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NASA PATENT ABSTRACTS
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INTRODUCTION

Several thousand inventions result each year from the aeronautical and space research supported by the National Aeronautics and Space Administration. The inventions having important use in government programs or significant commercial potential are usually patented by NASA. These inventions cover practically all fields of technology and include many that have useful and valuable commercial application.

NASA inventions best serve the interests of the United States when their benefits are available to the public. In many instances, the granting of nonexclusive or exclusive licenses for the practice of these inventions may assist in the accomplishment of this objective. This bibliography is published as a service to companies, firms, and individuals seeking new, licensable products for the commercial market.

The NASA Patent Abstracts Bibliography (NASA PAB) is a semiannual NASA publication containing comprehensive abstracts and indexes of NASA-owned inventions covered by U.S. patents and applications for patent. The citations included in NASA PAB were originally published in NASA's Scientific and Technical Aerospace Reports (STAR) and cover STAR announcements made since May 1969.

For the convenience of the user, each issue of NASA PAB has a separately bound Abstract Section (Section 1) and Index Section (Section 2). Although each Abstract Section covers only the indicated six-month period, the Index Section is cumulative covering all NASA-owned inventions announced in STAR since 1969. Thus a complete set of NASA PAB would consist of the Abstract Sections of Issue 04 (January 1974) and Issue 12 (January 1978) and the Abstract Section for all subsequent issues and the Index Section for the most recent issue.

The 131 citations published in this issue of the Abstract Section cover the period July 1993 through December 1993. The Index Section references over 5500 citations covering the period May 1969 through December 1993.

ABSTRACT SECTION (SECTION 1)

This PAB issue includes 10 major subject divisions separated into 76 specific categories and one general category/division. (See Table of Contents for the scope note of each category, under which are grouped appropriate NASA inventions.) This scheme was devised in 1975 and revised in 1987 in lieu of the 34 category divisions which were utilized in PAB supplements (01) through (06) covering STAR abstracts from May 1969 through January 1974. Each entry in the Abstract Section consists of a STAR citation accompanied by an abstract and, when appropriate, a key illustration taken from the patent or application for patent. Entries are arranged by subject category in order of the ascending NASA Accession Number originally assigned for STAR to the invention. The range of NASA Accession Numbers within each issue is printed on the inside front cover.

Abstract Citation Data Elements: Each of the abstract citations has several data elements useful for identification and indexing purposes, as follows:

NASA Accession Number
NASA Case Number
Inventor's Name
Title of Invention
U.S. Patent Application Serial Number
U.S. Patent Number (for issued patents only)
U.S. Patent Office Classification Number(s)
(for issued patents only)

These data elements are identified in the Typical Citation and Abstract and in the indexes.
INDEX SECTION (SECTION 2)

The Index Section is divided into five indexes. These indexes are cross-indexed and are used to locate a single invention or groups of inventions.

**Subject Index:** Lists all inventions according to appropriate alphabetized technical term and indicates the related NASA Case Number, the Subject Category Number, and the Accession Number.

**Inventor Index:** Lists all inventions according to alphabetized names of inventors and indicates the related NASA Case Number, the Subject Category Number, and the Accession Number.

**Source Index:** Lists all inventions according to alphabetized source of invention (i.e., name of contractor or government installation where invention was made) and indicates the related NASA Case Number, the Subject Category Number, and the Accession Number.

**Number Index:** Lists inventions in order of ascending (1) NASA Case Number, (2) U.S. Patent Application Serial number, (3) U.S. Patent Classification Number, and (4) U.S. Patent Number and indicates the related Subject Category Number and the Accession Number.

**Accession Number Index:** Lists all inventions in order of ascending Accession Number and indicates the related Subject Category Number, the NASA Case Number, the U.S. Patent Application Serial Number, the U.S. Patent Classification Number, and the U.S. Patent Number.

HOW TO USE THIS PUBLICATION TO IDENTIFY NASA INVENTIONS

To identify one or more NASA inventions within a specific technical field or subject, several techniques are possible with the flexibility incorporated into the NASA PAB.

1. **Using Subject Category:** To identify all NASA inventions in any one of the subject categories in this issue of NASA PAB, select the desired Subject Category in the Abstract Section (Section 1) and find the inventions abstracted thereunder.

2. **Using Subject Index:** To identify all NASA inventions listed under a desired technical subject index term, (A) turn to the cumulative Subject Index in the Index Section and find the invention(s) listed under the desired technical subject term. (B) Note the indicated Accession Number and the Subject Category Number. (C) Using the indicated Accession Number, turn to the inside front cover of the Index Section to determine which issue of the Abstract Section includes the Accession Number desired. (D) To find the abstract of the particular invention in the issue of the Abstract Section selected, (1) use the Subject Category Number to locate the Subject Category and (2) use the Accession Number to locate the desired invention within the Subject Category listing.

3. **Using Patent Classification Index:** To identify all inventions covered by issued NASA patents (not including applications for patent) within a desired Patent Classification, (A) turn to the Patent Classification Number in the Number Index of Section 2 and find the associated invention(s), and (B) follow the instructions outlined in (2)(B), and (D) above.
A virtual reality flight control system displays to the pilot the image of a scene surrounding a vehicle or pod having six degrees of freedom of acceleration or velocity control by the pilot and traveling through inertial space, the image itself including a superimposed figure providing the pilot an instant reference of orientation consisting of superimposed sets of geometric figures whose relative orientations provide the pilot an instantaneous feel or sense of orientation changes with respect to some fixed coordinate system. They include a first set of geometric figures whose orientations are fixed to the pilot's vehicle and a second set of geometric figures whose orientations are fixed with respect to a fixed or interstellar coordinate system. The first set of figures is a first set of orthogonal great circles about the three orthogonal axes of the flight vehicle or pod and centered at and surrounding the pilot's head, while the second set of figures is a second set of orthogonal great circles about the three orthogonal axes of a fixed or interstellar coordinate system, also centered at and surrounding the pilot's head.

NASA
Subject Categories
(1969-1973)

01 Aerodynamics
Includes aerodynamics of bodies, combinations, internal flow in ducts and turbomachinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft; and 32 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.

02 Aircraft
Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc.; and specific types of complete aircraft; e.g., ground effect machines, STOL, and VTOL; flight tests; operating problems; e.g., sonic boom; safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

03 Auxiliary Systems
Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

04 Biosciences
Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

05 Biotechnology
Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation; and piloting. For related information see also: 04 Biosciences.

06 Chemistry
Includes chemical analysis and identification; e.g., spectroscopy. For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

07 Communications
Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

08 Computers
Includes computer operation and programming; and data processing. For applications, see specific categories. For related information see also: 19 Mathematics.

09 Electronic Equipment
Includes electronic test equipment and maintainability; component parts; e.g., electron tubes, tunnel diodes, transistors, integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications; and 21 Navigation.

10 Electronics
Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see specific Physics categories.

11 Facilities, Research and Support
Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities; e.g., rocket engine test stands, shock tubes, and wind tunnels; test ranges; and tracking stations.

12 Fluid Mechanics
Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

13 Geophysics
Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

14 Instrumentation and Photography
Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gauges; recorders, transducers; aerial photography; and telescopes and cameras.

15 Machine Elements and Processes
Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control; reliability; drafting; and materials fabrication, handling, and inspection.

16 Masers
Includes applications of masers and lasers. For basic research see: 26 Physics, Solid-State.

17 Materials, Metallic
Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

18 Materials, Nonmetallic
Includes corrosion; physical and mechanical properties of materials; e.g., plastics; and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.
19 Mathematics
Includes calculation methods and theory; and numerical analysis. For applications see specific categories. For related information see also: 08 Computers.

20 Meteorology
Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

21 Navigation
Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

22 Nuclear Engineering
Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

23 Physics, General
Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

24 Physics, Atomic, Molecular, and Nuclear
Includes atomic, molecular and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

25 Physics, Plasma
Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

26 Physics, Solid-State
Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

27 Propellants
Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

28 Propulsion Systems
Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

29 Space Radiation
Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

30 Space Sciences
Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbits and trajectories. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

31 Space Vehicles
Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

32 Structural Mechanics
Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

33 Thermodynamics and Combustion
Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

34 General
Includes information of a broad nature related to industrial applications and technology, and to basic research; defense aspects; information retrieval; management; law and related legal matters; and legislative hearings and documents.
# TABLE OF CONTENTS

Revised Subject Categories
(Includes 1974 and 1987 revisions)

AERONAUTICS For related information see also Astronautics.

## 01 AERONAUTICS (GENERAL)

### 02 AERODYNAMICS
Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery. For related information see also 34 Fluid Mechanics and Heat Transfer.

### 03 AIR TRANSPORTATION AND SAFETY
Includes passenger and cargo air transport operations; and aircraft accidents. For related information see also 16 Space Transportation and 85 Urban Technology and Transportation.

### 04 AIRCRAFT COMMUNICATIONS AND NAVIGATION
Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control. For related information see also 17 Space Communications, Spacecraft Communications, Command and Tracking and 32 Communications and Radar.

### 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE
Includes aircraft simulation technology. For related information see also 18 Spacecraft Design, Testing and Performance and 39 Structural Mechanics. For land transportation vehicles see 85 Urban Technology and Transportation.

### 06 AIRCRAFT INSTRUMENTATION
Includes cockpit and cabin display devices; and flight instruments. For related information see also 19 Spacecraft Instrumentation and 35 Instrumentation and Photography.

### 07 AIRCRAFT PROPULSION AND POWER
Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft. For related information see also 20 Spacecraft Propulsion and Power, 28 Propellants and Fuels, and 44 Energy Production and Conversion.

### 08 AIRCRAFT STABILITY AND CONTROL
Includes aircraft handling qualities; piloting; flight controls; and autopilots. For related information see also 05 Aircraft Design, Testing and Performance.

### 09 RESEARCH AND SUPPORT FACILITIES (AIR)
Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands. For related information see also 14 Ground Support Systems and Facilities (Space).

ASTRONAUTICS For related information see also Aeronautics.

## 12 ASTRONAUTICS (GENERAL)
For extraterrestrial exploration see 91 Lunar and Planetary Exploration.

### 13 ASTRODYNAMICS
Includes powered and free-flight trajectories; and orbital and launching dynamics.

### 14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)
Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators. For related information see also 09 Research and Support Facilities (Air).

### 15 LAUNCH VEHICLES AND SPACE VEHICLES
Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles. For related information see also 20 Spacecraft Propulsion and Power.

### 16 SPACE TRANSPORTATION
Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques. For related information see also 03 Air Transportation and Safety and 18 Spacecraft Design, Testing and Performance. For space suits see 54 Man/System Technology and Life Support.

### 17 SPACE COMMUNICATIONS, SPACECRAFT COMMUNICATIONS, COMMAND AND TRACKING
Includes telemetry, space communications networks; astronavigation and guidance; and radio blackout. For related information see also 04 Aircraft Communications and Navigation and 32 Communications and Radar.
18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE
Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls. For life support systems see 54 Man/System Technology and Life Support. For related information see also 05 Aircraft Design, Testing and Performance, 39 Structural Mechanics, and 16 Space Transportation.

19 SPACECRAFT INSTRUMENTATION
For related information see also 06 Aircraft Instrumentation and 35 Instrumentation and Photography.

20 SPACECRAFT PROPULSION AND POWER
Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxiliary power sources. For related information see also 07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion, and 15 Launch Vehicles and Space Vehicles.

CHEMISTRY AND MATERIALS

23 CHEMISTRY AND MATERIALS (GENERAL)

24 COMPOSITE MATERIALS
Includes physical, chemical, and mechanical properties of laminates and other composite materials. For ceramic materials see 27 Nonmetallic Materials.

25 INORGANIC AND PHYSICAL CHEMISTRY
Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry. For related information see also 77 Thermodynamics and Statistical Physics.

26 METALLIC MATERIALS
Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

27 NONMETALLIC MATERIALS
Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials. For composite materials see 24 Composite Materials.

28 PROPELLANTS AND FUELS
Includes rocket propellants, igniters and oxidizers; their storage and handling procedures; and aircraft fuels. For related information see also 07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power, and 44 Energy Production and Conversion.

29 MATERIALS PROCESSING
Includes space-based development of products and processes for commercial application. For biological materials see 55 Space Biology.

ENGINEERING For related information see also Physics.

31 ENGINEERING (GENERAL)
Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

32 COMMUNICATIONS AND RADAR
Includes radar; land and global communications; communications theory; and optical communications. For related information see also 04 Aircraft Communications and Navigation and 17 Space Communications, Spacecraft Communications, Command and Tracking. For search and rescue see 03 Air Transportation and Safety and 16 Space Transportation.

33 ELECTRONICS AND ELECTRICAL ENGINEERING
Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry. For related information see also 60 Computer Operations and Hardware and 76 Solid-State Physics.

34 FLUID MECHANICS AND HEAT TRANSFER
Includes boundary layers; hydrodynamics; fluidics; mass transfer and ablation cooling. For related information see also 02 Aerodynamics and 77 Thermodynamics and Statistical Physics.

35 INSTRUMENTATION AND PHOTOGRAPHY
Includes remote sensors; measuring instruments and gauges; detectors; cameras and photographic supplies; and holography. For aerial photography see 43 Earth Resources and Remote Sensing. For related information see also 06 Aircraft Instrumentation and 19 Spacecraft Instrumentation.

36 LASERS AND MASERS
Includes parametric amplifiers. For related information see also 76 Solid-State Physics.
37 MECHANICAL ENGINEERING
Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

38 QUALITY ASSURANCE AND RELIABILITY
Includes product sampling procedures and techniques; and quality control.

39 STRUCTURAL MECHANICS
Includes structural element design and weight analysis; fatigue; and thermal stress. For applications see 05 Aircraft Design, Testing and Performance and 18 Spacecraft Design, Testing and Performance.

GEOSCIENCES For related information see also Space Sciences.

42 GEOSCIENCES (GENERAL)

43 EARTH RESOURCES AND REMOTE SENSING
Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography. For instrumentation see 35 Instrumentation and Photography.

44 ENERGY PRODUCTION AND CONVERSION
Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower. For related information see also 07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power, and 28 Propellants and Fuels.

45 ENVIRONMENT POLLUTION
Includes atmospheric, noise, thermal, and water pollution.

46 GEOPHYSICS
Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism. For space radiation see 93 Space Radiation.

47 METEOROLOGY AND CLIMATOLOGY
Includes weather forecasting and modification.

48 OCEANOGRAPHY
Includes biological, dynamic, and physical oceanography; and marine resources. For related information see also 43 Earth Resources and Remote Sensing.

LIFE SCIENCES

51 LIFE SCIENCES (GENERAL)

52 AEROSPACE MEDICINE
Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

53 BEHAVIORAL SCIENCES
Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT
Includes human engineering; biotechnology; and space suits and protective clothing. For related information see also 16 Space Transportation.

55 SPACE BIOLOGY
Includes exobiology; planetary biology; and extraterrestrial life.

MATHEMATICAL AND COMPUTER SCIENCES

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

60 COMPUTER OPERATIONS AND HARDWARE
Includes hardware for computer graphics, firmware, and data processing. For components see 33 Electronics and Electrical Engineering.

61 COMPUTER PROGRAMMING AND SOFTWARE
Includes computer programs, routines, algorithms, and specific applications, e.g., CAD/CAM.

62 COMPUTER SYSTEMS
Includes computer networks and special application computer systems.
63 CYBERNETICS
Includes feedback and control theory, artificial intelligence, robotics and expert systems. For related information see also 54 Man/System Technology and Life Support.

64 NUMERICAL ANALYSIS
Includes iteration, difference equations, and numerical approximation.

65 STATISTICS AND PROBABILITY
Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

66 SYSTEMS ANALYSIS
Includes mathematical modeling; network analysis; and operations research.

67 THEORETICAL MATHEMATICS
Includes topology and number theory.

PHYSICS For related information see also Engineering.

70 PHYSICS (GENERAL)
For precision time and time interval (PTTI) see 35 Instrumentation and Photography; for geophysics, astrophysics or solar physics see 46 Geophysics, 90 Astrophysics, or 92 Solar Physics.

71 ACOUSTICS
Includes sound generation, transmission, and attenuation. For noise pollution see 45 Environment Pollution.

72 ATOMIC AND MOLECULAR PHYSICS
Includes atomic structure, electron properties, and molecular spectra.

73 NUCLEAR AND HIGH-ENERGY PHYSICS
Includes elementary and nuclear particles; and reactor theory. For space radiation see 93 Space Radiation.

74 OPTICS
Includes light phenomena and optical devices. For lasers see 36 Lasers and Masers.

75 PLASMA PHYSICS
Includes magnetohydrodynamics and plasma fusion. For ionospheric plasmas see 46 Geophysics. For space plasmas see 90 Astrophysics.

76 SOLID-STATE PHYSICS
Includes superconductivity. For related information see also 33 Electronics and Electrical Engineering and 36 Lasers and Masers.

77 THERMODYNAMICS AND STATISTICAL PHYSICS
Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics. For related information see also 25 Inorganic and Physical Chemistry and 34 Fluid Mechanics and Heat Transfer.

SOCIAL SCIENCES

80 SOCIAL SCIENCES (GENERAL)
Includes educational matters.

81 ADMINISTRATION AND MANAGEMENT
Includes management planning and research.

82 DOCUMENTATION AND INFORMATION SCIENCE
Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography. For computer documentation see 61 Computer Programming and Software.

83 ECONOMICS AND COST ANALYSIS
Includes cost effectiveness studies.

84 LAW, POLITICAL SCIENCE AND SPACE POLICY
Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

85 URBAN TECHNOLOGY AND TRANSPORTATION
Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation. For related information see 03 Air Transportation and Safety, 16 Space Transportation, and 44 Energy Production and Conversion.
SPACE SCIENCES  For related information see also Geosciences.

88 SPACE SCIENCES (GENERAL)

89 ASTRONOMY
Include radio, gamma-ray, and infrared astronomy; and astrometry.

90 ASTROPHYSICS
Include cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also 75 Plasma Physics.

91 LUNAR AND PLANETARY EXPLORATION
Include planetology; and manned and unmanned flights. For spacecraft design or space stations see 18 Spacecraft Design, Testing and Performance.

92 SOLAR PHYSIC
Include solar activity, solar flares, solar radiation and sunspots. For related information see 93 Space Radiation.

93 SPACE RADIATION
Include cosmic radiation; and inner and outer earth's radiation belts. For biological effects of radiation see 52 Aerospace Medicine. For theory see 73 Nuclear and High-Energy Physics.

GENERAL
Include aeronautical, astronautical, and space science related histories, biographies, and pertinent reports too broad for categorization; histories or broad overviews of NASA programs.

99 GENERAL

Section 2 • Indexes

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Additive for the nuclei of electric automobiles
[NASA-CASE-LEW-13286-1] c 33 N84-14422

ELECTRIC BATTERIES

Spacecraft battery seals
[NASA-CASE-XMF-20564-1] c 27 N93-29669
Batteries -- electric
[NASA-CASE-LEW-13286-1] c 33 N84-14422

FAVITE (MATERIALS)

Fastener apparatus Patent
- NASA-CASE-ARC-10140-1  c 15 N71-17653
- Methods and apparatus employing vibratory energy for wear-resistant tooling Patent
- NASA-CASE-MFS-20586-1  c 15 N71-17686
- Coaxial cable connector Patent
- NASA-CASE-PAD-04731-1  c 15 N71-20851
- Latching mechanism Patent
- NASA-CASE-XMS-03707-1  c 15 N71-21076
- Taperlock fastening apparatus Patent
- NASA-CASE-XFR-05302-1  c 15 N71-22534
- Flexibly connected support and skin Patent
- NASA-CASE-XMS-01077-1  c 15 N79-33467
- One-step dual purpose joining technique
- NASA-CASE-LAR-12555-1  c 33 N82-26571
- Reusable captive blind fastener
- NASA-CASE-MSC-18742-1  c 37 N82-26573
- Dazl fasteners
- NASA-CASE-LAR-13009-1  c 37 N85-29258
- Mechanical fastener
- NASA-CASE-PAD-12738-2  c 37 N85-30235
- Dazl fasteners
- NASA-CASE-LIR-32099-1  c 37 N87-22976
- NASA-CASE-MSC-21354-1  c 37 N88-24969
- Double oval-lgg toggle release
- NASA-CASE-GSC-12300-1  c 37 N90-21900
- Overcenter collet station tool fastener
- NASA-CASE-MSC-21504-1  c 38 N91-21221
- Two-fault tolerant toggle hook release
- NASA-CASE-MSC-21671-1  c 39 N91-24958
- Liquid food feed system
- NASA-CASE-LAR-13009-2  c 39 N92-21500
- Metallic threaded composite fastener
- NASA-CASE-MSC-21560-1  c 39 N92-21726
- Quick-connect fasteners for assembling devices in space
- NASA-CASE-MSC-21648-1  c 39 N92-24051
- Work attachment mechanism/attachment fixture
- NASA-CASE-GSC-13430-1  c 39 N93-14712
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- NASA-CASE-LAR-14542-1  c 39 N93-22384
- Quick connect fastener
- NASA-CASE-MSC-28833-1  c 39 N93-29484

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Strain gage servo control system Patent
- NASA-CASE-XLA-08530-1  c 32 N91-25360
- TV fatigue crack monitoring system
- NASA-CASE-LEF-11490-1  c 39 N98-15387
- Fatigue LIFE

Fatigue-resistant shear pin
- NASA-CASE-MSS-10122-1  c 15 N69-27505
- Method of improving the reliability of a rolling element system Patent
- NASA-CASE-XLE-02999-1  c 15 N71-16052
- High speed rolling element bearing
- NASA-CASE-LEW-10586-1  c 15 N72-24960
- High speed rolling element bearing comprising a fluid bearing
- NASA-CASE-LEW-11152-1  c 15 N72-22559
- Method for use in monitoring fatigue life for a plurality of elastomeric specimens
- NASA-CASE-NPO-12731-1  c 15 N89-18409
- Fatigue TESTING MACHINES

Horizontal cryostat for fatigue testing Patent
- NASA-CASE-XLA-01782-1  c 14 N71-24234
- Light shield and infrared reflector for fatigue testing Patent
- NASA-CASE-XLA-01734-1  c 14 N71-26136
- Fatigue testing a plurality of test specimens and method
- NASA-CASE-MFS-28118-1  c 14 N87-25601
- Fatigue TESTS

Fatigue testing device Patent
- NASA-CASE-XLA-01231-1  c 32 N70-42000
- Fatigue testing head indicator
- NASA-CASE-LAR-12072-1  c 39 N79-22537
- Heating and cooling system — for fatigue test specimens
- NASA-CASE-LAR-12383-1  c 34 N83-34221
- Fatigue testing apparatus
- NASA-CASE-LAR-14542-1  c 35 N90-25372
- Furnace for tensile/fatigue testing
- NASA-CASE-LEW-14458-1  c 14 N91-21715
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Oil and fat absorbing polymers
- NASA-CASE-NPO-11609-2  c 27 N77-31308
- Pulse-type magnetic core memory element circuit with blocking oscillator feedback Patent
- NASA-CASE-XGS-02030-1  c 08 N71-18595
- Dynamic decoder Patent
- NASA-CASE-XKS-06167-1  c 06 N71-24890
- Dc motor speed control system Patent
- NASA-CASE-MFS-08985-1  c 09 N71-28866
- Sampled data controller Patent
- NASA-CASE-NPO-10700-1  c 07 N71-33613
- A dc servovalve including an ac controller Patent
- NASA-CASE-LAR-10682-1  c 02 N73-26004
- Regulated dc-to-dc converter for voltage step-up or step-down with intrinsic isolation
- NASA-CASE-HON-10792-1  c 33 N74-11049
- Diffused waveguiding capillary tube with distributed feed gas for a gas lens
- NASA-CASE-NPO-13544-1  c 36 N76-18624
- The dc-to-dc converters employing staggered-phase power switches with two-loop control
- NASA-CASE-NPO-15121-1  c 33 N77-10428
- System and method for tracking a signal source — employing feedback control
- NASA-CASE-LEW-11981-1  c 31 N78-17237
- Power range microfiber feedback controller
- NASA-CASE-GSC-12146-1  c 33 N82-32340
- Active notch filter network with notch bandwidth, width and frequency
- NASA-CASE-FRC-11055-1  c 33 N80-29583
- Variable speed drive
- NASA-CASE-GSC-12194-1  c 37 N83-29078
- Tuned analog network
- NASA-CASE-GSC-12655-1  c 33 N84-14442
- Three-phase phase factor controller
- NASA-CASE-MFS-25335-2  c 33 N88-22985
- Three-phase phase factor controller with induced EMF sensing
- NASA-CASE-MFS-25852-1  c 33 N88-33561
- Improved method and apparatus for testing complex systems
- NASA-CASE-NPO-15553-1  c 33 N85-29142
- Microfiber optic feedback system with heat feedback
- NASA-CASE-LAR-12785-1  c 37 N91-21824
- Feedback controlled optics with wavefront compensation
- NASA-CASE-GSC-12346-1  c 37 N92-29099
- Ultra-high temperature stability Joule-Thomson cooler with capability to accommodate temperature variations
- NASA-CASE-NPO-18148-1  c 35 N92-26883
FOSSIL FUELS

Solar cell with improved N-region contact and method of forming the same
[NASA-CASE-NPO-14205-1] c 44 N79-31752
Measurement of transmitting producing concentric hollow spheres -- internal confinement fusion targets
[NASA-CASE-NPO-14596-1] c 31 N83-32119
Process for producing tetrafluoroethylene tubing
[NASA-CASE-MSC-18340-1] c 37 N82-24941
Sphere forming method and apparatus
[NASA-CASE-NPO-15070-1] c 31 N83-35176
Method of fabricating composite structures
[NASA-CASE-MFS-28390-1] c 24 N91-13333

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Superconductive solid state reactor
[NASA-CASE-NPO-15210-1] c 25 N84-22709

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Expansible support means
[NASA-CASE-NPO-11059] c 15 N72-17454
Adjustable securing base
[NASA-CASE-MSC-19666-1] c 37 N78-17383
Station erectable manipulator placement system
[NASA-CASE-MSC-21096-1] c 18 N89-12621

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Continuous Fourier transform method and apparatus -- for the analysis of simultaneous analog signal components
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Remotely controllable real-time optical processor
[NASA-CASE-NPO-18750-1-CU] c 74 N88-14078

FRACTIONATION

Measuring apparatus for dissolution of liquids. Patent
[NASA-CASE-XNP-08124] c 15 N71-27184
Electrophoretic fractional elution apparatus employing a rotatory column
[NASA-CASE-MFS-22384-1] c 37 N80-14397
Electrophoresis device
Spillgate detector for liquid chromatography systems
[NASA-CASE-MSC-20260-1] c 25 N86-27431
Automatic fractionation separation method

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Process for positioning and loading a test specimen
[NASA-CASE-XLE-01300] c 15 N70-41993
Remote controllable real-time optical processor
[NASA-CASE-ARC-10466-1] c 60 N75-13539

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Controlling oscillator with a time dependent output frequency
[NASA-CASE-NPO-11982-1] c 33 N74-35801
High efficiency multifrequency feed
[NASA-CASE-GSC-11909] c 32 N74-20863
Modified fast frequency acquisition by adaptive least squares algorithm
[NASA-CASE-NPO-17845-2-CU] c 61 N93-14882

FREQUENCY DIVIDERS

Digital frequency discriminator Patent
[NASA-CASE-MFS-14322] c 08 N69-18692
Broadband frequency discriminator Patent
[NASA-CASE-RSC-10387] c 07 N71-27069
Continuous Fourier transform method and apparatus -- for the analysis of simultaneous analog signal components
[NASA-CASE-ARC-10466-1] c 60 N75-13539
Frequency discriminator and phase detector circuit
[NASA-CASE-ARC-11515-1] c 33 N77-13315
Vibration analyzer
[NASA-CASE-MSC-21480-1] c 37 N91-14607

FREQUENCY CONNECTORS

Bus pass compensation circuit for controlling direct current motor
[NASA-CASE-XMS-04215-1] c 08 N69-39987
Variable frequency magnetic multivibrator Patent
[NASA-CASE-XGS-00458] c 30 N70-38604
Variable frequency magnetic multivibrator Patent
[NASA-CASE-XGS-01031] c 60 N70-38995
Automatic frequency discriminators and control for a phase-lock loop providing frequency preselected Patent
[NASA-CASE-XMF-08665] c 37 N71-19487
Linear accelerator frequency control system Patent
[NASA-CASE-XGS-05441] c 10 N66-22962
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[NASA-CASE-XNP-09771] c 06 N71-24841
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[NASA-CASE-NPO-11711-1] c 33 N74-11462
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[NASA-CASE-XMF-10830] c 32 N74-19790
Accoustically controlled distributed feedback laser
[NASA-CASE-NPO-13175-1] c 36 N75-31427
Reflex feed system for dual frequency antenna with frequency cutoff means
[NASA-CASE-NPO-14022-1] c 32 N78-31321
Cam-operated pitch-change apparatus Patent
[NASA-CASE-LEW-13050-1] c 60 N79-14095
Digital numerically controlled oscillator Patent
[NASA-CASE-MSC-19747-1] c 33 N81-13749
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[NASA-CASE-MSC-19747-1] c 33 N81-13749
Standard frequency
[NASA-CASE-GSC-12228-1] c 33 N79-10338

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Technique for extending frequency range of digital standards
[NASA-CASE-NPO-13836-1] c 32 N78-15323
Method and apparatus for measuring frequency and phase difference
[NASA-CASE-ARC-10466-1] c 60 N75-13539
Frequency domain laser velocimeter signal processor
[NASA-CASE-LAR-12552-1-CU] c 33 N89-14385
Frequency measurement by coincidence detection with standard frequency
[NASA-CASE-MSC-11449-1] c 33 N76-16331
Time domain phase measuring apparatus
[NASA-CASE-ARC-12228-1] c 37 N78-10338
Method and apparatus for measuring frequency and phase difference
[NASA-CASE-XGS-00865-1] c 32 N87-18692
Programmable electronic synthesized capacitance compensation Patent
[NASA-CASE-MSC-20865-1] c 32 N87-18692

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Accelerometer with FM output Patent
[NASA-CASE-XMS-00402] c 14 N70-34799
Means for generating a sync signal in an FM communication system Patent
[NASA-CASE-XMF-11036-1] c 37 N71-11281
Bi-carrier demodulator with modulation Patent
[NASA-CASE-XMF-01160] c 37 N71-11298
Modulator having overlapping rector lobes on parallel axes Patent
[NASA-CASE-XGS-05715] c 32 N71-16100

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PN lock indicator for dithered PN code tracking loop
[NASA-CASE-NPO-14453-1] c 33 N81-33405
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[NASA-CASE-NPO-25201-1] c 35 N88-23966

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Antenna system using parasitic elements and two driven elements at 90 deg angle fed 180 deg out of phase Patent
[NASA-CASE-XLA-00544-1] c 07 N70-36200
Variable frequency oscillator with temperature compensation Patent
[NASA-CASE-XNP-02986] c 09 N71-28610
Ultra stable frequency distribution system
[NASA-CASE-NPO-13836-1] c 32 N78-15323
Method and apparatus for frequency spectrum analysis
[NASA-CASE-NPO-17759-1-CU] c 32 N92-29124

FREQUENCY DIVIDERS

Low phase noise digital frequency divider
[NASA-CASE-NPO-11569] c 10 N73-26229
Technique for extending the frequency range of digital dividers
[NASA-CASE-LAR-10730-1] c 33 N74-10223
Symmetrical odd-modulus frequency divider
[NASA-CASE-NPO-13426-1] c 32 N73-31320

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Satellite communication system and method Patent
[NASA-CASE-GSC-11018-1] c 37 N71-24621
Frequency division multiplex technique
[NASA-CASE-KSC-10501-1] c 37 N73-20176

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Accelerometer with FM output Patent
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Means for generating a sync signal in an FM communication system Patent
[NASA-CASE-XMF-11036-1] c 37 N71-11281

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Multiple varactor frequency doubler Patent
[NASA-CASE-XNP-02986] c 09 N71-28610
Open loop digital frequency multiplier
[NASA-CASE-MSC-12709-1] c 33 N77-24375
GLASS ELECTRODES
GLASS FIBER REINFORCED PLASTICS
GLASS COATINGS
GLASS
GLANDS (SEALS)

Method of producing a glass fiber-reinforced plastic composite material by reacting polymeric films and glass fibers with a high-temperature fiber insulation material.

GLASS

Method for producing a glass fiber-reinforced plastic composite material by reacting polymeric films and glass fibers with a high-temperature fiber insulation material.

GLASS COATINGS

Method for producing a glass fiber-reinforced plastic composite material by reacting polymeric films and glass fibers with a high-temperature fiber insulation material.

GLASS FIBER REINFORCED PLASTICS

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GLASS COATINGS

Method for producing a glass fiber-reinforced plastic composite material by reacting polymeric films and glass fibers with a high-temperature fiber insulation material.
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Nonintrusive method and apparatus for monitoring the
cure of polymeric materials
INASA-CASE-LAR-13465-1]
c 27 N90-23544
IMPEDANCE MATCHING
Signal multiplexer
INASA-CASE-XGS-011101
c 07 N69-24334
Reflectometer for receiver input impedance match
measurement Patent
INASA-CASE-XNP-10843]
c 07 N71-11267

Radio frequency coaxial high pass filter Patent
INASA-CASE-XGS-014181
c 09 N71-23573
Triaxial antenna Patent
INASA-CASE-XGS-022901
c 07 N71-28809
IMPEDANCE MEASUREMENT
High impedance measuring apparatus Patent
INASA-CASE-XMS-08589-1]
c 09 N71-20569
Apparatus for measuring semiconductor device
resistance
INASA-CASE-NPO-14424-11
c 33 N80-32650
IMPELLERS
Turbomachinery shaft insert
INASA-CASE-MFS-28345-2]
c 37 N89-28842
IMPLANTATION
Telemeter adaptable for implanting in an animal
Patent
INASA-CASE-XAC-05706)
c 05 N71-12342
Magnetic electrical connectors
for
biomedical
percutaneous implants
INASA-CASE-KSC-11030-1]
c 52 N77-25772
Prosthetic
occlusive
device
for
an internal
passageway
INASA-CASE-MFS-25740-1 ]
c 52 N84-11744
IMPLANTED ELECTRODES (BIOLOGY)
Pocket ECG electrode
(NASA-CASE-ARC-11258-1]
c 52 N80-33081
Subcutaneous electrode structure
[NASA-CASE-ARC-11117-1]
c 52 N81-14612
Implantable electrical device
[NASA-CASE-GSC-12560-1]
c 52 N82-29863
IMPLOSIONS
Hypervelocity gun Patent
[NASA-CASE-XAC-05902]
c11 N71-18578
IMPREGNATING
Composite lamination method
[NASA-CASE-LAR-12019-1]
c 24 N78-17150
Insoluble polyelectrolyte and ion-exchange hollow fiber
impregnated therewith
[NASA-CASE-NPO-13530-1]
c 25 N81-17187
High temperature silicon carbide impregnated insulating
fabrics
[NASA-CASE-MSC-18832-1]
c 27 N83-18908
Continuous fiber thermoplastic prepreg
[NASA-CASE-LAR-14459-1]
c 24 N91-15334
Continuous fiber thermoplastic prepreg
[NASA-CASE-LAR-14459-1]
c 24 N93-24597
Vacuum powder injector and method of impregnating
fiber with powder
[NASA-CASE-LAR-14179-1]
c 31 N93-26101
IMPULSE GENERATORS
Percutaneous connector device
[NASA-CASE-KSC-10849-1]
c 52 N77-14738
IMPURITIES
Method of making impurity-type semiconductor electrical
contacts Patent
[NASA-CASE-XMF-01016]
c 26 N71-17818
Method of mitigating titanium impurities effects in p-type
silicon material for solar cells
[NASA-CASE-NPO-14635-1]
c 44 N80-24741
Electromigration process for the purification of molten
silicon during crystal growth
[NASA-CASE-NPO-14831-1]
c 76 N82-30105
IN-FLIGHT MONITORING
System for use in conducting wake investigation for a
wing in flight — differential pressure measurements for
drag investigations
[NASA-CASE-FRC-11024-1)
c 02 N80-28300
INCIDENCE
Method of and means for testing a glancing-incidence
mirror system of an X-ray telescope
[NASA-CASE-MFS-22409-2]
c 74 N78-15880
INCIDENT RADIATION
Solar cell assembly — for use under high intensity
illumination
[NASA-CASE-LEW-11549-1]
c 44 N77-19571
INCLINATION
Hingeless helicopter rotor with improved stability
[NASA-CASE-ARC-10807-1]
c 05 N77-17020
INCLUSIONS
Method and apparatus for thermographically and
quantitatively analyzing a structure for disbonds and/or
inclusions
[NASA-CASE-LAR-14559-1]
c 38 N92-29829
INCOHERENT SCATTERING
Rapidly pulsed, high intensity, incoherent light source
[NASA-CASE-XLE-2529-3]
c 33 N74-20859
INDICATING INSTRUMENTS
Missile stage separation indicator and stage initiator
Patent
INASA-CASE-XLA-00791]
c 03 N70-39930
Inductive liquid level detection system Patent
[NASA-CASE-XLE-01609]
c 14 N71-10500
Apparatus for the determination of the existance or
non-existence of a bonding between two members
Patent
[NASA-CASE-MFS-13686)
c 15 N71-18132

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INDIUM ALLOYS

Hydrogen fire detection system with logic circuit to analyze the spectrum of temporal variations of the optical sections of the hydrogen flame [NASA-CASE-MFS-13130] c 10 N72-17173

INFORMATION FLOW

INFORMATION

INERTIAL PLATFORMS

INERTIAL CONFINEMENT FUSION

INERT ATMOSPHERE

INDUSTRIAL PLANTS

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LASER ANNEALING

LASER ANNEALING
Enhancement of radiation and retention in ferroelectric thin film memory capacitors by post-top electrode anneal treatment
[NASA-CASE-NPO-18551-1-CU] c 33 N93-17277

LASER APPLICATIONS
High power laser apparatus and system
[NASA-CASE-NPO-19529-2] c 36 N75-27364
Fiber distributed feedback laser
[NASA-CASE-NPO-19523-1] c 36 N76-24555
Wideline laser system
[NASA-CASE-MFS-23585-1] c 47 N77-10753
Beam-scan laser Doppler velocimeter employing antiparallel-reflector in the forward direction
[NASA-CASE-ARC-10937-1] c 36 N77-25501
Combined pulsed laser having improved heat conductance
[NASA-CASE-NPO-13147-1] c 36 N77-25502

LASER DETECTORS
LASER DETECTORS
LASER ANNEALING
Discharge axis
LASER ANNEALING
Orthogonal relationship between the probe laser and induced eddy current imaging of a sample

LASER ANNEALING
Beam without perturbation of now fields

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MAGNETOHYDRODYNAMIC FLOW

MAGNETOMETERS

MAGNETOHYDRODYNAMIC GENERATORS

MAGNETOHYDRODYNAMIC FLOW

MAGNETOHYDRODYNAMIC FLOW

MAMMALS

MANEUVERABILITY

MANDRELS

MAN-Computer Interface

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<td>NASA-CASE-LAR-13901-1-NP</td>
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High temperature fiber optic microphone having a pressure-sensing reflective membrane under tensile stress

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Polyimide processing additives

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Polysulfobutylenes

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A tough high performance composite matrix

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Novel polyimides containing cyanobiphenyl ether connecting groups

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Polyimides

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Polymers from trimers of monomeric dioxanes and esters of polyacrylic acids

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POLYMER MATRIX COMPOSITES

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2. Preparation of nadiamide films and coatings
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A process for preparing 1,3-diamino-5-pentafluorosulfanylbenzene and polymers thereof

A process for preparing 1,3-diamino-5-pentafluorosulfanylbenzene and polymers thereof

Polymers of perfluorobutadiene and method of their synthesis

New Condensation polymides containing 1,1,1-Triaryl-2,2,2-Trifluoroethanes and processes for their synthesis

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New Condensation polymides containing 1,1,1-Triaryl-2,2,2-Trifluoroethanes and processes for their synthesis

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Aerospace carbon fiber composites

Lightweight composite structure

Polyimide foils

Thermal insulation materials

Multi-throw assembly for nuclear reactor systems

Medical imaging systems

Non-destructive testing equipment

Nuclear reactor safety systems

Spacecraft heat shield systems

Advanced materials for aerospace applications

Nanotechnology for space exploration

Nanomaterials and nanotechnology

Nanotechnology for renewable energy

Nanotechnology for biotechnology

Nanotechnology for environmental applications

Nanotechnology for materials science
Low pressure process for continuous fiber reinforced polymeric acid resin matrix composite laminates

- NASA-CASE-LAR-14393-1-CU  c 24 N93-29414 Method of remotely characterizing thermal properties of a sample
- NASA-CASE-LAR-13506-3-CU  c 09 N93-11057 Semi-interpenetrating polymer network for tougher and more microcrack-resistant high temperature polymers
- NASA-CASE-LAR-13521-2  c 27 N93-11059 Boundary layer relaminarization device
- NASA-CASE-LAR-14479-1  c 02 N93-11876 Multi-layer light-weight protective coating and method for application
- NASA-CASE-LAR-14448-1  c 27 N93-19112 Method and apparatus for evaluating multilayer objects for imperfections
- NASA-CASE-LAR-14551-1-SB  c 36 N93-12204 Compensated high temperature strain gage

Polyimides containing the cyclobutene-3,4-dione

- NASA-CASE-LAR-14333-1  c 24 N93-13416 Method and apparatus for minimizing multiple degree of freedom vibration transmission between two regions of a structure
- NASA-CASE-LAR-14500-1-CU  c 39 N93-13420 Method of characterizing residual stress in ferromagnetic materials using a pulse humag function of acoustic emission sources
- NASA-CASE-LAR-14299-1  c 26 N93-14705 Low toxicity high temperature PMMA polymers
- NASA-CASE-LAR-14327-1  c 27 N93-14709 Method of forming a multiple layer dielectric and a heat sensitive film therewith
- NASA-CASE-LAR-13678-3  c 35 N93-14714 System for determining the angle of impact of an object on a structure
- NASA-CASE-LAR-14181-1  c 35 N93-17041 Rapid detection and quantification of features such as damage or flaws in composite and metallic structures
- NASA-CASE-LAR-14640-1-CU  c 74 N93-17052 Performance of blasting caps
- NASA-CASE-LAR-13932-1  c 28 N93-18274 Reflected type skin friction meter
- NASA-CASE-LAR-14520-1-SB  c 02 N93-18375 Polyl, 2,4,6-trisiloxane via aromatic nucleophilic displacement
- NASA-CASE-LAR-14440-1  c 23 N93-18833 Integral foil yam insertion and heatup method using inflatable membrane
- NASA-CASE-LAR-14406-1  c 31 N93-18857 Stall disturbance resistance enhancer
- NASA-CASE-LAR-14221-1  c 06 N93-19003 Numerical control fabrication technique for dynamic composite models
- NASA-CASE-LAR-14004-1  c 36 N93-19024 Fiber and apparatus for three dimensional braiding
- NASA-CASE-LAR-13947-1  c 31 N93-9038 Process for applying a superconductive powder to a wide variety of substrates
- NASA-CASE-LAR-14790-1-CU  c 33 N93-9051 Fault tolerant optical backplane
- NASA-CASE-LAR-14785-1  c 74 N93-9052 Underpinning compression vortex attachment device
- NASA-CASE-LAR-14420-1-SB  c 02 N93-19005 High temperature polymer from malodene-acetylene terminated monomers
- NASA-CASE-LAR-14475-1  c 27 N93-19037 Flow rate logging seepage meter
- NASA-CASE-LAR-14853-1  c 35 N93-19328 High speed thin plate fatigue crack monitor
- NASA-CASE-LAR-14816-1-SB  c 39 N93-19328 Method and apparatus for detection and control of precluding in a quartz-dished lens
- NASA-CASE-LAR-14790-1  c 36 N93-19373 Optical fiber strain sensor with improved linearity
- NASA-CASE-LAR-14455-1-SB  c 74 N93-19374 Crosslinked polymers prepared from N-ethyl phenylphthalimide
- NASA-CASE-LAR-14350-1  c 27 N93-19388 Dense optical fiber strain sensor
- NASA-CASE-LAR-14180-1-SB  c 36 N93-19492 Multiple layer dielectric, hot film sensors, and methods of producing same
- NASA-CASE-LAR-14591-1  c 35 N93-19493 Apparatus and method for improving spin recovery on aircraft
- NASA-CASE-LAR-14747-1  c 08 N93-20009 Improved ceramic slip casting technique
- NASA-CASE-LAR-14471-1  c 27 N93-20041 Shuttle Orbiter with telescoping main propulsion unit and payload
- NASA-CASE-LAR-13586-1  c 16 N93-20115 Second combustor injection device

A method of making a single layer multi-color luminescent display

- NASA-CASE-LAR-14811-1-CU  c 33 N93-20119 Inside/anyline ether copolyimers containing phosphate oxide groups
- NASA-CASE-LAR-14251-1  c 27 N93-20567 System for determining the angle of impact of an object on a structure
- NASA-CASE-LAR-14181-1  c 35 N93-20569 Acousticphoresis separation method
- NASA-CASE-LAR-13386-2  c 25 N93-20570 Optical fiber fluorescence
- NASA-CASE-LAR-14525-1-CU  c 74 N93-22008 Swept wing airframe for heat absorption
- NASA-CASE-LAR-13400-1  c 02 N93-22015 Polyamide from bisphenol and amides of diamides
- NASA-CASE-LAR-14327-1  c 44 N93-22033 Method and apparatus for cleaning rubber deposits from airport runways and roadways
- NASA-CASE-LAR-14488-1  c 23 N93-22035 Off surface infrared light visualization

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Thermal shock apparatus Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Arc electrode of graphite with ball tip Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Gas purged dry box glove Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Automatic recording gauge Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Electronic cathode having a brush-like structure and a relatively thick oxide emission coating Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

High temperature ferromagnetic cobalt-amine alloy Powder
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Induction furnace with perforated tungsten foil shielding Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Solenoid for prevention of sealed connected solar cells against open circuits by the use of shunting diode Patent
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Gd-5 pm doped silicon semiconductor composition Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Silicon solar cell with cover glass bonded to cell by metal patent Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Magneto-plasma-dynamic arc thruster Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Airflow control system for supersonic inlets Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Spiral groove seal Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Thermal shock apparatus Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Method of attaching a cover glass to a silicon solar cell Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Multilam summary alarm Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Method of forming superalloys Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Flow angle sensor and read out system Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Shock tube powder dispersing apparatus Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Thermal radiation shielding Patent
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Method of attaching a cover glass to a silicon solar cell Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Rocket engine injector Patent
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Multilam summary alarm Patent
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Method of forming superalloys Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Method of attaching a cover glass to a silicon solar cell Patent
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Multilam summary alarm Patent
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Method of forming superalloys Patent
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Method of attaching a cover glass to a silicon solar cell Patent
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Hand held oscillator Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Method of attaching a cover glass to a silicon solar cell Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Process for glass coating an ion accelerator grid Patent
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Ion beam deflector Patent
[NASA-CASE-XLE-00204-1] c 14 N71-22964

Flue gas treatment Patent
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Heat exchanger Patent
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Twisted multilamin superconductor Patent
[NASA-CASE-LEW-00204-1] c 26 N73-26752

Ophthalmic method and apparatus Patent
[NASA-CASE-LEW-00204-1] c 26 N73-26752

Single grid accelerator for an ion thruster Patent
[NASA-CASE-LEW-00204-1] c 26 N73-26752

Preparation of polynoloids from mixtures of monomeric dienes and esters of polyoxyethylene acids Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Method and apparatus for measuring electromagnetic radiation Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Welding blades to rotors Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Low mass rolling element bearings Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Swich to primary coil Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Enhanced diffusion welding Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Nicker alumimide coated low alloy stainless steel Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Cobalt-base alloy Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Nuclear fuel element Patent
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Electron beam controller Patent
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Method of heat treating a formed powder product Patent
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Apparatus for making curved reflectors Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Multialarm summary alarm Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Airtight control system for supersonic insects Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Airflow control system for supersonic insects Patent
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Glucose transport cells comprising relatively high expansion melts Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Hollow rolling element bearings Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Low level signal limiter Patent
[NASA-CASE-LEW-00204-1] c 19 N73-27008

Load insensitive electrical device Patent
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[NASA-CASE-LEW-00204-1] c 19 N73-27008

Jet exhaust nozzle Patent
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High current electrical lead Patent
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Magnetocaloric pump Patent
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In situ self-cross-linking of polyvinyl alcohol battery separators

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Electrochemical cell for rebalancing REDOX flow system

[NASA-CASE-LEW-13150-1] c 44 N79-26474
Catalyst surfaces for the chromous/chromic redox couple

[NASA-CASE-LEW-12995-1] c 52 N80-14664
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Composite seal for turbomachinery

[NASA-CASE-LEW-13149-1] c 44 N81-27346
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[NASA-CASE-LEW-12936-1] c 33 N81-27974
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High toughness-high strength iron alloy

[NASA-CASE-LEW-12919-2] c 70 N84-28565
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Plug-type heat flux gauge

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Extended temperature rocket igniter

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Method of making contamination-free ceramic bimaterials

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Three point load screw positioning mechanism

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Intermixed hybrid graphite fiber composite

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Substituted 1,1-triaryl-2,2-trifluoroethanes and processes for their synthesis

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Graphite fluoride from iodide intercalated graphitized carbon

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Phase-stepping fiber-optic projected fringe system for surface topography measurements

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Silicon carbide fiber reinforced aluminum oxide ceramic composite

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Composites for installation and replacement of Space Station components

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Method of applying a thermal barrier coating to a substrate

NASA-CASE-LEW-15050-2) c 24 N93-14706
Apparatus for checking threaded hole perpendicularity

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Conservative plate acoustic suppressor apparatus and methods

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Conservative plate acoustic suppressor apparatus and methods

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Multiwave-length pyrometer for gray and non-gray surfaces in the presence of interfering radiation

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Sensing silicon nitride

NASA-CASE-LEW-15498-1) c 02 N93-17060
Sensing silicon nitride
Solar powered actuator with continuously variable auxiliary power control

Wind dynamic range video camera

Automated weld torch guidance control system

Cryogenic anti-friction bearing with inner race

High temperature insulation barrier composite

Bidirectional control system for energy flow in solar environments

Production of mullite fibers
Multibeam single frequency synthetic aperture radar processor for imaging separate range twigs;

Multibeam single frequency synthetic aperture radar processor for imaging separate range twigs;

Multibeam single frequency synthetic aperture radar processor for imaging separate range twigs;

Multibeam single frequency synthetic aperture radar processor for imaging separate range twigs;

Multibeam single frequency synthetic aperture radar processor for imaging separate range twigs;

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Multibeam single frequency synthetic aperture radar processor for imaging separate range twigs;

Multibeam single frequency synthetic aperture radar processor for imaging separate range twigs;

Multibeam single frequency synthetic aperture radar processor for imaging separate range twigs;
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Distributed multiplier.[NASA-CASE-NPO-17275-1-CU] c 37 N89-29750
Predictive aging of polymers.[NASA-CASE-NPO-17521-1-CU] c 27 N90-10261
Acoustic controlled rotation and orientation.[NASA-CASE-NPO-16995-1-CU] c 37 N90-12289
Surrogate fed for a microsensor array of patch elements with teardrop shaped probes.[NASA-CASE-NPO-17012-1-CU] c 30 N90-16104
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The NASA Patent Counsel having cognizance of the invention is determined by the first three letters or prefix of the NASA Case Number assigned to the invention. The addresses of NASA Patent Counsels are listed alongside the NASA Case Number prefix letters in the following table.

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PATENT LICENSING REGULATIONS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
14 CFR Part 1245
Licensing of NASA Inventions

AGENCY: National Aeronautics and Space Administration
ACTION: Interim regulation with comments requested.

SUMMARY: The National Aeronautics and Space Administration (NASA) is revising its patent licensing regulations to conform with Pub. L. 96-517. This interim regulation provides policies and procedures applicable to the licensing of federally owned inventions in the custody of the National Aeronautics and Space Administration, and implements Pub. L. 96-517. The object of this subpart is to use the patent system to promote the utilization of inventions arising from NASA supported research and development.

EFFECTIVE DATE: July 1, 1981. Comments must be received in writing by December 2, 1981. Unless a notice is published in the Federal Register after the comment period indicating changes to be made, this interim regulation shall become a final regulation.

ADDRESS: Mr. John G. Mannix, Director of Patent Licensing, GP-4, NASA, Washington, D.C. 20546

FOR FURTHER INFORMATION CONTACT:
Mr. John G. Mannix, (202) 755-3954.

SUPPLEMENTARY INFORMATION:

PART 1245—PATENTS AND OTHER INTELLECTUAL PROPERTY RIGHTS

Subpart 2 of Part 1245 is revised to read as follows:

Subpart 2—Licensing of NASA Inventions

Sec.
1245.200 Scope of subpart.
1245.201 Policy and objective.
1245.202 Definitions.
1245.203 Authority to grant licenses.
1245.204 All licenses granted under this subpart.

Restrictions and Conditions

1245.204 All licenses granted under this subpart.

Types of Licenses

1245.205 Nonexclusive licenses.
1245.206 Exclusive and partially exclusive licenses.

Procedures

1245.207 Application for a license.
1245.208 Processing applications.
1245.209 Notice to Attorney General.
1245.210 Modification and termination of licenses.
1245.211 Appeals.
1245.212 Protection and administration of inventions.
1245.213 Transfer of custody.
1245.214 Confidentiality of information.

Authority: 35 U.S.C. Section 207 and 208.94 Stat 3023 and 3024.

Subpart 2—Licensing of NASA Inventions

§ 1245.200 Scope of subpart.

This subpart prescribes the terms, conditions and procedures upon which a NASA invention may be licensed. It does not affect licenses which (a) were in effect prior to July 1, 1981; (b) may exist at the time of the Government’s acquisition of title to the invention, including those resulting from the allocation of rights to inventions made under Government research and development contracts; (c) are the result of an authorized exchange of rights in the settlement of patent disputes; or (d) are otherwise authorized by law or treaty.

§ 1245.201 Policy and objective.

It is the policy and objective of this subpart to use the patent system to promote the utilization of inventions arising from NASA supported research and development.

§ 1245.202 Definitions

(a) “Federally owned invention” means an invention, plant, or design which is covered by a patent, or patent application in the United States, or a patent, patent application, plant variety protection, or other form of protection, in a foreign country, title to which has been assigned to or otherwise vested in the United States Government.

(b) “Federal agency” means an executive department, military department, Government corporation, or independent establishment, except the Tennessee Valley Authority.

(c) “Federally owned invention” means a Federally owned invention with respect to which NASA maintains custody and administration, in whole or in part, of the right, title or interest in such invention on behalf of the United States Government.

(d) “Small business firm” means a small business concern as defined at section 2 of Pub. L. 85-536 (15 U.S.C. 632) and implementing regulations of the Administrator of the Small Business Administration. For the purpose of these regulations, the size standard for small business concerns involved in Government procurement, contained in 13 CFR 121.3-6, and in subcontracting, contained in 13 CFR 121.3-12, will be used.

(e) “Practical application” means to manufacture in the case of a composition or product, to practice in the case of a process or method, or to operate in the case of a machine or system; and, in each case, under such condition, as to establish that the invention is being utilized and that its benefits are to the extent permitted by law or Government regulations available to the public on reasonable terms.

(f) “United States” means the United States of America, its territories and possessions, the District of Columbia, and the Commonwealth of Puerto Rico.

§ 1245.203 Authority to grant licenses.

NASA inventions shall be made available for licensing as deemed appropriate in the public interest. NASA may grant nonexclusive, partially exclusive, or exclusive licenses thereto under this subpart on inventions in its custody.

Restrictions and Conditions

§ 1245.204 All licenses granted under this subpart.

(a) Restrictions. (1) A license may be granted only if the applicant has supplied NASA with a satisfactory plan for development or marketing of the invention, or both, and with information about the applicant’s capability to fulfill the plan.

(b) Conditions. Licenses shall contain such terms and conditions as NASA determines are appropriate for the protection of the interests of the Federal Government and the public and are not in conflict with law or this subpart. The following terms and conditions apply to any license:

(1) The duration of the license shall be for a period specified in the license agreement, unless sooner terminated in accordance with this subpart.

(2) The license may be granted for all or less than all fields of use of the invention or in specified geographical areas, or both.

(3) The license may extend to subsidiaries of the licensee or other parties if provided for in the license but shall be nonassignable without approval of NASA, except to the successor of that part of the licensee’s business to which the invention pertains.

(4) The license may provide the licensee the right to grant sublicenses under the license, subject to the approval of NASA. Each sublicense shall make reference to the license, including the rights retained by the Government, and a copy of such sublicense shall be furnished to NASA.

(5) The license shall require the licensee to carry out the plan for development or marketing of the invention, or both, to bring the invention to practical application within a period specified in the license, and to continue to make the benefits of the invention reasonably accessible to the public.
PATENT LICENSING REGULATIONS

(6) The license shall require the licensee to report periodically on the utilization or efforts at obtaining utilization that are being made by the licensee, with particular reference to the plan submitted.

(7) All licenses shall normally require royalties or other consideration.

(8) Where an agreement is obtained pursuant to §1245.204(a)(2) that any products embodying the invention or produced through use of the invention will be manufactured substantially in the United States, the license shall recite such agreement.

(9) The license shall provide for the right of NASA to terminate the license, in whole or in part, if:

(i) NASA determines that the licensee is not executing the plan submitted with its request for a license and the licensee cannot otherwise demonstrate to the satisfaction of NASA that it has taken or can be expected to take within a reasonable time effective steps to achieve practical application of the invention;

(ii) NASA determines that such action is necessary to meet requirements for public use specified by Federal regulations issued after the date of the license and such requirements are not reasonably satisfied by the licensee;

(iii) The licensee has willfully made a false statement of or willfully omitted a material fact in the license application or in any report required by the license agreement; or

(iv) The licensee commits a substantial breach of a covenant or agreement contained in the license.

(10) The license may be modified or terminated, consistent with this subpart, upon mutual agreement of NASA and the licensee.

(11) Nothing relating to the grant of a license, nor the grant itself, shall be construed to confer upon any person any immunity from or defenses under the antitrust laws or from a charge of patent misuse, and the acquisition and use of rights pursuant to this subpart shall not be immunized from the operation of state or Federal law by reason of the source of the grant.

Types of Licenses

§1245.205 Nonexclusive licenses.

(a) Availability of licenses. Nonexclusive licenses may be granted under NASA inventions without publication of availability or notice of a prospective license.

(b) Conditions. In addition to the provisions of §1245.204, the nonexclusive license may also provide that, after termination of a period specified in the license agreement, NASA may restrict the license to the fields of use or geographic areas, or both, in which the licensee has brought the invention to practical application and continues to make the benefits of the invention reasonably accessible to the public. However, such restriction shall be made only in order to grant an exclusive or partially exclusive license in accordance with this subpart.

§1245.206 Exclusive and partially exclusive licenses.

(a) Domestic licenses.

(1) Availability of licenses. Exclusive or partially exclusive licenses may be granted on NASA inventions:

(i) 3 months after notice of the invention's availability has been announced in the Federal Register, or (ii) without such notice where NASA determines that expeditious granting of such a license will best serve the interests of the Federal Government and the public; and (iii) in any other situation, specified in (a)(1)(i) or (ii) of this section only if:

(A) Notice of a prospective license, identifying the invention and the prospective licensee, has been published in the Federal Register, providing opportunity for filing written objections within a 60-day period;

(B) After expiration of the period in §1245.206(a)(1)(iii)(A) and consideration of any written objections received during the period, NASA has determined that:

(1) The interests of the Federal Government and the public will best be served by the proposed license, in view of the applicants intentions, plans, and ability to bring the invention to practical application or otherwise promote the invention's utilization by the public;

(2) The desired practical application has not been achieved, or is not likely expeditiously to be achieved, under any nonexclusive license which has been granted, or which may be granted, on the invention;

(3) Exclusive or partially exclusive licensing is a reasonable and necessary incentive to call forth the investment of risk capital and expenditures to bring the invention to practical application or otherwise promote the invention's utilization by the public; and

(4) The proposed terms and scope of exclusivity are not greater than reasonably necessary to provide the incentive for bringing the invention to practical application or otherwise promote the invention's utilization by the public;

(C) NASA has not determined that the grant of such license will tend substantially to lessen competition or result in undue concentration in any section of the country in any line of commerce to which the technology to be licensed relates, or to create or maintain other situations inconsistent with the antitrust laws; and

(D) NASA has given first preference to any small business firms submitting plans that are determined by the agency to be within the capabilities of the firms and as equally likely, if executed, to bring the invention to practical application as any plans submitted by applicants that are not small business firms.

(2) Conditions. In addition to the provisions of §1245.204, the following terms and conditions apply to domestic exclusive and partially exclusive licenses:

(i) The license shall be subject to the irrevocable, royalty-free right of the Government of the United States to practice and have practiced the invention on behalf of the United States and on behalf of any foreign government or international organization pursuant to any existing or future treaty or agreement with the United States.

(ii) The license shall reserve to NASA the right to require the licensee to grant sublicenses to responsible applicants, on reasonable terms, when necessary to fulfill health or safety needs.

(iii) The license shall be subject to any licenses in force at the time of the grant of the exclusive or partially exclusive license.

(iv) The license may grant the licensee the right of enforcement of the licensed patent pursuant to the provisions of Chapter 29 of Title 35, United States Code, or other statutes, as determined appropriate in the public interest.

(b) Foreign licenses.

(1) Availability of licenses. Exclusive or partially exclusive licenses may be granted on a NASA invention covered by a foreign patent, patent application, or other form of protection, provided that:

(i) Notice of a prospective license, identifying the invention and prospective licensee, has been published in the Federal Register, providing opportunity for filing written objections within a 60-day period and following consideration of such objections;

(ii) NASA has considered whether the interests of the Federal Government or United States industry in foreign commerce will be enhanced; and

(iii) NASA has not determined that the grant of such license will tend substantially to lessen competition or result in undue concentration in any section of the United States in any line of commerce to which the technology to be licensed relates, or to create or maintain other situations inconsistent with antitrust laws.

(2) Conditions. In addition to the provisions of §1245.204, the following terms and conditions apply to foreign exclusive and partially exclusive licenses:

(i) The license shall be subject to the irrevocable, royalty-free right of the Government of the United States to practice and have practiced the invention on behalf of the United States and on behalf of any foreign government or international organization pursuant to any existing or future treaty or agreement with the United States.

(ii) The license shall be subject to any licenses in force at the time of the grant of the exclusive or partially exclusive license.

(iii) The license may grant the licensee the right to take any suitable and necessary actions to protect the licensed property, on behalf of the Federal Government.

(c) Record of determinations. NASA shall maintain a record of determinations to grant exclusive or partially exclusive licenses.

Procedures

§1245.207 Application for a license.

An application for a license should be addressed to the Patent Counsel at the NASA installation having responsibility for the invention and shall normally include:

(a) Identification of the invention for which the license is desired, including the patent application serial number or patent number, title, and date, if known;

(b) Identification of the type of license for which the application is submitted;

(c) Name and address of the person, company, or organization applying for the license and the citizenship or place of incorporation of the applicant;

(d) Name, address, and telephone number of representative of applicant to whom correspondence should be sent;
A subject index is provided for over 5500 patents and patent applications for the period May 1969 through December 1993. Additional indexes list personal authors, corporate authors, contract numbers, NASA case numbers, U.S. patent class numbers, U.S. patent numbers, and NASA accession numbers.