

**EXPERIMENTAL RESEARCHES  
ON THE IDENTITY OF THE  
VARIOUS MODIFICATIONS  
OF THE ELECTRIC FLUID**

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Experimental researches on the identity of the various modifications of the Electric Fluid by  
John Goodman

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**JOHN GOODMAN**

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BY JOHN GOODMAN, M.R.C.S.L.

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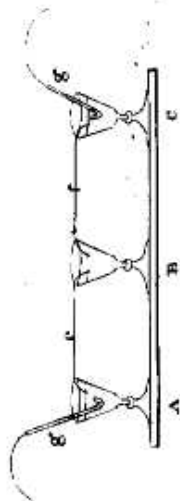
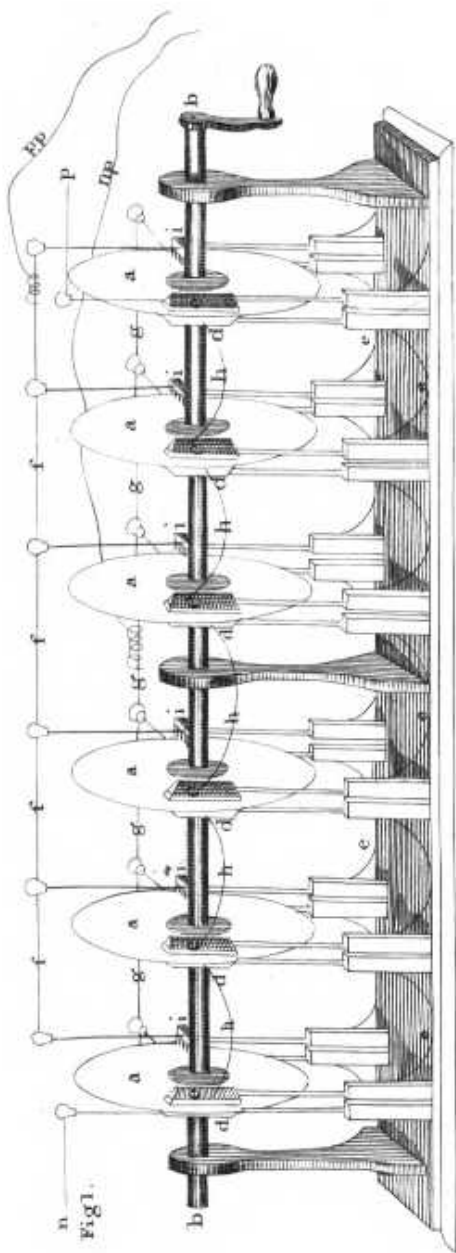


Fig. 2.

APPARATUS FOR POLARIZING FRICTIONAL ELECTRICITY.

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## ON THE MODIFICATIONS OF THE ELECTRIC FLUID.

*On the Identity of the Ordinary and Voltaic Electricity.* By  
J. GOODMAN, Esq., M.R.C.S., &c.

Read at the Royal Victoria Gallery of Practical Science, Manchester, at  
the Conversazione, October 22nd, 1840.

1. The views of electricians which have been so long entertained with regard to the identity of the electricities, the galvanic, frictional, and magnetic, appear to have commanded and obtained almost universal assent. The experiments, however, upon record, which I have hitherto perused, such as those of Dr. Wollaston, and others, and the more recent ones of Dr. Faraday, although manifesting in a high degree the analogy of galvanic and ordinary electricity, are still not perfectly decisive, and for reasons which will be hereafter adduced, have impressed me with the necessity of still further carrying on the inquiry. I doubt not but to many minds the experiments of the illustrious individuals above named may appear finally conclusive and satisfactory; but if there still remain those who are discontented, unless the two fluids so tested be submitted to exactly similar circumstances, be tested by indeed the same apparatus, effect chemical and other changes in precisely the same quality of materials, evince the government of the same laws in its conduction, insulation, polarity, &c., (see 41. 42. 44. 45.) and be indeed moulded into a perfectly identical form of fluid; if in the substance of the ensuing paper experiments be found which can add satisfaction to, and set the matter finally at rest in the minds of the latter class of individuals, this, and this alone, will fulfil the objects of the following investigation.

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2 *On the Analogy of Ordinary and Voltaic Electricity.*

2. On first surveying the distinctive characters of the two fluids, we find a wide unbounded contrast, and an unlimited diversity of properties. On the one hand our attention is directed to the roaring and tempestuous burst of fluids from the most extensive, immense, and immeasurable distances, polarizing, as it were, heaven and earth at the same moment, and traversing with fleetest strides the remote boundaries of the terrestrial and celestial empire; devastation, destruction, and ruin, marking frequently the footsteps of this subtle agent; whilst the other is silently, slowly, and almost imperceptibly executing the most beautiful, useful, and interesting productions of the material universe. It appeared that to attempt the establishment of identity between fluids of such opposite characters, it would become necessary to endeavour to mould the one under investigation, as nearly as possible, to the characters and properties of the opposing kind.

3. The subject which appeared least satisfactory, and which has induced me more particularly to commence a further inquiry, is, the decomposition of water by ordinary electricity; an experiment which it is well known has so frequently been accomplished by the galvanic fluid. For although this decomposition had been effected by many individuals, I am not aware that the gases were ever collected in a completely separate state, and submitted to a perfect analysis, and if we contemplate the manner in which the experiment has generally been performed, it has been without any reference to the character of the fluid imitated, and, as may be gathered from some of the following experiments, with mostly unsatisfactory results. (38. 43.) I doubt not, therefore, I shall be excused the boldness of my attempt, in *endeavouring* (although the subject has failed in the hands of the eminent) to establish the analogy of these fluids by experiments which have at all times been looked upon as possessing the most decisive character.

4. Finding, on the onset of my enquiry, the *tension* of ordinary electricity, in comparison with that of the most powerful voltaic battery, to be very much superior, and that this property may be instantly diminished (as will be shortly exhibited) (see 14) by charging a Leyden jar, I determined upon at once drawing out a statement of the properties of the galvanic and frictional electricities, to direct and guide me in all my future experiments.

5. Galvanic electricity, for instance, as existing in a common battery, or single pair of plates, usually presents the following properties or characters:—1. It is produced in a *continuous stream* of one or two fluids of opposite kinds, one positive, the other negative.—2. The two streams or currents of positive and negative electricities have a constant and mutual attraction for each other, there being a continual tendency of the *positive*



fluid to pass to the negative body, and to no other.—3. The galvanic fluid is subject to the influence of induction, or polarization of the most *contiguous* kind, being produced by the assumed oppositely electrical conditions of the atoms of matter when in *absolute contact*, and hence the *tension* of this fluid or its capability of passing through a non-conducting medium, is *exceedingly limited*, and may also be termed *atomic*.—4. It is *conducted* badly by metals, and scarcely at all by water.—5. Its *attractive and repulsive* powers are also of the *feeblest* kind, for without a considerable number of alternations of plates, gold leaves cannot be diverged, nor any effect produced upon the pith ball or other electrometers.—6. Its physiological effects are very feeble in proportion to the quantity of the fluid, nor are they experienced at all unless contact of the poles be made and broken.—7. The poles of this fluid do not require insulation, a consequence of No. 2 and 3.—8. Its *quantity* is *exceedingly great*, and far surpassing the amount of fluid generated by an ordinary electrical machine.—9. It is incapable of being accumulated in the shape of charge; one instantaneous contact with the coating of a Leyden jar being productive of as great an amount of electric fluid as the continuation of the same for any length of time, its quantity being alone obtainable in a continuous current.—10. By increasing the polarizing influence by a given number of alternations, *tension* becomes apparent, is rendered evident by the passing of a spark and other effects, and by still further augmenting this influence, a greater degree of tension is obtained, altogether, however, much inferior to the effects of this kind in the ordinary electricity.

6. If we now proceed to contrast these peculiarities of the galvanic fluids with the modified forms of fluid under which frictional and ærial electricity appear, we find that the fluid termed lightning, and that which passes in sparks from the machine, differ most widely from the properties herein described. Now it is singular that these very forms of electricity should have been almost the only kinds made use of in the investigations of philosophers in imitating the galvanic action, and it is also more singular, that in all the experiments (except the first) no negative pole was ever made use of which had a mutual decomposing dependence with the positive, and, consequently, bearing not the slightest resemblance to the properties of the galvanic fluid, especially as described (No. 5. 2.)

7. Dr. Wollaston's experiments were performed chiefly by *sparks* from the machine of various dimensions, and in one instance by *current alone*, but at the same time with only *one* pole, and, says he, "the *appearance* of two currents of air may also be imitated by occasioning the electricity to pass by fine points of communication on both sides of the water, but, in fact, the resemblance is not complete, for in every way in

which I tried it, I observed that each wire gave both oxygen and hydrogen gas, instead of their being formed separately, as by the electric pile." Perhaps it is unnecessary to state that here no mention is made of connecting more than one pole to any electrical body whatever.

8. In 1807 Sir H. Davy immersed a guarded platina point connected with the machine in distilled water, and dissipated the electricity from the water into the air by moistened filaments of cotton. In this way it is stated that he obtained oxygen and hydrogen separately from each other.

In 1832, the late Mr. Barry communicated a paper to the Royal Society, stating to have decomposed water by electricity, and to have obtained separate oxygen and hydrogen, from a kite-string in communication with one wire or pole, whilst the other wire was merely connected with the ground.

10. In the experiments of Dr. Faraday, (I believe our latest authority upon this subject) as stated in his series of experimental researches in electricity in 1833, in the decomposition of water, it is stated, (389) "if with a constant pair of points the electricity be passed from the machine in sparks, a certain portion of gas is evolved, but if the sparks be rendered shorter, less gas is evolved, and if no sparks be passed, there is scarcely a sensible portion of gas set free. On substituting solution of sulphate of soda for water, scarcely a sensible quantity of gas could be procured, even with powerful sparks, and nearly none with the mere current. (390.) "When what I consider the true effect only was obtained, the quantity of gas given off was so small that I could not ascertain whether it was as it ought to be, oxygen at one wire and hydrogen at the other."

11. As the other decompositions performed by this celebrated philosopher appear to have been accomplished by attaching the positive pole to the prime conductor, and the negative to the "discharging train," (321) it is not improbable that the decomposition of water was attempted by him in the same manner, but the fact is not stated. With regard to the experiment of Sir H. Davy, Dr. Faraday adds in a note to (471) series 5, that "it does not remove any of the objections I have made to the use of *Wollaston's apparatus as a test of true chemical action*;" of the one quoted by Barry, he remarks, (339) "nor have any of the numerous philosophers who have employed such an apparatus obtained any such decomposition either of water or of a neutral salt by the use of the machine;" also, (342) "Mr. Barry's experiment is a very important one to repeat and verify. If confirmed, it will be, as far as I am aware, the first recorded case of true electro-chemical decomposition of water by common electricity." A very similar remark is also made by him. (359.)

12. It is apparent from what is recorded of these experiments

that no attention was ever paid to the properties of galvanic electricity described (No. 5. 2.) viz., of providing poles dependent one upon the other for decomposing power and action. The positive pole was at all times connected to a positively charged body, but the negative pole was attached to matter, either in the natural state of electrization (speaking of it as a mass) as in the case of the "discharging train" used by Dr. Faraday, the "ground" by the late Mr. Barry, the "air" by Sir H. Davy, &c., or in a negative state to which the fluid from the positive pole had no special tendency to pass *the negative conductor*, (see now 45.) of which, nevertheless, we have, I believe no positive statement that it was ever used at all. Dr. Faraday also remarks, concerning the poles used by Wollaston, "that the poles, or rather points, have no mutual decomposing dependence may be shewn by substituting a wire, or the finger for one of them, a change which does not at all interfere with the other, though it stops all action at the charged pole."

13. On examining the modifications of the electric fluid derived from the machine, or lightning, we find it existing in two very opposite conditions, determined by the distance of polarizing bodies, or the thickness of the insulating medium through which the polarization is effected. Thus lightning and the sparks from the machine (the kinds generally employed by electricians in imitating galvanic decomposition) are subject only to *very distant* polarization, (see No. 5. 3.) and may be denominated *free electricity*, from their capability of passing to *any* body in their vicinity, (see No. 2.) having no tendency to pass to one conductor more than another, except from contiguity, being in an *interrupted* stream or streams (see No. 1.) possessing the most *unbounded tension*, (see No. 3.) powerful, attractive, and repulsive powers, (see No. 5.) conducted excellently by metals and with great facility by water, (see No. 4.) Physiological effects only when the current is broken or intensity very great, (see No. 6.) Insulation essential to its very existence, (No. 7.) Its quantity is exceedingly small, (No. 8.) but can be accumulated to any amount. (No. 9.)

14. The *tension* obtained by the influence of this polarization gives to the fluid *considerable mechanical force* and *powerful momentum*, and by the expansive character thus obtained, the pressure of the atmosphere, and of water (when passing through that fluid) is more forcibly resisted and sustained. By this means an exceedingly *minute* quantity of electricity may be rendered visible by expansion (17. b) and may appear to the observer as fluid of great quantity, and "high intensity" (17. a) The influence by which this modification of electricity is governed, I have named *remote polarization*, and when this kind of electricity is submitted to the action of *polarizing* influence of the proximate kind within its immediate neighbourhood,