ing in others, including charge and magnetic moment. When normal matter collides with ANTI-MATTER, both are annihilated and tremendous amounts of energy are released.

49. The kind of rays emitted and the HALF LIFE (the time in which half the radioactivity decays) are constant characteristics of each radioactive isotope, and are used to identify that isotope.

50. In general, the gamma rays are very PENETRATING, beta rays less so, and alpha particles are easily stopped. Even though the alpha and beta rays are not very penetrating, they have enormous speed.

51. ENERGY is capacity to do work. It is work stored up for future use.

52. If you raise a weight to a height above the ground and suspend it there by some device, the WORK you put into raising it can be stored there indefinitely as POTENTIAL ENERGY. It will be there, ready, whenever you decide to release it.

53. The energy that a moving body has because it is in motion is called KINETIC ENERGY. The kinetic energy of any particle depends upon its mass and its velocity. When the moving particle strikes an object, work is done.

54. Particles of atomic size have kinetic energy arising from several different kinds of MOTION. All atoms are constantly in motion.

55. If the atoms are so dispersed that the material constituting them is a GAS, that gas will exert pressure on all sides of the container holding it, because of the motion of the gas molecules.

56. Atoms composing an element that will combine readily with another element, as hydrogen or carbon will combine with oxygen, have incomplete arrangements of the outer electrons in their systems. These incomplete arrangements allow CHEMICAL COMBINATION to take place when elements with suitable combining powers are brought together.

57. When chemical reactions occur, energy can be absorbed or released in the process. Reactions in which energy is absorbed are called ENDOTHERMIC REACTIONS; those in which energy is released are called EXOTHERMIC REACTIONS.

58. Chemical energy, electricity and heat are all forms of ENERGY. Potential and kinetic energy may be distinguished in each case.

59. These energies all arise from motion of the atom as a whole, or motion resulting from attractions and repulsions between the outer ELECTRONS of the atom's structure.

60. Energy resulting from changes in the nucleus of the atom was unknown until the discovery of RADIOACTIVITY.

61. Radioactive isotopes undergo SPONTANEOUS breaking up of their nuclei, giving off beta, alpha or gamma radiation. Loss of these particles causes the radioactive isotopes to change into isotopes of other elements.

62. The energies shown in these TRANSMUTATIONS are millions of times greater than the kinetic energies the molecules of a gas have by reason of their motion when heated. They are about a million times greater than the energy changes per atom in chemical reactions.

63. The property of matter that connects it with motion is INERTIA. Inertia is resistance to change of motion and is the measure of the MASS of an object.

64. One conclusion that appeared early in the development of the theory of RELATIVITY is that the mass of a moving body increases as its speed is increased.

65. This increase implies an equivalence between an increase in energy of motion of a body (kinetic energy) and an increase in its MASS.

66. It is for this reason that Einstein suggested that studies of radioactivity might show the EQUIVALENCE of mass and energy.

67. Einstein's statement is that the amount of energy, E, equivalent to a mass, m, is given by the equation $E = mc^2$, where c is the VELOCITY OF LIGHT.

68. From this equation, one kilogram (2.2 pounds) of matter, if CONVERTED entirely into energy, would give 25 billion kilowatt hours of energy.

69. The heat produced by BURNING one kilogram of coal is 8.5 kilowatt hours of energy.

70. Two axioms of physics state: (1) MATTER can be neither created nor destroyed; (2) ENERGY can be neither created nor destroyed. For all practical purposes they were true and separate principles until about 1940.

71. It is now known that they are, in fact, TWO PHASES of a single principle, for we have discovered that energy may sometimes be converted into matter and matter into energy.

72. Such conversion is observed in the phenomenon of nuclear FISSION, a process in which atomic nuclei split into fragments with the release of an enormous amount of energy.

73. The extreme size of the CONVERSION FACTOR explains why the equivalence of mass and energy is never observed in ordinary chemical combustion.

74. We now believe the heat given off in chemical COMBUSTION has mass associated with it, but this mass is so small it cannot be detected by the most sensitive balances available.

75. From the standpoint of the Laws of the Conservation of Matter and of Energy alone, transformation of matter into energy results in the DESTRUCTION of matter and CREATION of energy.

(Compiled originally by Helen M. Davis; revised 1960.)

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TECHNOLOGY

TV Helps Mine Recovery

➤ AN UNDERWATER TELEVISION camera is helping the Navy to recover valuable ordnance units from the ocean floor at depths where divers cannot safely operate.

The camera guides a 12-ton shipboard crane in quickly retrieving air-dropped or submarine-laid mines from a test area of the Naval Ordnance Laboratory Test Facility at Fort Lauderdale. The area is three miles off-shore.

The mines under test are developed by the Naval Ordnance Laboratory, White Oak, Silver Spring, Md., and then sent to the NOLTF at Fort Lauderdale for full-scale sea trials.

When mines are planted, their location is pinpointed by two spotting towers situated about three miles apart on the beach. This information is relayed to a recovery ship that anchors directly over the area and lowers the camera assembly to search the ocean floor.

Once on the bottom, the TV unit rotates in a full 360-degree circle and scans from the ocean floor beneath the camera assembly to almost directly above it in a 100-degree arc. Objects more than 75 feet away at 360-foot depths can be spotted by the camera's wide-angle lens under good natural light conditions. Natural light is preferable to artificial light because the tiny plankton life in the seawater reflects artificial light, clouding the TV picture.

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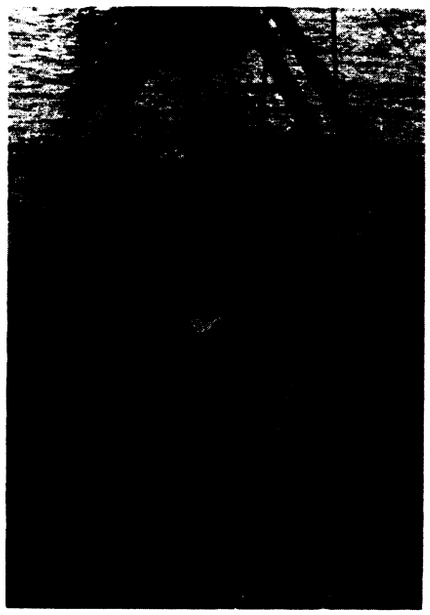

RECOVERED MINE—Guided by an underwater television camera, a 12-ton crane on a U. S. Naval Ordnance Laboratory recovery ship hauls up a mine in a clamshell bucket near Fort Lauderdale, Fla. The mine was spotted in 360 feet of water.

RADIO ASTRONOMY

New Method Found for Large Radio Telescopes

➤ A LARGE RADIO TELESCOPE can be made by mathematically combining the radio information received on two smaller radio telescopes. This new method has been developed by two astronomers at the Cavendish Laboratory in Cambridge, England.

Drs. M. Ryle and A. Hewish devised the synthetic radio telescope to obtain increased resolving power. Many investigations of the sources of radio waves in the heavens are limited by the resolving power that can be achieved by conventional methods of constructing the receiving antennas.

To overcome such limitations, Drs. Ryle and Hewish developed a method by which two antennas are so arranged that their relative positions can be altered to occupy successively the whole area of a much larger equivalent aerial.

The results of such observations are then combined mathematically, they report in the Monthly Notices of the Royal Astronomical Society, 120:220, 1960, published in London.

The new method of obtaining increased resolving power can be applied to both "pencil beam" systems and interferometers. An interferometric system designed for the study of radio sources has been built with an equivalent area for resolution of 800,000 square feet.

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