

DM 1310 [contd.]

[Strongroom]
Store

Catalogue of the papers and correspondence of
SIR FREDERICK CHARLES FRANK Kt, OBE, FRS
(b.1911)

Compiled by Timothy E. Powell and Peter Harper

Volume II

Sections G - K

Bibliography

Index of Correspondents and Organisations

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SECTION G

CONSULTANCIES

G.1-G.130

This section contains material relating to Frank's work for British and overseas commercial organisations only. He also acted as consultant for a number of governmental agencies and departments. Material of this nature is to be found in Section F.

BRITISH AIRCRAFT CORPORATION (BAC)	G.1
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G.1 BRITISH AIRCRAFT CORPORATION (BAC) 1964

Correspondence re offer of consultancy in Guided Weapons Division. BAC's letter of 8 May 1964 is annotated by Frank "Answered, accepting but asking for further copy of original letter, 24 July 1964".

G.2-G.23 BRITISH RAILWAYS (BR) 1949-51

Frank was invited to serve as "an independent scientific adviser" to the Water Treatment Committee, 23 September 1949, on the recommendation of R.V. Jones. This Committee was established to study the problems "in the provision and use of softened water" used in steam locomotive boilers. It first met on 2 December 1949 and held a further thirteen meetings before issuing its report in February 1951.

The Committee considered the problems and costs associated with the various systems of softening the water fed to locomotives to reduce scaling (with its deleterious effect on the costs of boiler maintenance). While allowing for regional diversity (due to differing water hardnesses and to the pre-nationalisation practices of the four great railway companies) the Committee recommended "that further extensions of water treatment should be made as far as possible by internal treatment on the locomotive" rather than by large-scale water treatment plants.

The material, predominantly committee papers and background information, is arranged in a chronological sequence.

G.2 Invitation to become a consultant and Frank's letter of acceptance; Frank's 4pp manuscript notes and references headed "Notes on water treatment", written 28 November 1949; list of committee members, sent 29 November.

G.3 "Questions for Enginemen, &c", London Midland and Scottish Railway's Handbook for Enginemen, December 1931. Sent to Frank 28 November 1949 (see covering note at G.2).

- G.4-G.8 First committee meeting, Derby, 2 December 1949. Frank was present.
- G.4 Papers and minutes of meeting. With Frank's "Memorandum to the Chairman" recording the views he expressed at the meeting, 2pp typescript.
- G.5-G.8 Reports on water treatment submitted by BR Regions. The reports are retained in their original folders.
- G.5 East and North East Region.
- G.6 London Midland Region.
- G.7 Southern Region.
- G.8 Western Region.
- G.9 Correspondence with S. Bairstow, Divisional Chemist, London Midland Region, December 1949, January 1950, re L.O. Gunderson and W.L. Denman's paper "Polyamide Foam Inhibitors - Mechanism of Foam Inhibition in Steam Generators", *Industrial and Engineering Chemistry* 40 (1948). Includes reprint of paper for ease of reference.
- G.10 Second committee meeting, Doncaster, 17 January 1950. Frank was absent.
- Agenda, papers and minutes of meeting.
- G.11 Report on "The Toton-Brent Experiment" by J.S. Hancock, January 1950. In original folder.
- Hancock was a water softening chemist with London Midland Region. He reported for the committee on the Toton-Brent experiment, designed to find whether a "continuous supply of correctly conditioned water" for locomotives on the Toton-Brent section of track resulted in "clean, corrosion-free locomotive boilers". The experiment suggested it did, but also highlighted the inefficiency of the water softening plants.

- G.12 Committee meetings 3-11, January-August 1950. Frank was absent from all these meetings.
- Minutes only.
- G.13 Letter and Frank's manuscript notes of a meeting with J.S. Hancock, S. Bairstow and T.F.B. Simpson (Committee Chairman), Derby, 24 February 1950.
- Letter to R.V. Jones complaining about BR's "complete lack of acquaintance with research", 4 April 1950.
- G.14 Memorandum on visit to France by representatives of Water Treatment Committee, April 1950. In original stiff cover binding.
- The Committee representatives (not including Frank) visited France to inspect locomotive boilers and the water treatment system on French railways.
- G.15 Twelfth committee meeting, Derby, 4 October 1950. Frank was present.
- Agenda, papers and minutes of meeting. Includes report "Water softening on the London Midland Region" by J.S. Hancock.
- G.16 Correspondence from T.F.B. Simpson re tests on the effect of dirty boilers on fuel consumption, August, October 1950.
- G.17 Thirteenth committee meeting, Derby, 9-10 January 1951. Frank was absent.
- Correspondence, agenda, papers and draft minutes of meeting.
- Fourteenth committee meeting, Derby, 20 February. Frank was present.
- Draft minutes only.

- G.18-G.20 Committee Report, completed February 1951.
- G.18 Frank's manuscript corrections to first draft of Report.
- G.19 Second "Draft Report", December 1950. With Frank's manuscript corrections and related correspondence.
- G.20 Final "Report on Treatment of Water used for Locomotive Purposes", February 1951. Frank's bound copy.
- G.21-G.23 Miscellaneous background material.
- G.21 Chief Mechanical Engineer's Department, London and North Eastern Railway, "Report on Comparative Evaporation Tests on Locomotive Boilers", August 1931. 8pp typescript plus photographs, graphs, table.
- With Frank's manuscript calculations and diagrams found with it.
- G.22 Information on T.I.A. (Traitement Interne Integral Armand) system of water treatment.
- The T.I.A. system was widely used in France and was of much interest to the Committee (see G.14). It combined external treatment of the "feed water" with dosage of water in the tender with a special alkali-tannin solution.
- G.23 Manuscript notes by Frank.
- G.24-G.99 DE BEERS 1949-86
- Frank's association with De Beers, the South African mining company, began in 1949 when, at the suggestion of F.E. (later Sir Francis) Simon, a De Beers subsidiary, Industrial Distributors Ltd., invited Frank to serve as a consultant on diamond research, initially for three years but renewed thereafter. Frank's other formal connections with De Beers were through the Diamond Conferences and the Diamond Research Committee, which the company funded, and through a series of patent cases in the early 1960s in which he gave evidence in his capacity as consultant.

According to Frank's account, given to the 1975 Diamond Dinner (G.95), the Diamond Conferences were initiated by Simon, who persuaded Sir Ernest Oppenheimer, Chairman of De Beers "that at the comparatively small cost of funding an annual conference he could be in touch with a hundred scientists, who would have cost him one or two million a year to put on his payroll." The first was held in 1950.

Shortly after Simon's death in 1956 the Diamond Research Committee was formed, under the chairmanship of the Reading physicist R.W. Ditchburn, both to organise the Diamond Conferences, and to allocate funding from De Beers for diamond research projects in the UK. Frank was a member of the committee from its foundation.

Frank's consultancy with De Beers led to his involvement in a series of cases brought against the American company General Electric's attempt to patent its method of synthesising diamond in South Africa. Frank gave affidavits for the Transvaal and Orange Free State Chamber of Mines who represented De Beers' interests.

In connection with his work for De Beers, whether as a consultant on diamonds or as a member of the Diamond Research Committee, Frank made a number of visits to South Africa.

The material is arranged as follows:

G.24-G.27	Industrial Distributors
G.28-G.55	Diamond Conferences
G.56-G.75	Diamond Research Committee
G.76-G.86	Patent Cases
	With an introductory note
G.87-G.99	Miscellaneous

Industrial Distributors

- G.24 Correspondence with F.E. Simon and Industrial Distributors, 1949-57.

Includes brief exchanges re offer of consultancy and its renewal in 1952; "Memorandum on growth of diamonds", 12pp manuscript, 16 December 1951; letter from Simon, 13 May 1954, re "continuing the contract" in view of Frank's lecture on "Tin whiskers" to the 1953 Diamond Conference (G.29) which some "thought a little remote".

- G.25 Brief correspondence, July 1954, with P. Grodzinski of Industrial Distributors' Diamond Research Department re paper "Über die synthese des Diamanten" by A. Neuhaus.

Includes "original" typescript draft of Neuhaus's paper with Frank's manuscript notes on Grodzinski's translation of Part III of the paper.

G.26 Correspondence, 1957-60.

Includes correspondence re diamonds required for research at Bristol University, 1957-60; typescript record of cable sent to J.F.H. Custers, Director of Research, 24 November 1959, congratulating him on the successful synthesis of diamond; press-cutting recording Frank's condemnation of apartheid in South African universities.

G.27 Visit to South Africa, 1961.

Frank was invited to help Industrial Distributors' Adamant (later Diamond) Research Laboratory, Johannesburg, "start a programme aiming at the production of synthetic diamonds considerably larger than the ones we now make every day".

The invitation mentions the success of General Electric in this field and expresses the hope that Frank's work on diamonds for G.E. will not prevent his assisting Industrial Distributors.

Invitation; memorabilia.

Diamond Conferences

Further material relating to the organisation of the conferences may be found under the Diamond Research Committee, G.56-G.75.

G.28 Oxford, July 1952.

Frank's manuscript notes on proceedings.

G.29 Oxford, 9-11 July 1953. Frank spoke on "An explanation of the formation of tin whiskers" (see G.25).

Correspondence re arrangements; lecture list; manuscript notes on proceedings; manuscript notes on "Whiskers".

G.30 Caius College Cambridge, 1-3 July 1954. Frank spoke on "Necessary conditions for the growth of diamonds".

Provisional programme; manuscript notes on proceedings.

G.31 Oxford, 30 June - 2 July 1955. Frank spoke on "Martensitic transformations".

Provisional lecture list; manuscript notes on proceedings.

- G.32 Reading, 18-19 July 1961. Frank had recently returned from South Africa (G.27) and did not feel able to give a paper.
- Brief correspondence; annotated provisional programme; list of participants.
- G.33 Cambridge, 25-26 June 1962.
- Annotated programme and list of participants.
- Reading, July 1965.
- Includes Frank's after-dinner "words of thanks".
- Cambridge, 10-11 July 1967.
- Lists of participants.
- G.34 Bristol, 8-9 July 1968. Frank helped organise the conference and presented a paper jointly with M. Moore and A.R. Lang on "Simulation of solution forms of diamond".
- Letter re arrangements.
- G.35 Reading, 24-27 September 1969.
- List of participants; letter from E. Gerryts, 19 September, with "Comment on 'Defect in Diamond'" by D.R. Grantham. Before his death Grantham sent Gerryts this "Comment" on a paper delivered by Frank at the 1966 International Industrial Diamond Conference (G.90-G.92), asking that it be submitted to the Reading conference.
- G.36, G.37 Brasenose College Oxford, 12-15 July 1970.
- G.36 Correspondence re Soviet participation; lists of participants and papers; manuscript notes on proceedings etc.
- G.37 Guidebook for "A Kimberlite Exhibition" organised by J.W. Harris and H.J. Milledge.

- G.38 Cambridge, 14-17 July 1971.
Correspondence re arrangements, including correspondence from R.W. Ditchburn re Soviet participation; list of participants; heavily annotated programme; brief manuscript notes.
- G.39 Bristol, 13-15 July 1972. Frank spoke on "Kinematic theory of dissolution shapes".
Correspondence re arrangements; annotated lists of papers.
- G.40 Reading, 15-18 July 1973.
Lists of papers submitted and participants.
- G.41 Oxford, 3-6 July 1974.
Correspondence re Soviet participation; lists of participants.
- G.42 Churchill College Cambridge, 6-9 July 1975.
List of participants; miscellaneous correspondence including letter from the Industrial Diamond Information Bureau inviting Frank to write on the future of diamond research for *Diamond Research*, and typescript draft of Frank's contribution.
- G.43 Kimberlite Symposium, St. John's College Cambridge, 10-11 July 1975. This was held immediately following the Diamond Conference.
Invitation; information; lists of participants; provisional programme.
- G.44 Bristol, 12-14 July 1976.
Includes brief manuscript notes on programme for 1976 and finance for 1977 conference.
- G.45 Reading, 6-9 July 1977.
Information; list of participants; programme; Frank's manuscript notes on proceedings.

- G.46 St. Catharine's College Oxford, 9-12 July 1978.
Letter from R.W. Ditchburn re Soviet participation; programme; list of participants.
- G.47 Newnham College Cambridge, 8-11 July 1979.
Conference information; abstracts; "Diamond: properties and definitions" by J.E. Field compiled for the conference.
- G.48 Kimberlite Symposium II, Cambridge, 11-14 July 1979. This was held immediately following the Diamond Conference.
Brief correspondence arising from a discussion in which Frank participated; "summary" of discussion.
- G.49 Bristol, 7-9 July 1980.
Programme; list of participants.

Reading, 8-11 July 1981.
Brief correspondence only.
- G.50 Oxford, 5-7 July 1982.
Includes annotated programme.
- G.51 Newnham College Cambridge, 6-9 July 1983. Frank led a discussion.
Conference information; abstracts; programme; list of participants.
- G.52 Bristol, 9-11 July 1984. Frank led a discussion.
Annotated programme; list of participants.
- G.53 Reading, 10-13 July 1985. Frank led a discussion.
Programme; list of participants; abstract.

- G.54 Royal Holloway and Bedford New College London, 7-9 July 1986.
Brief correspondence including reference to current unrest in South Africa.
- G.55 Oxford, nd. Frank spoke on "Plastic deformation in diamond".
Lecture list; manuscript and typescript drafts on plastic deformation; manuscript notes on proceedings.

Diamond Research Committee

The material is principally papers for Committee meetings to consider research proposals, half yearly reports on research, and correspondence, chiefly with R.W. Ditchburn, re diamond conferences, research proposals and patenting.

R.W. Ditchburn was chairman of the Committee until July 1982 when he was succeeded by E.W.J. Mitchell.

20 folders.

G.56	1964-66	G.66	1979
G.57	1967-68	G.67	1980
G.58	1969	G.68	1981
G.59	1970-71	G.69	1982
G.60	1972	G.70	1983
G.61	1973	G.71	1984 (1)
G.62	1974	G.72	1984 (2)
G.63	1975	G.73	1985 (1)
G.64	1976-77	G.74	1985 (2)
G.65	1978	G.75	1986

Patent Cases

In February 1955 the American company General Electric (GE) announced it had found a method of synthesising diamonds. This was immediately placed under a US government secrecy order as it was judged to be of strategic significance.

The order was lifted on 8 September 1959 and the next day GE filed five patent applications in South Africa to protect its inventions. Three were opposed by the Transvaal and Orange Free State Chamber of Mines, on behalf of De Beers (3550/59, 3551/59 and 3547/59). A further patent application was made on 7 December (4878/59) and this too was challenged. Frank was asked by the lawyers acting for the Chamber of Mines to provide affidavits on its behalf.

As GE also occasionally employed Frank as a consultant, there was a potential clash of interests. This was resolved by GE providing a contract in which work on diamonds was excluded from its provisions (see G.110). Frank duly testified for the objector.

The basic patent (3550) was for a method of synthesising non-diamond carbon into diamond by subjecting it to a pressure of 80,000-110,000 atmospheres and a temperature of 1400-1800°C in the presence of a metallic solvent or catalyst. The molten metal dissolves the carbon which is distributed through the metal until saturated. Upon cooling the solution becomes super-saturated and carbon is shed as solid crystals - diamonds. The other patents referred to improvements on this process. 3551 related to using an alloy as the catalyst (lowering the temperature and, more importantly, the pressure required for the conversion of carbon to diamond), 3547 to a way of eliminating the need to determine the temperature at which conversion occurs by providing a method of observing changes in electrical resistance, and 4878 to a method of creating better artificial diamonds by arranging the carbon and catalyst in alternate laminae or layers.

Various grounds for objection were raised but only two were used in court, the "obviousness" and the "inutility" of the alleged inventions. The first maintained that no inventive step was required beyond what was common knowledge in the area, the second that within the terms of the patent application the invention would not necessarily work. Frank's affidavits mainly supported the objection of "obviousness" and the related "lack of novelty" charge (which was, however, dropped, partly because as Frank himself stated GE were correct in claiming the natural processes for the formation of diamond were "not assuredly known").

The first judgement, delivered on 30 November 1964 by the Commissioner for Patents Sir John Clayden, dismissed the objections. The chief "inutility" argument, based on whether the GE term "carbaceous material" might not also refer to forms of carbon for which the process would be ineffective, was rejected because the objectors could not come up with any reasonable such material for which the process would not work. Frank had in fact argued against another objection on these grounds, which claimed that the patent specification included metals which would not melt at the temperatures specified, and felt that the "inutility" case was rather weak. The "obviousness" case was also dismissed. According to Clayden the "common knowledge in the art at the effective date of the application" did not include the precise forms of the carbon and catalyst to be used in the GE process, or the right pressure and temperature required. He ruled that it was not common knowledge that graphite would be the form of carbon used, and that following K. Lonsdale's analysis of the GE diamonds it would be assumed Nickel (or a Nickel-based substance) must be the catalyst.

Most importantly the judge found that an attempt to create synthetic diamonds by the GE method in September 1959 would have failed because of mistakes in the calculation of pressure. In their work GE had relied upon experiment to determine the pressures and temperatures needed for success, but soon afterwards R. Berman and Sir Francis Simon produced their "curve" which became accepted as the theoretical guide to the correct thermodynamic conditions for diamond synthesis. The accepted Bridgman Electrical Resistance method of calibrating pressure, however, which Clayden ruled was "common

knowledge" in 1959, was faulty. In 1961 it was found to be 30% out at high pressures. Therefore in 1959 anyone following the Berman-Simon curve to reach the right pressure and temperature to create diamonds by the GE method would fail, they would not be calculating pressure accurately.

Frank criticised the judgement noting "The odd outcome is the following: GE placed too much reliance on Bridgman. This is taken as cogent evidence that everyone would place too much reliance on Bridgman ... so that GE succeeds because of this mistake on its part." He felt that there were "good grounds" for challenging this judgement.

The Chamber of Mines went to the Court of Appeal. Here too, on 16 June 1966, the "inutility" arguments were rejected. But that on the grounds of "obviousness" was sustained. J. Galgut presiding found that GE itself had revealed most of the facts behind the processes and the rest were "obvious" to any competent diamond-synthesiser. As Frank had stated in his affidavit, the only novelty with the GE process was its "excellent apparatus" which could sustain the high pressures and temperatures which were commonly known to be required.

According to Galgut Graphite was obviously the most likely form of carbon to be used (being easily obtained in a pure form which could be broken down). Furthermore, it was not likely that Nickel would be thought of as the only catalyst. Frank had argued that it was well-known that a number of molten metals from group VIII of the periodic table (and not just Nickel, which has a high melting point) would "dissolve substantial quantities of carbon in an atomically dispersed form", including iron. Finally he rejected the ruling that the undetected flaw in the Bridgman Electrical Resistance calculation of pressure would have effectively prevented synthesis, pointing out that the alternative (and accurate) Bridgman volume method was well-known, and that using the Berman-Simon curve with the uncorrected electrical resistance calculation of pressure, it was possible to achieve diamond synthesis.

In 1961 GE applied for two more related patents, 2117/61, which was for the "production of electrically conductive diamonds" by adding boron or aluminium to the melt, and 1218/61 referring to the etching of diamond surfaces. Both were contested, Frank producing affidavits to the effect that in both cases the process was obvious and no more than an imitation of known natural occurrences.

The material is chiefly copies of the affidavits and other evidence presented at the hearings, together with copies of the two judgements, correspondence from Spoor & Fisher representing the Chamber of Mines, and manuscript drafts of Frank's affidavits. There are also copies of affidavits presented in respect of a rival De Beers patent application (3974/58) to which GE objected. The applicants claimed that whereas the GE process for synthesising diamond operated, according to their application, by catalytic process, theirs operated purely by a "solvent" process. As it was accepted in the cases brought against GE that, if broadly defined, a "catalyst could also be a solvent", case 3974 was dropped in 1962.

- G.76 Correspondence with Spoor & Fisher and notes re the case, chiefly on diamond synthesis, 1962.
- G.77 Correspondence with Spoor & Fisher, Frank's notes on the case etc., 1963.
- G.78 "Summarised Report on Experimental Work Carried Out at Adamant Research Laboratory in Connection with General Electric Company Affidavits", 12 June 1963, 11pp duplicated typescript and table. With two envelopes of photographs inscribed "Diamonds grown in metal" (9 photographs) and "Diamond dissolution by metals" (7 photographs).
- G.79 Correspondence with Spoor & Fisher 1964. Includes manuscript draft of Frank's letter, dated 19 December, criticising Sir John Clayden's Judgement (G.82).
- G.80 Frank's manuscript draft affidavits.
- G.81 Frank's manuscript draft "Replies to Applicant's evidence".
- G.82 Original Judgement, 30 November 1964.
- G.83 Appeal Court Judgement, 16 June 1966.
- G.84-G.86 Evidence presented.
3 boxes.
- G.84 Box 1 Patent applications, letters of demands and notices of opposition; memorandum on evidence; exhibits.
- G.85 Box 2 Affidavits for 3550/59.
- G.86 Box 3 Affidavits for 3974/58, 3547/59, 3551/59, 4878/59, 1218/61 and 2117/61.

Miscellaneous

- G.87 Visit to South Africa, 1959. Frank was invited to South Africa by the Students' Visiting Lecturers Trust Fund of the University of the Witwatersrand, at the suggestion of F.R.N. Nabarro.
- Invitation; letters from W.F. Cotty of the Diamond Producers Association London Committee introducing Frank to the Secretary and the Chief Diamond Valuator of De Beers.
- G.88 Report by E.W.J. Mitchell on High Pressure Conference, Le Creusot, France, 2-6 August 1965, with reference to the implications for diamond research.
- G.89 Visit to South Africa, August-September 1965. Frank was invited by the Students' Visiting Lecturers Trust Fund Committee of the University of Natal, 12 June 1964. While in South Africa Frank visited the universities of Port Elizabeth and the Witwatersrand and worked at the Diamond Research Laboratory.
- Invitation; correspondence re arrangements.
- G.90-G.92 International Industrial Diamond Conference, Oxford, 19-22 September 1966. Frank spoke on "Defects in diamonds" (*Bibliog.* 91). The conference was sponsored by De Beers.
- G.90 Conference brochure; background information etc.
- G.91 33pp manuscript and 28pp typescript drafts of Frank's contribution; 1p manuscript list of references. D.R. Grantham's comments on Frank's contribution were submitted to the 1969 Diamond Conference. See G.35.
- G.92 Manuscript diagrams of lattices and diamonds found with the preceding.
- G.93 De Beers Industrial Diamond Division One Day Conference on Recent Developments in Production Grinding with Diamond, London, 2 July 1968.
- Invitation only.

- G.94 Correspondence, signed menu from colleagues attending dinner in honour of W.F. Cotty's promotion to Technical and Diamond Consultant with De Beers' Industrial Diamond Division, 17 March 1971. Frank was unable to attend, having to undergo an operation and the letters express the hope that he will make a swift recovery.
- G.95 Diamond Dinner, 21 March 1975.
Invitation; Frank's speech recalling the establishment of the Diamond Conferences and early participants.
- G.96 Visit to South Africa, October-November 1977. Frank was invited by the University of the Witwatersrand in conjunction with De Beers.
Invitation and correspondence re arrangements; programme for visit to Kimberley, 9-10 November.
- G.97 Photocopy of article on natural diamond by D.N. Robinson, annotated by Frank, 2 July 1979.
- G.98 Photograph of "man made platelets in diamonds", signed and dated "Trevor Evans 6/5/80".
Invitation to visit Diamond Research Laboratory in January or February 1987 to discuss the results of a study on the "morphology and growth mechanism" of large synthetic diamonds.
- G.99 Note by Frank beginning "What is the magnitude of the absorption coeff[icient] of Diamond betw[een] 2000A and 3000A", 1p manuscript, nd.
"Cutting action, wear and fracture of rounded diamond", 15pp typescript, nd. (latest bibliographical reference 1966). Author not named.

G.100-G.113 GENERAL ELECTRIC (GE) 1951-62

Frank served as occasional consultant in the Metallurgy and Ceramics Research Department of GE's Research Laboratory, Schenectady, NY, under flexible contracts that allowed him scope to attend conferences and visit colleagues in other research establishments. His 1956 consultancy specified he was an advisor on "physics of solids". Exclusion of consulting about diamonds had been informally agreed from the beginning, but in 1962 in view of the South African patents dispute between GE and de Beers, this exclusion was explicitly written into the contract (see G.76-G.86 and G.110).

"There was no formal end to this consultancy. It was put to me that it would be tactful if I deferred my next summer vacation visit (which I had been making every second year) by a year, by which time the patents dispute between GE and de Beers would doubtless be concluded. However, the dispute dragged on and by the time it was over my principal friends at Schenectady, with whom details of the next visit would have been arranged, had moved elsewhere. I did make several visits of one or two days subsequently, at which I was consulted on various scientific questions (one of which might have led to something patentable, but didn't) but never for long enough to receive payment." (F.C.F., private communication, 9 September 1989).

G.100, G.101 1956 May-September.

During this extensive consultancy with GE Frank attended a number of conferences in North America (see H.26, H.27).

G.100 Copy of consultancy contract; notice of special seminar on "Liquid crystals : (3)" given by Frank, 11 July; brief correspondence re patent for Magnetic Annealing in Rotating Magnetic Field.

G.101 Miscellaneous memorabilia. For photographs of Frank and colleagues at GE, see A.95.

G.102-G.108 1958.

As in 1956 Frank was able to combine a lengthy consultancy with GE with attendance at a number of conferences and seminars in America (see H.29-H.31).

G.102 Brief correspondence; copy of consultancy contract; notices of GE Research Laboratory seminars and colloquia etc. Frank gave seminars on 5 and 11 September on "Kinematic theory of crystal dissolution and growth" and "Coincidence Lattices - sub-boundaries and Kronberg-Wilson relationships".

- G.103 Memorabilia.
- G.104-G.108 Miscellaneous manuscript and typescript drafts and notes by Frank found with material re 1958 consultancy.
- G.104 "Layering in the higher coordination structures", 11pp typescript with manuscript corrections plus figures.
- G.105 "The geometrical basis of structures of intermetallic compounds", 2pp typescript plus figures.
"Detailed geometry of the four special coordination shells", 5pp manuscript and 3pp typescript drafts.
- G.106 "Some definitions relating to coordination", 5pp manuscript and 2pp typescript drafts.
"Properties of regular solids", 1p duplicated typescript plus tables.
- G.107, G.108 Manuscript notes and diagrams chiefly re lattices.
- G.109 1960.
Correspondence from J.H. Hollomon, 1960 re possibility of Frank visiting Schenectady laboratories, etc.
- G.110-G.113 1962.
- G.110 Letter re "Consulting Agreement Between General Electric Company and F.C. Frank", 9 August 1962.
To avoid a conflict of interests between Frank's consultancies for GE and De Beers it was agreed that the terms of the GE consultancy should exclude diamond research.
- G.111 Includes *Research Laboratory Notes* for 22 August 1962 mentioning Frank's seminar "A commentary on theorems concerning crystal surface energies".

- G.112 Includes press release, 7 September, re "A new 'direct process' for making diamonds".
- According to the press release "... it has become possible to achieve pressures and temperatures so high that the metal catalyst is no longer needed" to convert non-diamond carbon into diamond.
- G.113 Calculations by Frank found with preceding material. Includes 5pp manuscript calculation of a "Problem: Of random paths which cross a plane, how many do not re-cross it?"
- G.114 IMPERIAL CHEMICAL INDUSTRIES (ICI) 1974-75
- Frank's consultancy with ICI was terminated in July 1975.
- Brief correspondence includes Frank's comments on ICI's "dairy-separator version of the gas centrifuge", 1974.
- G.115-G.122 INTERNATIONAL BUSINESS MACHINES CORPORATION (IBM) 1973-82
- Frank served as occasional consultant to IBM at their Thomas J. Watson Research Center, Yorktown Heights, NY, combining short spells at the Center with visits to colleagues at other research centres, and attendance at conferences, in the US and Canada.
- G.115 1973.
- Invitation to serve as consultant.
- G.116 1977.
- Invitation, 9 December 1976, suggesting Frank combine attendance at the 1977 International Conference on Crystal Growth, Boston, MA, with consultancy work.

- G.117, G.118 1978.
- G.117 Letter re arrangements etc. See also H.116.
- G.118 IBM Thomas J. Watson Research Center Report "The science of crystal growth", an IBM education course. With Frank's annotations and interleaved manuscript notes.
- G.119, G.120 1980 3-7 November.
- Frank was invited to the Watson Research Center on the occasion of his being made a Foreign Associate of the US National Academy of Engineering (see A.27, H.140-H.142).
- G.119 Correspondence re arrangements; contract; notices of Frank's Physics Colloquium "On definitions of supersaturation"; etc.
- G.120 Correspondence and papers re attempt to obtain permanent US residence for Swiss IBM colleague.
- G.121, G.122 1982 24-28 July
- Frank was invited to the Watson Research Center in conjunction with the 1982 Gordon Research Conference (H.150, H.151).
- G.121 Correspondence re arrangements; contract; itinerary; etc.
- G.122 Contents of folder inscribed "Van Vechten". Includes reprints of two articles, 1977 and 1978, by J.A. Van Vechten, a member of the Research Center, with Frank's manuscript annotations and miscellaneous manuscript notes. Found with G.121.
- G.123 PCI DISPLAYS PTE LTD 1981
- Request from the solicitors of PCI to "review the technical arguments concerning the novelty, inventiveness or otherwise of the [Hoffman La] Roche patent" covering "the so-called Schadt-Helfrich twisted nematic liquid crystal display", 2 September. With photocopy of the patent specification.

- G.124-G.130 J.A. RADLEY (LABORATORIES) LTD 1960-63
(later J.A. RADLEY RESEARCH INSTITUTE)
- The Radley Laboratories were a commercial research company started "to cater for small firms ... who were, individually, not in a position to set up their own laboratories". Frank was initially asked to become a consultant in connection with work being done on metal whiskers and crystal structure in April 1960. He later became a co-opted governor of the Institute.
- G.124 Correspondence re consultancy, April 1960; booklet "An introduction to Radley Industrial Research and Development Laboratories".
- G.125 Notice of formation of Radley Research Institute 1961; annual reports 1959-60 and 1961-62; Chairman's interim progress report, 6 September 1961; agenda for first AGM of Board of Governors, 10 April 1962.
- G.126 Letter to Frank, 23 January 1963, including list of "ideas for research proposals".
- G.127-G.130 Radley Laboratories/Research Institute Final Technical Reports:
- G.127 "The effect of sugars and other hydroxy compounds as inhibitors of corrosion ... ", 1958.
- G.128 "General mechanism of drainage from solid surfaces", 1959.
- G.129 "Mechanism of corrosion of copper and copper alloys by ammonia solutions ... ", 1959.
- G.130 "Catalysis at semi-conductor surfaces", 1962.