

BULLETIN



BRITISH SOCIETY OF RHEOLOGY

1979, Vol. 22, No. 3

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FOREWORD

In this my first editorial foreword I would like to thank the outgoing editor Martin Camina for leaving the ship floating with sufficient material for this issue; however, the editor is always looking for articles of both general interest and on specific topics.

Looking through the editor's bound copies of the Bulletin from 1941 to the present, two major differences are noticeable. One, and a progressive step, is the increase in size from two pages in 1941 to some 20 pages in recent issues. Secondly, and in my view a retrograde step, is the decrease in the personal attention given to members. No longer do we seem to acknowledge promotion or success of members, or know that Dr X has moved from food processing to printing inks or that Professor Y is spending six months in Canada. I hope members will communicate this type of information to the editor.

I would also like to welcome contributions from our European, Australian and North American members.

OFFICERS AND MEMBERS OF COUNCIL, 1978-1979

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Secretary: DR. C. J. S. PETRIE, Department of Engineering Mathematics, University of Newcastle upon Tyne, Newcastle upon Tyne, NE1 7RU.

Treasurer: MR. A. EVANS, Department of Surgery, Royal Victoria Infirmary, Newcastle upon Tyne.

Membership Secretary: DR. T. E. R. JONES, School of Mathematical Sciences, Plymouth Polytechnic, Plymouth.

Abstracts Editor: MR. J. ASTIN, Department of Applied Mathematics, U.C.W., Penglais, Aberystwyth.

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BRITISH SOCIETY OF RHEOLOGY

CONSTITUTION†

Name

1. The Society (formerly known as The British Rheologists Club) shall be called The British Society of Rheology.*

Objects

2. (a) The objects of the Society shall be the promotion of scientific inquiry and the diffusion to the public of knowledge connected with the advancement of pure and applied rheology defined as the science of the deformation and flow of matter.
(b) In furtherance of the objects hereinbefore defined the Society may
 - (i) purchase or otherwise acquire or procure to be written and print copies issue and circulate gratuitously or otherwise any reports of periodicals books pamphlets or other documents provided that any sums received from sales under this sub-section shall be applied solely for the charitable purposes of the Society.
 - (ii) arrange and provide for or join in arranging and providing for the holding of exhibitions meetings lectures and classes.
 - (iii) assess promote encourage undertake or organise research.
 - (iv) affiliate or become affiliated to any body having similar objects to those herebefore defined and acquire and undertake all or any part of the assets liabilities and engagements of any such body which the Society may lawfully acquire.

Membership

3. (a) Any person interested in rheology shall be eligible to apply for membership of the Society but no application for group membership will be entertained.
(b) Application for membership of the Society shall be made in writing and supported in writing by a member of the Society in a manner to be approved from time to time by Council (see 5 (a)). The Entrance Fee (see below) shall be sent with the application for membership. Council shall consider any such application and if a majority of Council members present at a meeting approve the application then notice shall be given to the applicant of his election and he shall be requested

†Reprinted 1979; last amended 1971.

*The Society was registered as a charity, registered number 249967, in September 1966.

to pay his first subscription. Having paid his first subscription he shall be enrolled as a member and be entitled to all the benefits and privileges of membership and be bound by these rules.

(c) If an applicant elected as aforesaid shall not have paid his subscription within one month of being notified of his election then Council may at its absolute discretion declare the election of such applicant to be void.

(d) Council shall have power to elect to honorary membership any person who has attained distinction through scientific attainment or by reason of service to the Society. A member retiring from normal employment after more than 20 years' membership is eligible to become an honorary member.

(e) Any member may resign his membership by giving to the Membership Secretary notice in writing to that effect. Every such notice shall, unless otherwise expressed, be deemed to take effect as from 1st October next following receipt thereof and the member shall cease to be a member from that date.

(f) Council may if at any time it shall be of the opinion that the interests of the Society so require by letter invite any member to resign from the Society within a time specified in such letter. Notwithstanding the provisions of the preceding sub-clauses hereof the resignation of a member so resigning shall be deemed to take effect immediately it is received. If the member does not resign within the time specified then Council shall consider his expulsion. The member shall be given an opportunity to offer an explanation of his conduct verbally or in writing and if thereupon Council shall by a two-thirds majority of those present and voting decide to expel him he shall thereupon cease to be a member of the Society.

(g) Any person shall upon ceasing to be a member of the Society forfeit all right to and claim upon the Society and its property and funds.

Subscription

4. An Entrance Fee of £1 shall be paid by anyone applying for membership.

(b) An annual subscription of such amount as the Annual General Meeting may decide shall be paid by each member.

(c) All subscriptions (except the first subscription of a new member as provided by rule 3) shall be payable on October 1st in each year.

(d) If the subscription of any member shall be three months in arrear notice shall be sent to be him calling his attention

thereto and if he does not pay the amount within 21 days of such notice the Society may forthwith cease to send him any of the Society's publications. If the annual subscription of a member shall still be unpaid at the expiration of 12 months from the date it was due, then a further notice shall be sent calling his attention thereto and if the subscription be not paid within one month of the posting of such further notice then he shall cease to be a member of the Society and his name shall be removed from the list of members. Any person who ceases to be a member under this rule may be re-elected to membership, but only after re-application and payment of a further Entrance Fee.

Council and Executive Officers

5. (a) The affairs of the Society shall be managed by a Council of 12 members which shall include the President and five executive officers of the Society, namely a Secretary, a Treasurer, a Membership Secretary, an Editor (Abstracts), an Editor (Bulletin).

(b) A President shall be elected at an Annual General Meeting to serve in that office for two years and all other members of Council shall be elected at each Annual General Meeting to serve for one year. Candidates for the Presidency or for any executive office or as ordinary membership of Council may be proposed and seconded (i) by two members of the Society giving the Secretary written notice at least three days before the Annual General Meeting or (ii) by two members verbally at the Annual General Meeting before the election takes place. Any member of the Society shall be eligible to be elected as President or as an officer or as an ordinary member of Council, and any officer or Council member shall be eligible for re-election except that (i) a member shall not be eligible to fill the office of President for more than two years successively (ii) a member shall not be eligible to fill the same office for more than four years successively and (iii) a member shall not be eligible to serve on Council for more than four years successively without filling an executive office. The election of the President, the executive officers and the other members of Council shall be by those present at the Annual General Meeting and in the event of a contested election shall be by each member of the Society present having one vote for each position to be filled. The candidate who receives the most votes for a particular office shall be declared elected to that office. The vacancies on Council shall be filled by the candidates up to the number of vacancies who shall receive most votes and they shall be declared elected. If two or more candidates re-

ceive an equal number of votes either for an office or for a vacancy on Council the election to such office or vacancy shall be decided by drawing lots.

(c) Council shall have power to appoint any member of the Society to fill any casual vacancy among the executive or on the Council until the next Annual General Meeting. Any member so appointed shall retire at the next Annual General Meeting but shall be eligible for election at that meeting.

Auditors

6. The accounts of the Society shall be audited by professional accountants. The appointment of auditors and the fixing of their remuneration shall be made at the Annual General Meeting.

Meetings

7. (a) Council shall meet at least four times during the year. Four members of Council shall form a quorum except that a quorum of eight members of Council shall be required when Council is considering the expulsion of a member who has not resigned at Council's request. Council shall elect each year a Chairman from among its own members (excluding the President) who may take the chair if the President is absent or does not wish to do so. In the event of an equality of votes the Chairman of the meeting shall have a second or casting vote.
- (b) The Annual General Meeting of the Society shall be held in the month of September or therabouts in each year upon a date and at a time to be fixed by Council. The business at such meeting shall include the following:
 - (i) The election of officers and other members of Council.
 - (ii) To receive a report and audited accounts from Council.
 - (iii) To deal with any resolution or special matter which Council desire to bring before the members or any member wishes to raise and receive suggestions from the members for consideration by Council.

Notice convening the Annual General Meeting shall be sent to the members not less than three weeks before the meeting. The notice shall specify any proposed change in the rules and where possible it shall also specify the other matters to be dealt with provided that nothing in this rule shall prevent matters (other than a change in the rules the winding up of Society or the severance of the Society's connection with a Branch) from being considered by the Annual General Meeting solely because notice of such matters has not been circulated to the members.

(c) At the request of four members of Council or of twenty members of the Society the Secretary shall call an Extraordinary General Meeting within two months of receiving such request. Such an Extraordinary General Meeting shall have the full authority of an Annual General Meeting to consider only the business for which the meeting was called. Notice convening an Extraordinary General Meeting shall be sent to all the members not less than ten days before the meeting and shall specify the matters to be dealt with.

(d) The quorum at all General Meetings shall be 20 or 8% of the total membership of the Society whichever shall be the less. All decisions at General Meetings shall be made by a simple majority of the members voting except that a change in the rules shall require a two-thirds majority of the members present and voting provided that the members voting in favour of such a change must number at least 20 or 8% of the total membership of the Society whichever shall be the less.

(e) The President shall take the Chair at Annual and Extraordinary General Meetings of the Society and at meetings of Council. If the President is absent or does not wish to take the Chair at any of these meetings then the Chairman of Council or failing him another member elected at any such meeting shall take the chair.

Powers and Duties of Executive Officers and Council

8. (a) Council shall manage the funds and affairs of the Society and shall do all such acts as may appear to them necessary or desirable for carrying into effect the objects and views of the Society.

(b) Council may engage remunerate and dismiss any servants as may be deemed necessary or expedient.

(c) Council may appoint any sub-Committee which it may think necessary or expedient for carrying out its business. Any number not exceeding one-third of the members of any sub-Committee may be persons who are not members of Council. Council may delegate any of its powers to a sub-Committee and may give general or particular directions as to the exercise of such powers to which directions the sub-Committee shall conform. Council may at any time add any member to or remove any member from any sub-Committee or may dissolve the sub-Committee but need not in any such case assign a reason for such action.

(d) Subject to the provisions of this constitution Council may regulate its own procedure.

(e) The Secretary shall be responsible for the general conduct of the Society's correspondence and other day to day business. He shall prepare the Agenda for each meeting of the Society and of Council and shall give notice of meetings and invite nominations for any elections on the Agenda. He shall take the minutes at all meetings of the Society and at meetings of Council and enter them in a Minute Book.

(f) The Membership Secretary shall be responsible for all matters relating to membership of the Society, other than the receipt of subscriptions.

(g) The Treasurer shall receive all sums of money due to the Society transact all its pecuniary affairs and keep a proper account of receipts and payments. The financial year of the Society shall end on June 30th.

(h) The Editor (Abstracts) shall be responsible for the Society's publication of Rheology Abstracts and the Editor (Bulletin) shall be responsible for the Society Bulletin for private circulation to the members.

(i) Council shall present to each Annual General Meeting a written report and audited accounts of the Society for the preceding year.

Conferences

9. (a) Non-members may be admitted to any of the Society's Conferences at the discretion of Council. Council shall have the power to charge a fee for such admission if it considers this desirable.

(b) Representatives of the Society on other bodies or at Conferences of other organisations shall be elected from among the members of the Society by Council.

Branches

10. (a) A Branch of the Society may be formed in any area outside the United Kingdom subject to the approval of Council. The activities of a Branch shall be governed by the rules of the Society and by the rules of the Branch.

(c) The rules of a Branch shall be approved by Council. Such rules shall provide for the election of a Chairman, Secretary, Treasurer and Committee and when the rules have been approved the officers and the Committee shall be elected and the Branch shall commence to function.

(d) The Committee of a Branch of the Society shall be subject to any directions given to it by Council but so that neither Council nor the members of the Society (other than members of the Branch) shall be responsible for any action taken by the Branch Committee.

(e) An application for membership of the Branch shall if approved by the Branch Committee in accordance with the rules of the Branch be treated also as an application for membership of the Society and shall be sent to the Membership Secretary of the Society for consideration in the normal way by the Council. If the applicant is elected to membership of the Society he shall be given notice of his election and shall be requested to pay his first subscription in accordance with the next following rule to the Treasurer of the Branch. Upon payment of his subscription he shall be enrolled as a member of the Society and of the Branch and be entitled to all the privileges of membership of the Society and the Branch and shall be bound by these rules and by the rules of the Branch.

(f) The subscription payable by a Branch Member shall be decided from time to time by the Branch Committee and shall be due on the first day of October in each year, a Branch Member shall not be called upon to pay any subscription in respect of his membership of the Society apart from his Branch subscription. Part of the subscription of each Branch Member shall be sent with a list of names of paid up Branch Members to the Treasurer of the Society before the last day of December of each year. This part of the subscription shall be decided from time to time by Council.

(g) The Council may sever any connection between itself and a Branch if such severance is supported by two-thirds majority of the members present at a General Meeting of the Society. The Branch shall be notified forthwith of any such decision and shall thereupon cease to be a Branch of the Society but the members of that Branch may at the discretion of Council remain members of the Society.

General

11. (a) The Society shall not be liable for any damage or loss to the persons or the property of members howsoever caused whether the Society has been negligent or not. Provided nevertheless that Council may in its absolute discretion make an ex gratia payment out of the Society's funds in respect of any such damage or loss if it thinks that such a payment is appropriate.

(b) Every member of the Society shall from time to time communicate to the Membership Secretary his address and all notices posted to such address shall be considered as having been given on the day following the date of posting.

Alteration to Rules

12. These rules may be added to repealed or amended by resolution at any annual or Extraordinary general meeting provided

that no such resolution shall be deemed to have been passed unless (a) it be carried by a majority of at least two-thirds of the members voting thereon and (b) the votes in support of the change number at least 20 or 8% of the total membership of the Society, whichever is the less.

Dissolution

13. A resolution for the dissolution of the Society may be proposed at any General Meeting where at least four weeks' notice has been given to the members of the intention to propose such a resolution. If the resolution for the dissolution of the Society shall be passed at such a General Meeting by a majority of two-thirds of the members voting thereon and the members voting in favour of the resolution number at least 20 or 8% of the total membership of the Society whichever is the less Council shall thereupon or at such future date as shall be specified in such resolution, proceed to realise the property of the Society and after the discharge of all liabilities shall apply the same for charitable purposes approved by the Secretary of State for Education and Science and upon the completion of such application the Society shall be dissolved.

Interpretation

14. Council shall be the sole authority for the interpretation of these rules and the decision of Council upon any question of interpretation or upon any matter affecting the Society and not provided for by these rules shall be final and binding on the members.

COULOMB AND RHEOLOGY

By J. Kerisel and B. Persoz, adapted into English and abridged by D. W. Hadley.

(First published in French in Cahiers du Groupe Française de Rhéologie, 1978, 4, 243-247, and reprinted with the authors' permission.)

Charles Augustin Coulomb was born at Angouleme on 14th June, 1736, son of an inspector of the royal domains, whose career had brought him by chance more than 200 miles NW from the Coulomb homeland of Montpellier, where the family were, by tradition, jurists. Coulomb's mother was authoritarian, his father a man of tradition but of little character. Very soon the family moved to Paris where young Charles Augustin began his studies, and soon announced his intention of becoming a mathematician; but he ran up against the total opposition of his mother, who wished him to become a doctor. (Montpellier was the home of a renowned medical college.) When his father, ruined by unfortunate speculations, retired to Montpellier his more fortunate mother threatened to disinherit her son if he refused to comply with her wishes. But, though penniless, Charles Augustin decided to rejoin his father at Montpellier.

That decision was to influence his studies, for *la Société royale des sciences de Montpellier* prided itself as having been recognized in 1706 as the second royal scientific society in France. Coulomb was admitted there at the age of 21, after submitting a paper on the geometry of mean proportional curves. Within 16 months he presented to that venerable society four further notes, one on mechanics and three on astronomy.

In 1760, despite lacking the trappings of aristocracy, his mathematical aptitude gained him entry to the famous royal military college of engineering at Mézieres. Thence, at the age of 27, after a brief sojourn at Brest, he was sent to Martinique to construct Fort Bourbon. In 1772, following two severe illnesses, and with the fort practically completed, Coulomb was at least allowed to return to France. For the next nine years he led the nomadic life of an officer of engineers; but unlike his comrades, who were content to perform quietly the routine tasks that were handed out, his enquiring, inventive mind compelled him not only to try to understand the reason for all things, and so perfect his methods, but gave him an equal interest in problems lacking any direct relation with his calling.

He was elected to the Acadamey of Sciences in 1781 and moved to Paris; but it was the period of the Terror, and having seen his colleagues Lavoisier and Condorcet condemned, he sought refuge

near Blois, where for three years he studied the circulation of sap in trees.

When calmer times returned he moved back to Paris, living at 15 *quai de la Monnaie*, close to the Institute. In this modest apartment he performed his final series of electrical experiments, using a room overlooking the courtyard because it was quiet, and the vibrations of road traffic would not shake the torsion balance.

In 1820 he was appointed by Napoleon as a member of the commission charged with reforming education in France, and then became Inspector General of Public Instruction. His health declined due to overwork and the effects of fevers contracted in the colonies, and on 23rd August, 1806, he died, a retired Lt. Colonel of the Royal and Military Corps of Engineers, a former administrator of waters and fountains, a member of the Institute and of the *Legion d'honneur*.

Works in Rheology

Coulomb's scientific work, of which most people know hardly anything beyond that concerning electrostatic and magnetic forces, surprises in its extent. The major part is concerned with soil mechanics and with the strength of materials, with which he was associated since his first years as an officer of Engineers. The question of the true nature of friction and cohesion was of passionate concern throughout his life, following the paper of 1773 on the pressure and cohesion of soils and that of 1777 on friction. In the following paragraphs it is possible to discuss only a few salient aspects of his work.

The fracture of a compressed column

Coulomb's career as an engineer led him to study the fracture stress of rocks in tension, compression and shear, and of particular concern was the fracture of a column of masonry under axial compression. The common experience of oblique fracture caused him to investigate the inclination (ϑ) of the plane for which shear stress is a maximum, for the column ought to fail in shear along such a plane when the applied load is progressively increased. Coulomb deduced obviously that $\vartheta = \pi/4$, but experiments demonstrated that in practice the angle is always somewhat greater. He therefore introduced the concept of friction between the two surfaces of the plane of fracture, and deduced that when fracture occurs the shear stress along this plane is equal to the fracture stress (R) (*cohérence*) plus the frictional stress, itself equal to the product of the normal stress times the coefficient of friction $\tan \phi$. The inclination of the plane along which fracture occurs is then found to be not $\pi/4$ but $\vartheta = \pi/4 + \phi/2$.

The pressure due to soils

Here also Coulomb introduced friction to account for the observation that the fracture stress in shear is increased by a pressure acting normal to the fracture plane. A prism of earth, susceptible to sliding along a plane inclined at an angle ϑ to the horizontal, is retained by a vertical wall, from which it receives a horizontal force F per unit thickness. The problem is to calculate F so that a suitable wall can be constructed.

The horizontal and vertical forces can be resolved to determine the stresses both normal and tangential to the slip plane. Slip will occur if the latter is equal to the *cohérence* (R) plus the effect of friction. From this equality it is possible to extract F , which is a maximum for $\vartheta = \pi/4 + \phi/2$. Coulomb's expression is in use today, though the notation differs from that of his time.

Coulomb was then able to calculate, by putting $F=0$, the maximum depth of a trench which was to have vertical sides, and if the depth of the excavation exceeded this critical value analogous principles gave the angle at which the soil should be cut so that it should "maintain itself by its proper cohesion".

From studies of the case of an excess load Coulomb suggested the following propositions: (i) freshly dug soils lack coherence; (ii) the friction of soil against masonry is less than that between particles of the soil; (iii) percolating water can form a liquid sheet between the soil and the masonry, so substituting the pressure of a frictionless fluid for the pressure of the soil.

Friction

Coulomb warns his readers about an experiment performed in a series of small steps; it needs only the slightest irregularity, the smallest obstacle placed between the contacting surfaces, the coherence of a few more or less homogeneous parts, to cause very large irregularities in the results. He distinguishes between two completely different situations: (1) if the bodies are in contact for a finite time the friction between them will depend on (a) the nature of the materials in contact, and of any surface coating, (b) the extent of their surfaces, (c) the precision with which the surfaces are in contact, (d) the time that has elapsed since contact was established; (2) if the bodies slide on one another at a given speed the relevant parameters will include (a) (b) and (c) together with the magnitude of the speed.

Coulomb's experimental arrangement consisted of a laden sledge drawn by a system of cord-pulley-weight, and sliding on a wooden surface. The area of the contact was altered by hollowing out the under surface of the sledge. The experimental results did not confirm completely Amontons's law (1699), $F=fP=P \tan \phi$, which is

often wrongly attributed to Coulomb. For static friction Coulomb noted the great importance of the time t for which the surfaces had been in contact, and proposed initially that $F = F_0 + kT^\gamma$, later modifying the expression to where F_0 was the frictional force at $t=0$, γ was an exponent of order 0.2 and $\alpha > \beta$.

$$F = F_0 (1 + \alpha t^\gamma / 1 + \beta t^\gamma)$$

Moving friction ($t=0$) was much weaker, by as much as 4.3 times for elm wood. The role of asperities was not neglected, and the fibres with which the wooden surfaces were coated were compared with the bristles of two brushes against one another.

The torsion of wires

While at Cherbourg in 1774 Coulomb decided to compete for a prize, offered by the Academy at Cassini's instigation for the best design of magnetic compass. It was this circumstance that directed part of his activities towards the torsion of wires, which are used to suspend compass needles, and so to measure very weak couples and forces with the torsion balance.

First he studied scientifically the torsion of filaments of silk and hair, and after verifying that they produced only very small couples he proposed in 1777 that the moment of this couple (M) was directly proportional to the angle of twist (ϑ), was proportional to the cube of the diameter (D) and inversely proportional to the length of the filament (l). The fact that experimentation led to the cube and not the fourth power of diameter was due probably to the small range of diameters tested, as well as the difficulty in measuring the thickness of the filaments. Coulomb corrected the error later, when the use of metal wires enabled him to vary diameters over a much wider range.

In 1784 Coulomb reported that brass wires showed a linear relation between M and ϑ if the deformation was small, but a non linear relation at large deflections. In the linear region he proposed the use of torsion to measure weak forces. That was the origin of the torsion balance, which enabled him to measure with high precision forces of the order of a microgramme weight.

By observing the oscillations of a cylinder suspended in turn from brass and iron wires he determined the restoring couple as $M = \mu \vartheta D^4 / l$, and obtained numerical values for μ corresponding to a torsion modulus of 7.63×10^{10} Pa for iron and 2.78×10^{10} pa for brass. Coulomb explained the D^4 law by considering that the cross-section varies as D^2 , the mean strain of the particles as D , and the lever arm of the partial couple with reference to the axis as D also, so making a total of D^4 .

In the non linear region he proposed to study torsion for its own

sake, in order to determine the laws of cohesion and elasticity in metals and other solid bodies. At the time he considered torsion as an intramolecular elastic and intermolecular plastic phenomenon, and related the molecular slip produced in non linear torsion to his theory of fracture in soils and masonry columns.

Also in 1784, he observed that in metals the elastic limit was modified by cold working and annealing, although the modulus was unaltered. Cohesion and elasticity were thus distinct phenomena. He supposed that up to a certain limit intramolecular deformations were restored elastically. Between that limit and the point of fracture the material was "rearranged" (i.e. creep or flow along molecular planes). Timoshenko considers that distinction as one of the most important results obtained in the eighteenth century in the field of materials.

Coulomb applied the torsion balance in the study of elasticity, magnetism and electrostatics as well as for the resistance of fluids. It also provided a means of determining the moment of inertia of a body.

The resistance of fluids

Coulomb was more than 60 years old when he attacked the problem of the resistance of liquids to the movement of bodies immersed in them. Scholars such as Newton*, Bernoulli, d'Alembert, Désaguliers and others had previously proposed laws that were, for the most part, quadratic in form. Coulomb's perspicacity led him to abandon traditional experimental methods, such as a boat immersed in a tank or a simple pendulum consisting of a sphere suspended by a wire, because of the influence of the walls of the containing vessel. He used instead the rotation of a cylinder or disc placed in a large coaxial cylinder, and constructed what was probably the first viscometer of that type. For reasons of simplicity in mounting he considered not continuous rotation but an oscillatory motion with periods between 20 and 30 seconds and amplitudes between 8° and 480° . He made profitable use of the torsion of wires, which he had studied thoroughly in constructing various types of torsion balance.

*It is interesting to search in the works of Newton for the true contribution that he made towards enunciating the law named after him. According to G. W. Scott Blair he wrote simply "the resistance that arises from the lack of flexibility of the parts of a liquid is, all else being equal, proportional to the speed at which the particles of the liquid are separated one from another". According to S. Gillmor [2] he proposed

$$F = av + a^{\frac{1}{2}}v^{\frac{3}{2}} + bv^2, \text{ and later } F = K + v^2$$

Knowing that the resistance F of fluids was in many cases a function of speed v he stated *a priori* a series of the form $F = k + av + bv^2 + cv^3 + \dots$, but experimentation caused him to ter-

minate the series at the squared term. He suspected the presence of a threshold k for certain highly viscous liquids, but was unable to determine it.

A greased disc gave the same results as one that was ungreased, which led him to his first fundamental conclusion that the part of the resistance found proportional to the speed is due to the mutual adherence of the molecules of the fluid, and not to the adherence of these molecules to the surfaces of the body.

Benjamin Franklin and Bossut had noted that the resistance to forward motion of a body immersed in a fluid varied with the depth at which it was immersed. Coulomb performed the experiment with a disc in 2cm of water and then in 50cm and found no difference. He repeated the experiment in a vacuum, using the Institute's air pump, and confirmed that pressure had at most a negligible effect.

With a particular cylinder the term in av was 17 times greater in oil than in water, but the quadratic terms (av^2) was almost identical in both liquids, a result that must be due to the inertia of the molecules and not their cohesion. Coulomb was the first to distinguish these two sorts of resistance, one due to inertia, the other to the internal friction of the liquid.

He stated his intention of following up these studies, notably by considering the shape of the displacing body, and also by an attempt to elaborate a general theory of the resistance of fluids, but he died before achieving his aims, and many of the unpublished papers of this period have been lost.

Conclusion

What would have been Coulomb's career had he acceded to his mother's demands and directed himself towards medicine? It is probable that in that sphere also he would today be cited as an innovator: the spirit, when it is inventive, is so in all circumstances, but as is the case with plants some terrains and some climates are more fertile than others.

Without doubt his work on soil mechanics, friction and the flexion of beams resulted directly from an inherent preoccupation with the intelligent exercise of his profession as an engineer, but the idea of competing for the prize for the construction of a magnetic compass demonstrated the imperative need for him to create and innovate. It was in this indirect manner that he was guided towards the torsion of wires, the elastic and plastic deformation of metals, and eventually to the construction of one of the first viscometers* as an application of the torsion balance.

Rheology owes much to Coulomb, and it is a pleasant thought that the shear modulus is sometimes called by his name.

*Scott Blair (3) believes the first viscometer to be that described by the Russian Lomonosov in 1751. It appeared to be "somewhere between a capillary and an orifice instrument".

REFERENCES

1. J. Kerisel. The bicentenary of C. A. Coulomb's essay of 1773. Special lecture, 8th Int. Cong. of Soil Mechs. & Founds., Moscow 1973.
2. S. Gilmor. Coulomb. Princeton U.P. 1971.
3. G. W. Scott Blair. Bull. B.S.R. 1968, No. 3, 1-5.

INTERNATIONAL COMMITTEE ON RHEOLOGY NEWSLETTER

Members of the British Society of Rheology probably guess that there is some sort of organisation behind the International Congresses which "happen" every four years. Of course the "happening" is largely in the hands of a local Organising Committee which for the VIIIth International Congress in Naples next year has Professors G. Astarita and L. Nicolais as President and Secretary respectively. There is also an Honorary Committee, about whose precise duties the writer of this note is not clear although its President, Professor J. Kubat, will be Honorary Chairman of the Congress.

The International Committee on Rheology, whose history, activities and future prospects are described by R. S. Marvin, has as one major function the choice of a venue for each International Congress. In addition the International Committee on Rheology has started to produce a Newsletter which it circulates to national societies (which each have a delegate to the I.C.R.; our delegate is our President and both he and the Secretary have copies of the Newsletter). The following items have been abstracted from the latest Newsletter (January 1979) for the information of members.

1. The Mexican Society of Rheology was formed last year and is seeking membership of the I.C.R. Its President is Dr. Baltasar Mena.
2. It is expected that an Israeli Rheological Group will be formed. (Report from Dr. A. Silberberg.)
3. Offers to hold the IXth International Congress (1984) in the U.S.A., Germany (Berlin) and Mexico have been received. The decision will be announced, if precedent is followed, at the VIIIth Congress in Naples next year.

4. Plans for the VIIIth International Congress include
 - (a) Opening address by C. Truesdell on the History of Rheology.
 - (b) Five parallel sessions of lectures; of 500 papers so far!
 - (c) In the choice of invited lectures, about which we and other societies were asked to make suggestions, there will be emphasis on "younger persons who can make noteworthy contributions".
5. Other topics under discussion or on which comment is invited include an International Award (neither we nor the U.S. Society, each having our own awards, have expressed any enthusiasm) nomenclature and notation, rheological dictionaries, a rheological Who's Who or a Directory of rheological laboratories (the latter receiving more support from I.C.R. member societies—as being less painful to compile than a Who's Who).

The Secretary of the I.C.R. is Professor N. W. Tschoegl and its Chairman is Professor J. Kubat. These were appointed at the VIIIth International Congress in Gothenburg in 1976.

Your Secretary will be happy to collect views on International rheological matters for transmission to your Council and thence to the I.C.R.

C. J. S. PETRIE

1. R. S. Marvin, *Bulletin of the British Society of Rheology*, 19 (3), 31-44 (1976). (See also *Proceedings of the VIIth International Congress of Rheology*, Gothenburg, 1976, p.p. 31-36.)

APPLICATIONS FOR MEMBERSHIP—JULY 1979

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| <p>Dr. Yilmaz Ozturk, Ph.D.
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FUTURE MEETINGS

Naples, September 1980

Members should all have received the Second Circular from Naples (in February 1979). As for previous International Congresses, the Society will try to arrange group travel and accommodation. Anyone likely to be interested in this is invited to write to the Secretary (with any relevant information)

Cleveland, Ohio, August 1980

The Third International Symposium on Polyvinylchloride is to take place in Cleveland on August 10th-14th, 1980. One of the seven topics covered at the conference is Rheology, Compounding and Processing.

Further details can be obtained from the British delegate on the Scientific Committee, Mr. F. N. Cogswell, ICI Ltd. Plastics Division, Welwyn Garden City, Herts., U.K.

Meetings arranged by IUTAM and affiliated organisations

There follows a selection of meetings with (apparent) rheological content abstracted from a list received by the Secretary from the secretariat of the British National Committee for Theoretical and Applied Mechanics. The meetings are generally restricted to invited participants, and anyone interested should write to the Chairman of the scientific or organising committee named for each meeting far in advance of the date of the meeting.

- (a) IUTAM Symposium on Finite Elasticity Theory
Place: Bethlehem, Pennsylvania, U.S.A.
Date: 11-15 August, 1980.
Chairman: Professor R. S. Rivlin, Lehigh University, Center for the Application of Mathematics, 203 E. Packer Avenue, Bethlehem, PA 18015, U.S.A.
- (b) IUTAM Symposium on the Mechanics and Physics of Bubbles in Fluids
Place: Pasadena, California, U.S.A.
Date: 1980.
Chairman: Professor M. S. Plesset, California Institute of Technology, Engineering Science Department, Pasadena, CA 91125, U.S.A.
- (c) IUTAM Symposium on Threedimensional Constitutive Relations
Place: Palaiseau, France
Date: 1980.
Chairman: Professor J. Mandel, Laboratoire de Mecanique des Solides, Ecole Polytechnique, F-91128 Palaiseau, Cedex, France.

- (d) IUTAM/IUPAC Symposium on Interaction of Particles in Colloidal Dispersions
 Place: Canberra, Australia (tentative).
 Date: 1981.
 Chairman: Professor B. W. Ninham, Research School of Physical Sciences, The Australian National University, Box 4, P.O., Canberra, A.C.T., 2600, Australia.
- (e) Second IUTAM Symposium on Stability in the Mechanics of Continua
 Place: (not yet decided).
 Date: 1981.
 Chairman: Professor F. Schroeder, Bergische Universität—Gesamthochschule Wuppertal, D-5600 Wuppertal, BRD.
- (f) IUTAM Symposium on Mechanics of Composite Materials
 Place: (not yet decided).
 Date: 1981.
 Chairman: Professor P. Meijers, Technische Hogeschool Delft, Vakgroep Technische Mechanica, Mekelweg 2, Delft, The Netherlands.
- (g) ICF/IUTAM Symposium on the Foundation of Fracture Mechanics
 Place: Providence, Rhode Island, U.S.A. (tentative).
 Date: 1981.
 Chairman: Professor J. R. Rice, Division of Engineering, Brown University, Providence, RI 02912, U.S.A.

C. J. S. PETRIE

NEWS OF MEMBERS

Drs. J. M. Stearne and J. J. Cross, members of the Australian branch of the Society, are currently visiting this country. Dr. Sterne is visiting the ICI Agricultural Division until January 1980 and Dr. Cross is spending time mainly in Oxford and Cambridge and also in France collecting material for a book.

NEW BOOKS

Research Notes in Mathematics Series No. 29

ELONGATIONAL FLOWS: Aspects of the Behaviour of model Elasticoviscous Fluids

C. J. S. PETRIE, University of Newcastle upon Tyne

Readership: Applied mathematicians, chemical engineers, mechanical engineers, and research workers in the plastics and man-made fibre industries.

Published by Pitman Publishing Limited, London.

DIARY

1979

28th October-2nd November. U.S. Golden Jubilee Meeting—Boston.

6th December. "Rheology of Thin Layers"—Paris.

1980

26th-28th March. "Practical Rheology in Polymer Processing"—Loughborough.