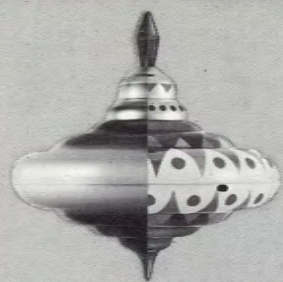




HIGH SPEED PHOTOGRAPHY

FASTAX

Revere-Wollensak Division **3M**
COMPANY



AVAILABLE
FRAME SPEED
150 to 18,000 p.p.s.

COMPLETE
SELF-
CONTAINED
UNIT

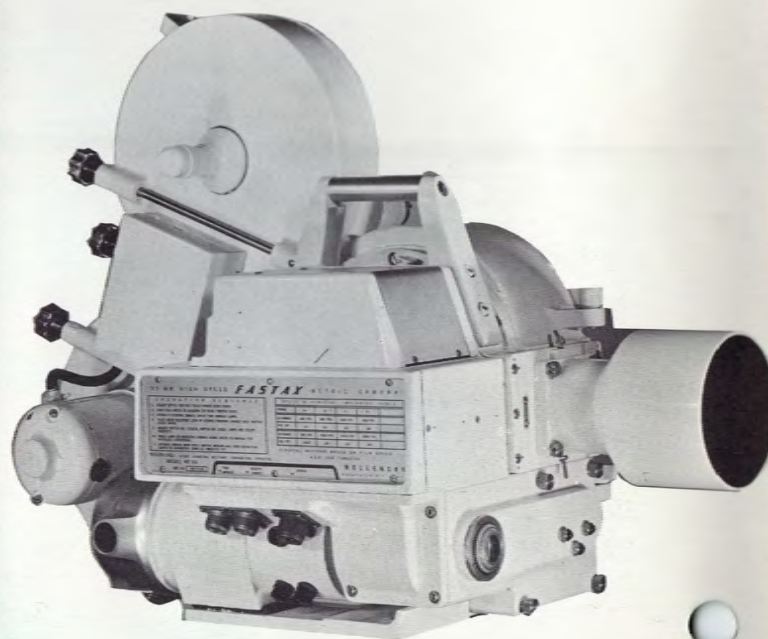
THRU-THE-
LENS
FOCUSING
AND
COMPOSING

SLIT
APERTURES
FOR SHORT
DURATION
EXPOSURE

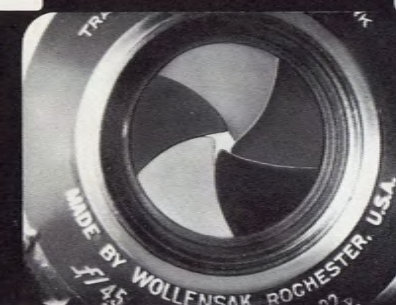
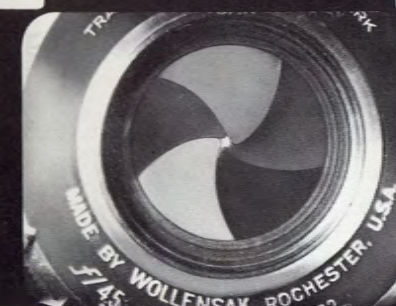
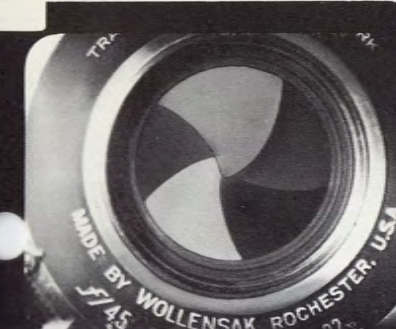
PROVEN
RELIABILITY
THE WORLD
OVER



WF 1, 3, 3T and 6 • 100' 16mm FASTAX



WF 8A • 35mm FULL FRAME FASTAX



FASTAX® ... TIME MICROSCOPE

Years ago photography settled a question that puzzled the sporting world: "Does a galloping horse always keep one hoof on the ground?" In 1877 a man named Muybridge set up a row of 24 cameras with shutters tripped by strings which the horse broke as he galloped past. The resulting wet plate pictures showed that there is a point where all four hoofs are off the ground. For perhaps the first time photography showed phenomena too fast for the human eye to see.

Now 86 years later high speed motion picture cameras are recording pictures permanently at frame rates from 150 to 18,000 pictures a second. By taking pictures at a rate many times faster than the normal projection speed, an ultra slow-motion film results which, when shown on the screen, reveals events hitherto lost in the blur of speed. Just as a micrometer is used to measure space in terms of thousandths of an inch, the High Speed Camera is used to measure action in thousandths of a second. A High Speed Camera, such as the FASTAX, is in effect a time microscope, designed to "stop" motion, literally magnifying space and time. If, for example, pictures are taken at 16,000 frames per second, and are projected at the normal speed of 16 frames per second, a time magnification of 1,000 to 1 is obtained and subject motion literally ceases. An event which has a duration of one second is thus stretched out 1,000 seconds on the screen for leisurely examination and study.

FASTAX High Speed motion picture cameras are used extensively

on the production floor and in the laboratory as a valuable engineering analysis tool. Insofar as mechanical devices are concerned, its principal use is that of a time-saver, spotlighting design weaknesses in prototypes, exposing the reasons for part failures and showing up, often dramatically, the split second behavior of a machine. Its applications, however, are limited only by the ingenuity of the engineer with a problem to solve. It is used in electrical, mechanical, medical, chemical, and physical fields on all kinds of problems and by a multitude of companies both large and small. As a general rule there is an application for a camera of this type wherever there is a problem in which the speed of subject movement is too fast to follow with the eye. It may be that the subject is as small as a single fibre of cotton during a tensile strength test, or as large as the explosion of a nuclear weapon. For example, a study of wing tips, made by a prominent research laboratory, showed that at supersonic velocities, structural weaknesses resulted. Analysis of the projected film pointed to the parts needing redesigning. A medium-size tool company studied cracking of rapidly moving metal cams. "Seeing" the problem made the solution easy. The adjustment of papermaking machinery is becoming a predictable art now that "slow motion" has permitted reasonable examination and measurement of the turbulence which occurs as fluid speeds are increased in order to produce more at less cost with no reduction in quality.



FASTAX HIGH SPEED MOTION PICTURE STUDIES

ELECTRICAL • Arcs and flashovers • Circuit breakers • Fuse blowouts • Mercury switches • Motors and generators • Relays • Telephone equipment • **MECHANICAL** • Bomb releases • Explosive effect of bombs, shells, rockets and grenades • Impact of incendiary bullets and shells • Jamming actions on machine guns • Measurement of acceleration of missiles • Measurement of muzzle velocities • Power units of torpedoes • Rocket studies • Calculating machinery • Cams • Cash registers • Clutches • Gears • Springs • Tabulating machines • Typewriters • Vibration • Coil-winding machines • Contacts • Equipment shock and

vibration • Governors • Aircraft, both ground and flight studies • Carburetor and valve studies • Propellers • Transmissions • Cutting and wrapping machinery • Linotype machines • Printing presses • Textile equipment • Watch and clock movements • Impact and tension tests • Cutting tools •

MOVEMENT OF LIQUIDS AND GASES • Effect of impact and pressure waves on various materials • Ejection of torpedoes from both deck tubes and underwater tubes • Flight-of-projectile studies • Wind tunnel studies • Spark distribution • flow • Welding • Cavitation • Jet propulsion • Turbine studies • Air compression • Flow of liquids • Flow of metals • Bubble formation • Surface tension of fluids • Pigment mixing • Extrusion of metals • **CHEMICAL** • Internal-combustion firing chambers • Rocket engine ignition • Evaporation of liquids • Fuel burning • Film coating • **MEDICAL** • Heart fibrillation • Blood cell acceleration and velocity • Vocal cord • Muscle interaction • Effect of acceleration and deceleration • Human tissue under impact • Body fluid pressure • Sports • Ear drums.



Examination of result of die change on high speed punch press operation.

High speed study shows hammer travel and firing pin bounce of shot gun.

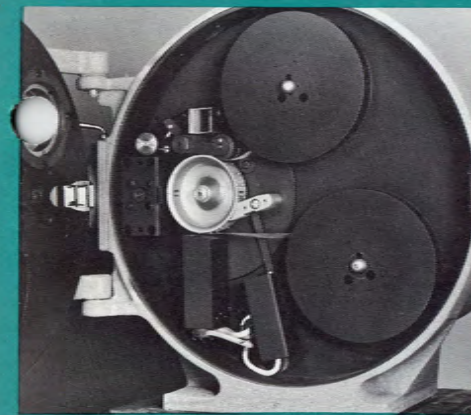
Design change improved efficiency in corn kernel removal reducing cost.



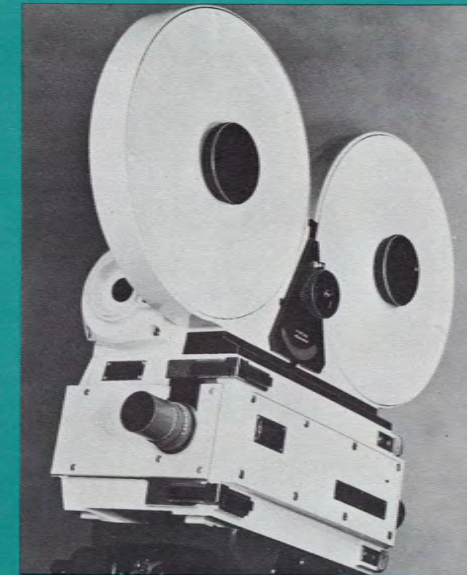
FASTAX High Speed Camera transforms a blur of action into leisurely motion.

FASTAX HIGH SPEED MOTION PICTURE CAMERAS

FASTAX cameras are not complex instruments. They can be operated by nearly anyone with some knowledge of photography and a little training. All FASTAX cameras differ from ordinary motion picture cameras in that the film is pulled past the aperture in a continuous motion by means of a drive and a takeup motor. These high-



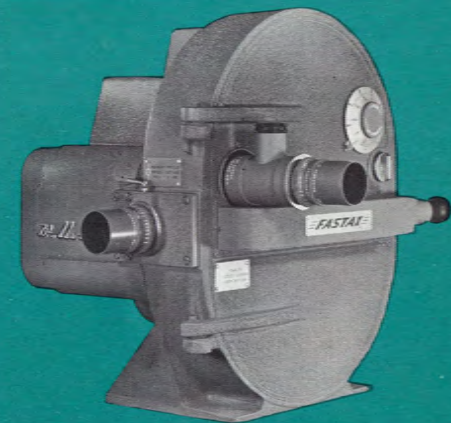
er framing rate systems expose each frame through a rotating prism compensator which moves the subject image in synchronism with the film. This method permits speeds up to 18,000 frames per second. An integral sleeve with windows enveloping the prism functions as a shutter. Other Fastax cameras in addition to the prism have either drum or disc shutters with which it is possible to vary shutter speed.



WF30 • 1200' 16mm FASTAX

8mm, 16mm and 35mm FASTAX cameras with 100', 400', 500' and 1200' capacities, and speeds from 150 to 18,000

frames per second, are available in both straight motion picture, oscillographic, or combined motion picture-oscillographic models. 30 cameras are available to fit all requirements.

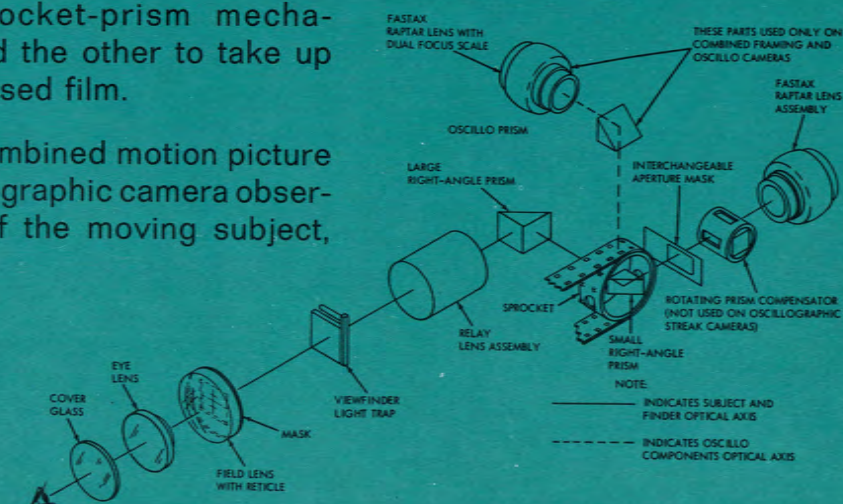


WF 14S, 14ST, 15S, 15ST • 400' START-STOP FASTAX with superimposed oscillographic streak.

In the FASTAX camera, light from the subject passes through the taking lens, through a rotating prism and then on to the film. Two motors are used—one to drive the film-sprocket-prism mechanism and the other to take up the exposed film.

In the combined motion picture—oscillographic camera observation of the moving subject,

as well as visual representation of other data peculiar to the operation of the subject, is superimposed over the motion picture and is available for a correlated study.





HOW INDUSTRY USES FASTAX CAMERAS TO SOLVE DESIGN PROBLEMS,

PRODUCTION

In Wisconsin's paper mills, pulp changes into paper at the rate of 2,500 ft. a minute, obviously much too fast to follow with the eye. A series of studies made with FASTAX cameras has resulted in new and better manufacturing techniques.

★

At General Motors Proving Grounds a mixture of air and fuel, which has been making our automobiles tick for half a century, has been improved by high-speed studies. In this instance, the head of an engine or portions of a head of an engine have been replaced with a thick quartz window. Photographing into a mirror positioned at 45° above the block records the mixture burning and reveals the speed of the ignition front. This is fundamental information for the designer.

DESIGN/DEVELOPMENT

Test engineers in a well-known watch company studied motion of the escapement when it engaged pins on the fork. They made certain there was no bounce thereby assuring greater accuracy of the movement.

★

Pratt & Whitney Aircraft studies combustion principles in modern aircraft engine. Results are extremely important to test engineers for the design and development of high heat release rate devices. The ignition of the mixture of air and fuel in the proper proportions, and the rapid mixing of burned and unburned gases involve a most complex series of interrelated events—events occurring simultaneously in time and space. Only by slowing up this fast-moving action with FASTAX High Speed camera can engineers "see" what is happening.



Close-up view of combustion process within the afterburner of advanced jet engine test.

MEDICAL

In London a medical research worker had a problem of analyzing speed of blood flow in the arteries of small animals. The part of the blood vessel to be examined was about three centimeters in length, and the flow speed was such that a high-speed camera operating at 1,500 pictures per second was used to catch the very fast acceleration and deceleration of the blood during the heartbeat cycle. Color film was used and fugitive dyes were injected upstream from the area being studied to act as reference markers. Ordinary black and white film also was used in which the reference marker consisted of a small oxygen bubble readily visible through the artery wall. Simultaneously with camera exposure, recording manometers measured pressure changes within the blood vessels so that they could be correlated with the visual picture. Knowing the speed at which the film was moving through the camera, and measurement of the change of position of the reference markers from frame to frame, acceleration and velocity were easily computed.

MATERIAL TESTING

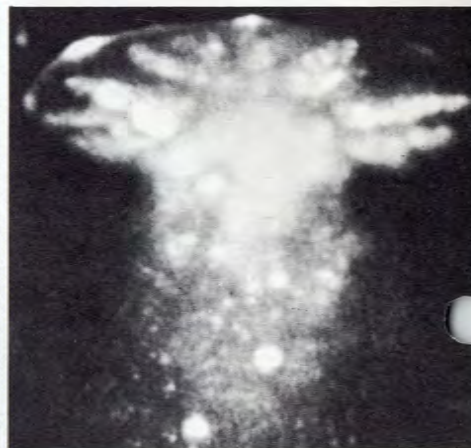
Sperry Gyroscope Company, as well as several others, use the high-speed motion picture camera to study shock and vibration. Engineers in their electrical measurements laboratory report that it provides more complete qualitative and quantitative information than can be obtained by other devices. This information is applied to the development of Gyro compasses, radar systems, anti-aircraft weapons and missiles. Footage of units undergoing tests which simulate environmental shock and vibration shows how and at what point failures occur. Breakage of the delicate Tungsten wire heaters of the Sperry Klystron hi-amp radar tube was isolated and rectified by use of high-speed films.

FLUID RESEARCH

Cavitation damage of metals is a well-known hydraulic phenomenon which is often associated with destructive effects in hydraulic turbines and diesel cooling systems. The word "cavitation" itself refers to the formation and collapse of vapor bubbles, while "cavitation damage" refers to the destruction of the adjacent surface at the point of bubble collapse.

Using a FASTAX camera operating at 8,000 pictures per second, cavitation damage of metals has been graphically illustrated. The FASTAX also demonstrated that cavitation damage in diesel cooling systems can be reduced by con-

trolling the dominant liquid characteristics of temperature, pressure and wettability. Up to this time many experts had considered cavitation damage a chemical corrosion, rather than the now-accepted mechanical erosion as demonstrated by the FASTAX films. Since this high-speed motion picture work was done in distilled water, and the films correlate the cavitation bubble pattern with the resulting damage pattern, the actual mechanics of cavitation damage were clearly demonstrated, rendering it more accessible to corrective action.



Bubble pattern on vibrating test button from cavitation study.

METAL PROCESSING

A milling machine company has made many interesting studies. One resulted in recommendations for machining Titanium. Here they ingeniously modified microscope equipment to use in conjunction with the high-speed camera so magnified studies result. Comparison of chip size and formation with those of standard 1010 or 1020 carbon steels have resulted in a whole series of recommendations on machine speeds, feeds, tool material, and tool tip configurations.



Chip formation process and tool life study when machining Titanium.

SPEED RESEARCH, IMPROVE PRODUCTION, CUT COSTS.



PHOTOGRAPH COURTESY OF CONSOLIDATED PAPERS, INC.

Steel box dangles in mid-air above a sea of paper pulp rushing by at 1,500 feet a minute. A technician starts rolling his FASTAX high speed motion picture camera. In one second 2,000 perfect pictures of the speeding pulp are captured on film.

Studying these pictures at normal speed (16 frames a second) papermaker technicians can recommend machinery adjustments that will give the very best level and type of pulp turbulence, resulting in more perfect formation of the paper.

MANY SATISFIED FASTAX USERS

Abitibi Power & Paper Co. (Canada)
Aeronutronic Systems Inc.
Aluminum Co. of America
American Cyanamid Co.
American Tobacco Co.
Armour Research Foundation
Avco Research & Advanced Development
Bell Telephone Laboratories, Inc.
Beloit Iron Works
Bigelow-Sanford Carpet Co., Inc.
Black & Decker Mfg. Co.
Burroughs Corp.
Chrysler Corp.
Cornell Aeronautical Laboratories
Douglas Aircraft Co., Inc.
E. I. DuPont de Nemours & Co., Inc.
Elgin National Watch Co.
Fellows Gear Shaper Co.
Food Machinery & Chemical Corp.
Ford Motor Co.
Friden Co.
General Motors Corp.
General Dynamics
Hallmark Cards, Inc.
Hercules Powder Co.
International Business Machines
International Harvester Co.
Jos. Schlitz Brewing Co.
Kiekover Corp.
Arthur D. Little, Inc.
Lockheed Aircraft Corp.
Martin Company
Mason & Hanger
Massachusetts Institute of Technology
Mead Corp.
North American Aviation, Inc.
Olin-Mathieson Chemical Corp.
Oxford Paper Co.
Philco Corporation
Phillip Morris Research Center
Phillips Petroleum Co.
Pratt & Whitney Aircraft
Space Technology Laboratories Inc.
Sunbeam Corp.
The Budd Company
Thiokol Chemical (Reaction Motors)
Union Carbide Chemical Co.
United States Air Force
United States Army
United States Navy
University of California
University of Michigan
Wayne State University
and many more

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MINNESOTA MINING & MANUFACTURING CO.

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