) appeared at the beginning of 1241. This difference in year numbers might be explained in the following way. At the time of the second conjunction of Mars and Jupiter (12 March 1240) the sun was in ♓ 29°, and hence vernal equinox occurred around March 12/13. If the years were to be counted from vernal equinox, then these March style years would overlap the Julian years (see Fig. 2). In particular, January 1241, Julian style, would correspond to January 1240, March style. If we assume that all but one of Pingré's sources recorded the event using the March style year — while the exception used the Julian calendar — these reports would coincide. If we then repeat our arguments using the March style year, the last conjunction of Mars and Jupiter would happen at the very beginning of the year 1240, March style, and the comet could have appeared any time during the following approximate twelve months. In January 1240, March style, Saturn would still be in Leo and the moon's node would still be in Scorpio as the text requires.

[16] *Ibid.*, p. 404.

# Father Procopius Diviš — The European Franklin

BY KAREL HUJER *

IN the critical introduction to the recent edition of Benjamin Franklin's book on electricity, the editor states: [1] "As a matter of fact, we have no way of determining whether Franklin erected a rod in Philadelphia before any were erected on the Continent. In any case, the invention is his whether he was the first to put it to practical use or not." Furthermore: [2] ". . . before Franklin wrote a word about lightning or about lightning rods, he knew that the point must be grounded in order 'to draw off' the electrical fire from a charged body."

At the time of Franklin there was lively activity on the Continent in electrical experimentation. Some reports of Franklin's discoveries, communicated to Peter Collinson of the Royal Society of London, reached the Continent and stimulated increased experimentation in this new field. Thus by May, 1752, the French electricians, Dalibard and Delor, erected a lightning rod, following Franklin's suggestion. Their experimental lightning rods, however, were not grounded. They were primarily intended to prove the hypothesis of the identity of lightning and electricity, which Franklin advocated, and in this they succeeded.

A permanent and grounded lightning conductor, originating quite independently, was erected, however, at Přímětice in Moravia, 15 June 1754, where it stood six years. It was constructed by Father Procopius Diviš, a Premonstratensian priest. Father Diviš did not know of Franklin and constructed the lightning conductor according

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[1] Franklin, Benjamin. *Benjamin Franklin's Experiments: A new edition of Franklin's "Experiments and Observations on Electricity."* Edited, with a critical and historical introduction, by I. Bernard Cohen. Cambridge, Mass., Harvard University Press, 1941. p. 130.

[2] *Ibid.*, p. 131.

to his own ideas, although based on the same practical experience as Franklin's, i.e., the power of points "to draw off" the electrical fire from the charged bodies. It is interesting to investigate more closely the work of Father Diviš.

Franklin earnestly suggested that experiments be made with a lightning rod in order to test his hypothesis of the identity of lightning and electricity [3] and Dalibard's and Delor's experiments are usually identified with the first successful lightning rod. Dalibard presented a report on his experiment to the French Academy of Science in Paris, dated 13 May 1752,[4] three days after its performance. In this lightning rod, instead of grounding, silk ribbons connected the rod with the Leyden jar in order to collect any possible charge of atmospheric electricity. Dalibard, and 8 days later Delor, successfully accomplished the purpose of their experiments, the electrical nature of lightning was confirmed.

Dalibard's experiment with the lightning rod and all attempts to investigate the nature of lightning were generally a sensation in their day and were discussed throughout the civilized world. On the Continent, however, they were not always associated with Franklin's name as his letters to P. Collinson of the Royal Society of London could hardly have reached a wider circle than England in those days. In view of Dalibard's experiment, it is interesting to read the following statement in *Geschichte der Physik*, the work of the distinguished physicist, J. C. Poggendorff: [5]

In Deutschland hatte schon unabhängig von Franklin in demselben Jahre unser Winkler in einer kleinen Schrift: Programma de avertendi fulminis artificio, Lips. 1753, die Anlegung der Blitzableiter empfohlen und Vorschriften dazu gegeben, und muthmasslich in Folge dessen wurde schon ein Jahr darauf 1754 der erste Blitzableiter wirklich ausgeführt. Diesen ersten Blitzableiter in Europa errichtete Prokopius Divisch, Prämonstratenser Chorherr und Pfarrer in Prenditz bei Znaym in Mähren, an seinem Wohnort.

This information is again repeated as fact by A. Heller of Budapest, in his extensive work on the history of physics.[6]

What is the basis for the opinions of Poggendorff and Heller? Undoubtedly, they must have known of the experiments of Dalibard and Delor. Yet, the statements of these eminent physicists cannot be lightly disregarded. Father Procopius Diviš, whose name is mentioned in connection with the first accomplished and grounded lightning conductor in Europe, erected his "machina meteorologica" on 15 June 1754, in the garden of his parish at Přímětice, near the ancient town of Znojmo in southern Moravia. Indeed, a special memorial to that effect was unveiled both at Přímětice and at Znojmo in 1948, the 250th anniversary of the birth of Father Diviš, with delegates of the Physical Institutes of Prague and Brno universities officiating.

It is now generally admitted that, not knowing of Franklin, Father Diviš followed his own idea in the construction of his lightning conductor. There is no doubt that in his experiments he followed a similar trend to all those current in Europe in the new and exciting science of electricity. Being a good mechanic, he made his own frictional machine as a source of electricity. He also profusely used Leyden jars of his own making, soon after their independent discovery by Ewald G. von Kleist of Pomerania and Musschenbroek of Leyden. Yet, it is not difficult to show that Diviš could not have been influenced even by Winkler in his construction of the lightning conductor, as maintained by Poggendorff and Heller. Winkler in his brief work [7] primarily describes the circumstances of the tragic death of Georg W. Richmann of St Petersburg's Imperial Academy of Science, who was killed while experimenting with a lightning rod, probably ungrounded, as was Dalibard's the previous year in

[3] *Ibid.*, p. 111–113.
[4] *Ibid.*, p. 257–262.
[5] Poggendorff, Johann Christian. *Geschichte der Physik*. Leipzig, 1879, p. 867.
[6] Heller, A. *Geschichte der Physik*. Stuttgart, 1882–1884, 2 vols. (vol. I, p. 489).
[7] Winkler, Johann Heinrich. Programma de avertendi fulminis artificio, Leipzig, 1753; cf. *Nova Acta Eruditorum*, 1755, 117–133.

France. Although Winkler's work was written in 1753, it was not published until 1755, in Leipzig's *Acta eruditorum*.[8] This work presents the subject rather primitively while there is evidence to show that Diviš already had his idea of the lightning conductor all complete, and was generally far ahead of Winkler because of his rich and valuable experimental experience.

Father Diviš also reacted to the death by lightning of Professor Richmann. It was a widely discussed topic in Europe in connection with the revolutionizing studies of the nature of atmospheric electricity. In this same year, 1753, Diviš wrote to Leonhard Euler, the famous mathematician, then director of the Berlin Academy of Science. He asked him to submit his paper, "Scriptum contra Petropolitanum electricum de theoria perperam applicata," to the Academy for consideration. In this paper, Diviš warns against experimentation with ungrounded lightning rods, as was done the previous year in France. As it appears, the problem of atmospheric electricity and of the lightning rod was a very remote subject to Euler. From various indications, we realize that Euler was also unaware of Franklin's existence, and unlike Collinson's prompt and encouraging replies to Franklin, Euler did not answer Father Diviš before the enterprising priest erected his meteorological machine 15 June 1754 in Přímětice.

The story of the lightning conductor is exhaustively discussed in connection with Winkler and Diviš as well as Franklin by H. Meidinger of the Technical University in Karlsruhe.[9] Concerning Winkler, Meidinger admits that Winkler expressed a thought on the identity of electricity and lightning as early as 1746 but he never substantiated his statement experimentally. Whatever Winkler wrote on the lightning rod, Meidinger considers worthless.

Meidinger dedicates seven pages to Diviš' work. As a source, he uses a biography of Diviš by his contemporary, F. M. Pelzl,[10] and also the careful study by Julius Friess, professor at the German college in Olomouc, Moravia, published in a limited number of copies in 1884. The Friess essay is particularly valuable because it uses all available manuscripts of Diviš deposited in the Olomouc Museum Library. Meidinger describes the activity of Father Diviš and sometimes is an unjust critic of the Přímětice wizard, particularly when he unconditionally agrees with the scientific judges of Vienna concerning his treatise on electricity. In concluding his account, however, Meidinger is favorable to Diviš and recognizes that he had an original and independent idea in the construction of his lightning conductor. It was an idea not conceived by contemporaries of Diviš, who, like him, were experimenting in the field of electricity.

Meidinger's criticism is valuable and we must further consider those of his objections which may appear serious. For example, he praises the genial simplicity of Franklin's plain rod. That may be true as we observe today, but the need for the Franklin or Diviš structure could not have been foreseen at the beginning. Meidinger objects to the use of chains for grounding the conductor because chains break easily when struck by lightning. At the same time, Meidinger maintains it was entirely superfluous to have three chains. Chains were frequently used as electric conductors in the time of Diviš but were later abandoned. By using three or even four iron chains, Diviš specifically sought good grounding, which he stressed above all else. Also, the chains held the lightning conductor in vertical position.

The outstanding feature of Diviš' apparatus was the large number of points, which he considered essential to drawing off the electrical fire from the atmosphere. These points were pinned into twelve metallic boxes, 33 points to each, with three boxes on each of the four arms of the horizontal iron cross making the head of the conductor.

[8] Pšenička, J. *Zlatá Praha*, vol. XIII, 1896; quoted from F. Nušl's *Prokop Diviš* (Ref. no. 14).

[9] Meidinger, Heinrich. *Geschichte des Blitzableiters*. Karlsruhe, 1888.

[10] Pelzl, F. M. *Abbildungen böhmischen und mährischen Gelehrten*. Prag, 1777.

The thirteenth and larger box contained approximately 77 points and was placed on a vertical rod, topped by a wind vane. Meidinger very vehemently opposed this arrangement of the Diviš machine, asserting that it made the entire structure both complicated and expensive, still without obtaining the desired results. This criticism was not wholly justified, however, as Diviš evolved his type of lightning conductor from actual experience. This experience is also connected with an amusing incident related by F. M. Pelzl,[11] in whose work we have the earliest detailed description of the Diviš meteorological machine from the original records which were then located in Louka Premonstratensian Monastery.

The fame of the Přímětice priest as physicist spread and in 1750 he was invited to the imperial court at Vienna to perform his skillful electrical demonstrations for Emperor Francis and Empress Maria Theresa, by both of whom he was later decorated. While in Vienna, a learned Jesuit, Father Francis, also preoccupied in the field of experimental electricity, invited Father Diviš to attend one of his famous public demonstrations with various objects electrically charged. Father Diviš accepted the invitation and arrived well prepared to control the results of Father Francis' display. In his wig Diviš had concealed over twenty sharp points of iron. By inclining his head, as if intently observing, he could draw off at will the electrical charge of any object. Consequently, no matter how highly charged an object was, the Jesuit could not obtain sparks out of it to proceed with his demonstration. Of course, the explanation was revealed later, indicating the scientific superiority of the Premonstratensian over the Jesuit, but this did not help Diviš' relation with the Jesuits. When the time came, their influence in Vienna helped to prevent the publication of the Diviš treatise on electricity in the capital and throughout the Austrian empire. It was only in the year 1765, through the efforts of Diviš' friends, B. K. Oetinger, Superintendent in Württemberg, and the Protestant minister, Fricker, that the Diviš work (in German) was published by J. Schramm in Tübingen. This was shortly before the learned Přímětice priest passed away. This publication was entitled *Theoretischer Tractat, oder die längst verlangte Theorie von der meteorologischen Electricität*, and it reached its second edition in Frankfurt by 1768. About five copies of this publication are known to exist today.

If we critically analyze this theoretical treatise on electricity, we must first thoughtfully consider the complicated and difficult conditions under which Diviš labored. Fostering progressive ideas of experimentalism in his specific surroundings, Diviš struggled under unfavorable conditions, quite unknown to Franklin in his liberal society at Philadelphia. Restrained, as he was, by the regulations of his religious order and living in a period and in a society which was just emerging from the mentality of negative medievalism, any theory he propounded had to meet, not only the requirements of his numerous experiments, but first of all had to fit into the fixed frame of his religious convictions and the theological dogma imposed by tradition. That this was the starting point in his research is evidenced in the very beginning of his Treatise. There he poses the question of theological dogma even in reference to such an objective phenomenon as electricity. Franklin, on the other hand, was not so encumbered and was able to shape his theories without restraint or preconscience. Meidinger does not consider this fact when he analyzes Diviš' writings and objects to the frequent unnecessary and meaningless theological speculations mingling with facts of experimental observations. Most of the Přímětice peasantry, too, opposed his strange experiments, particularly his sinister meteorological machine. Yet, in his general findings, evolved, as they were, in this hostile atmosphere, Father Diviš was far ahead of his contemporary in France, Abbé Nollet, who had the additional advantage of knowing of Franklin and his ideas. Abbé Nollet, a very popular demonstrator of sensational electrical

[11] Pelzl, F. M. *op. cit.* Also Czech translation in Albert's *Prokop Diviš* (Ref. no. 16), p. 17.

experiments at the French court, wrote of himself as "un homme parmi les Physiciens électrisans de l'europe." [12] Still he opposed the idea of the lightning conductor and preferred to place his confidence in the ringing of church bells.[13]

By his occasional theological excursions, Diviš gave the impression of a surviving scholastic and was so accused by Vienna mathematicians. Yet, in the scientific field he was entirely liberated from the Aristotelian tradition. His analyses were carefully based upon practical experimental observation and he, himself, was a skillful mechanic and experimenter. When teaching for some time, he used experimental demonstrations in his physics instruction, a novelty in his days, and thus gained the admiration and respect of his students. As F. Nušl states in his report to the Czech Academy:[14]

> The importance of Diviš does not rest in his published Treatise nor in any other writing, but in his experiments, which he performed for the sole reason of finding the fundamental nature and properties of electrical fire and which guided him in his thoughtful analysis, application and finally in his successful construction of the first European lightning conductor. Diviš accomplished this work and deserves his full recognition.

If this independent discovery is established, this interesting priest deserves due recognition in the history of man's victory over the fear of lightning. Just as Turgot eulogized Franklin: "He tore from the skies the lightning and from tyrants the sceptre," [15] so an enthusiastic contemporary wrote an epigram to Diviš: "Non laudate Iovem gentes, quid vester Apollo? Iste magis Deus est fulminis atque soni." [16]

Diviš did not write about his lightning conductor in his published *Theoretischer Tractat*. It is significant that theoretically he did not ascribe any importance to his meteorological machine. Nušl says [17] that Diviš would be surprised to know of our efforts to find documentary evidence to establish his independent discovery of the principle of the lightning conductor. In the manuscript at Olomouc Museum Library describing the machine, the priest-physicist modestly writes: "Quamquam haec Machina meteorologica in Theoria mea ultimum obtineat locum, tanquam contestatio praecedentium; hic tamen in praxi prioritatem ob suam eminentiam universalitatis habere Dignum censetur." [18]

It is interesting to note that both Diviš and Franklin, each independently, were guided to the discovery of the lightning rod by the power of points in drawing off electrical fire from a charged body. I. B. Cohen says [19] that Franklin "found that a pointed conductor would discharge an electrified body at great distances." When Franklin made his first comment on the property of pointed conductors, in his letter to P. Collinson of 25 May 1747, he did not know that electrifying pointed conductors had been experimented with in Europe for some time. The historic incident of Father Diviš at the demonstration of the Jesuit Francis in Vienna, previously referred to, reveals that by the early part of 1750 he already was well versed in this electrical technique.

Let us now consider the two different applications of pointed conductors. Franklin's suggestion was to ground the lightning by means of the iron rod, thus making it harmless. Diviš suggested and actually constructed a conductor of many points, to prevent the accumulation of an electrical charge or lightning. Both propositions were made on the basis of experience. Was not Diviš justified in his supposition that by means of a sufficient number of points he could "draw off" the electrical fire from the clouds? Basically, both theories have equal value and Meidinger's criticism of Diviš

[12] Franklin, Benjamin, *op. cit.*, p. 115.

[13] *Ibid.*, p. 133.

[14] Nušl, František. *Prokop Diviš*. Vylíčení jeho života a zásluh vědeckých. Překlad hlavního jeho spisu: Theoretického traktátu o elektřině. Praha, Česká akademie pro vědy, slovesnost a umění, 1899, p. 15.

[15] Turgot, Anne Robert Jacques. Inscription on the tombstone of Benjamin Franklin's grave in Philadelphia.

[16] Albert, Eduard. *Prokop Diviš. Ku 200-leté památce jeho narození*. Wien, 1898, p. 13.

[17] Nušl, František, *op. cit.*, p. 15.

[18] Diviš, Procopius. *Descriptio machinae meteorologicae*. Manuscript, Olomouc Museum Library. Quoted from Nušl's *Prokop Diviš*.

[19] Franklin, Benjamin, *op. cit.*, p. 130–131.

is not justified. Only continued experiments could prove that Franklin's suggestion was more practical, and this Franklin, himself, could not foresee. Besides, should Father Diviš be denied any credit due him only because his construction proved less practical?

Franklin had the additional advantage of being in contact with the scientific center of the time — the Royal Society of London — through communication with one of its members, Peter Collinson. Father Diviš did have a rich correspondence with eminent people both in Austria and Germany, but unfortunately none excelled him in the field of physics or more particularly electricity. The only authority in the field of Diviš' interest was Dr Scrinci, professor of physics at Prague University. Diviš communicated his studies and observations to Dr Scrinci, who published them in *Prager Postzeitung*. The Duke of Lothringen also invited Diviš to visit him four times and Count von Hohenlohe and Count Nostic were frequent callers upon him at his parish in Přímětice. He was also respected by his superiors as shown when Father Diviš was asked to replace Abbot Nolbeck of Louka Premonstratensian Monastery near his parish during the Silesian wars, when the latter was imprisoned by the invading Prussians.

Despite the adverse attitude of some Přímětice parishioners, Father Diviš, nevertheless, insisted on remaining in this otherwise peaceful retreat and refused all opportunities to go elsewhere. His Premonstratensian superiors willingly afforded all conveniences for his studies and researches and faithfully defended him during outside opposition from villagers. The relation of this priest toward his congregation was indeed paradoxical when contrasted with general priesthood of those days. In Přímětice, under Diviš, it was the priest and not the people who represented the revolutionary force of progress. Then, the timid priesthood looked rather suspiciously on any scientific exploration, and experimentation with lightning was short of sheer heresy. Only a full understanding of the mentality of the village, its customs and traditions, would enable us to grasp the courage of the Přímětice priest. Being a priest, protected by his superiors, he did escape more acute persecution than he would as a layman. His difficulties were not serious so long as his experiments were confined to the magic room of his parish laboratory, but it was different after he had erected his lightning conductor, his famous "meteorological machine." While it was the triumph of his genius, it was also the beginning of a great struggle with the ignorance of the populace. The Diviš lightning conductor stood at the Přímětice parish garden from 15 June 1754 until 10 March 1760,[20] when the populace, blaming the priest's machine for the drought, pulled the chains from the ground and the storm the following night blew down the surmounting cross with the 13 boxes of sharp points. In the following year, when the weather became even more unfavorable, the peasants asked Diviš to erect his machine once again. But after his sad experiences, Diviš heeded the friendly advice of his superiors and refused to re-erect his lightning conductor in its former position. Even Jesuit neighbors in Přímětice seemed disturbed by Father Diviš' interests and by his bold and liberal sermons. All this constituted the challenging atmosphere surrounding him but did not deter his steady stride forward.

Whatever results Father Diviš obtained under these circumstances, must be weighed accordingly. His views on the nature of electricity more or less paralleled the common trends of his contemporaries, known or unknown to him. Yet, in all his conjectures he faithfully tried to trace the results of his experiments. To illustrate his reasoning, several times in his Treatise he wrote that "electricity cannot influence electricity," therefore he could not recognize the existence of electrical polarity. Even though Franklin used the terms "plus" and "minus," neither did he recognize two forms of electricity. Diviš attempted to prove not only that two electrical objects do not in-

[20] Sach, Vladimír. "P. Prokop Diviš," Brno, *Okrsek Národní Jednoty ve Znojmě*, 1936, p. 32. Also Nušl, F., *op. cit.*, p. 7.

fluence each other but that they repel each other, so that the creation of the spark could be prevented. Non-electrical, or as he called them, elementary objects behave in a similar manner — non-electrical repel non-electrical objects.

To support this view, Diviš thought out an amusing experiment. He tied a silk thread to the conductor connected with his electrical machine and at the end of the thread he suspended a light metallic ring. He touched the ring so that both hand and the ring were non-electrical or elementary. Now, after the contact was accomplished, the ring was still repelled from the hand. Diviš comments, however, that this experiment succeeds only in the atmosphere of the electrical machine. Today we maintain that in both the ring and the hand negative electricity is bound by the positive electricity of the electrical machine, and therefore the ring is repelled from the hand. Incidentally, F. Nušl suggests [21] that this interesting demonstration should be called the "Diviš Experiment," in memory of the Přímětice pioneer in electrical studies.

In his work originally entitled *Magia naturalis seu nova electricae rudimenta per tractatum theoreticum deducta, experimentis firmata,* Father Diviš describes his theories as founded on the results of his experiments. It was this manuscript, now in the Olomouc Library, that Diviš first submitted for publication in Olomouc and Vienna. Viennese mathematicians, who were to pass judgment on this work, accused Diviš, the zealous experimentalist, of Aristotelian speculative philosophy. It is indeed interesting that the Vienna Jesuits, who themselves had just emerged from the dogmas of scholasticism, influenced the Vienna judges as earnest opponents of scholastic, speculative philosophy. Evidently the study of electricity was such a novelty, it made an impression of sheer speculation, and the Diviš style of writing did not minimize this impression. Abbé Marci, the influential Vienna friend of the Přímětice priest, answered Diviš' protest against the negative verdict on his manuscript. In his letter of 23 March 1763, he commented on the Vienna mathematicians "blasphemant quae ignorant." Diviš rewrote his *Magia naturalis* in an abridged form in German and, as before mentioned, it was this text which was published in Tübingen, shortly before Father Diviš passed away, on 21 December 1765 in Přímětice, where he had spent most of his life.

According to his manuscripts, it is evident that Diviš had the plan of his lightning conductor all complete by the end of 1752 or the beginning of 1753, as he also writes to his friend B. K. Oetinger at Waldorf near Tübingen.[22] In 1753, Dean Oetinger sent his student, Fricker, to Father Diviš in Přímětice, where he remained about half a year. Fricker wrote from Přímětice to his teacher in Waldorf: "Before my departure, Father Diviš discussed with me the tragic case of Professor Richmann of St Petersburg. Father Diviš explained his plan to me for the construction of such an apparatus, which is entirely different from the iron rod by means of which Richmann conducted atmospheric electricity; this apparatus will be the Diviš' 'Machina meteorologica.' " [23] This letter is dated 26 July 1753.

Thus, Poggendorff appears justified in maintaining [24] in his *Geschichte der Physik* that Father Procopius Diviš erected the first lightning conductor in Europe. Poggendorff evidently considered the construction of the lightning rods in France, in 1752, merely as preliminary experiments to prove Franklin's hypothesis of the identity of electricity with lightning. Father Diviš' lightning conductor was erected for the sole purpose of safeguarding the surrounding vicinity against lightning. Therefore, in addition to its large number of points, it was also well grounded. For nearly six years it stood in the Přímětice garden as the first permanent protection against electrical storm, the result of independent search and discovery based upon sound experimental observation and reasoning.

[21] Nušl, František, *op. cit.*, p. 14.
[22] Sach, Vladimír, *op. cit.*, p. 34; Nušl, F., *op. cit.*, p. 7.
[23] Sach, Vladimír, *op. cit.*, p. 34.
[24] Poggendorff, J. C., *op. cit.*, p. 867.