

# THE HISTORY OF EXTRUDER SCREW DESIGN

**BY: R. F. DRAY AND R. B. GREGORY**

THIS HISTORICAL REPRESENTATION IS GENERATED FROM THE ACTUAL PATENTS. IN TECHNOLOGY ADVANCES THAT WERE NOT PATENTED, THE INFORMATION SHOWN WAS GIVEN BY PEOPLE WHO WERE DIRECTLY INVOLVED AT THE TIME. THE DESCRIPTIONS SHOWN IN THE "UNIQUE AREAS" ARE BY THE AUTHOR, EDITED BY R. B. GREGORY, AND TAKEN FROM THE ACTUAL PATENTS. THE ART DESCRIBED IN THE TOP (LARGER) DRAWINGS IS BEST DESCRIBED AS "BASIC". THAT IS, UNIQUE WITH NO PRECEDENT AND CANNOT BE DESCRIBED AS AN IMPROVEMENT. THE LOWER PATENTS CAN BE DESCRIBED AS "IMPROVEMENT PATENTS" AND ARE LINKED TO THE PRIOR ART. ANY INACCURACIES OR OMISSIONS THAT ARE OBSERVED, IF PRESENTED TO THE AUTHOR, WILL BE CHECKED AND, IF VALIDATED, EITHER CORRECTED OR INSERTED AS APPLICABLE IN THE NEXT SHOWING OR PUBLICATION. THE INTENT IS TO PROVIDE THE GREATEST ACCURACY POSSIBLE. ANY PERTINENT INFORMATION WILL BE WELCOMED.

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**1928 - 1932**

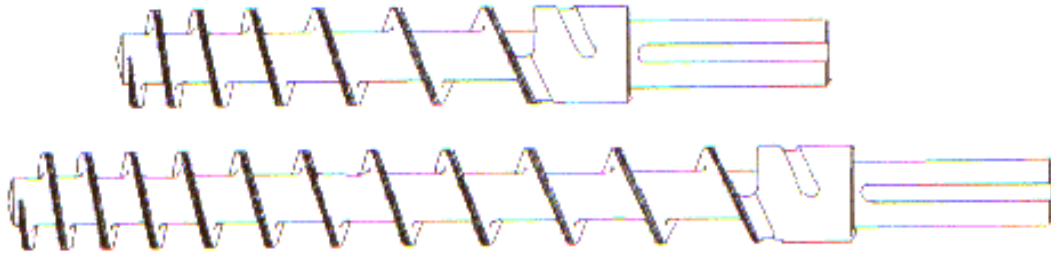
BASIC PATENT

NEW ADVANCES

- 1.) FIRST PLASTICS EXTRUDED {MELT INPUT}
- 2.) L/D RATIOS 4:1 & 8:1

## NEW MATERIALS PROCESSED

- 1.) CELLULOSE
- 2.) PVC



## VARIABLE LEAD RUBBER DESIGN

Inventer Unknown

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## 1945 – 1950

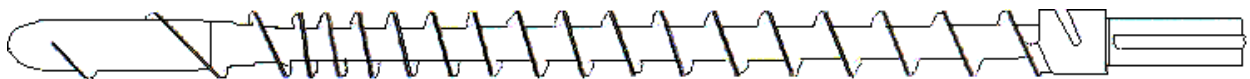
### BASIC PATENT

### NEW ADVANCES

- 1.) 16:1 L/D
- 2.) TORPEDO DESIGN
- 3.) DULMAGE PATENT
- 4.) FIRST BLOWN FILM LPDE RATE  $3 \frac{1}{2}$  - 16:1 L/D - 75 PPH

## NEW MATERIALS PROCESSED

- 1.) LDPE



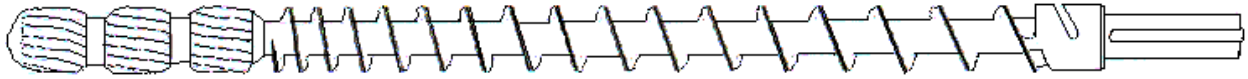
## TORPEDO DESIGN

Inventer W. A. MAGERKURTH FILED 02/21/1941 PATENTED

09/10/1946

ASSIGNED TO DOW CHEMICAL CO. PATENT# 2,407,503

UNIQUE AREAS FLIGHTED TORPEDO AREA AT DISCHARGE END.  
USED FOR PROCESSING CELLULOSE AND CELLULOSE ACETATE  
BUTYRATE



DULMAGE MIXING TORPEDO DESIGN

Inventer F.E. DULAGE FILED 02/26/1945 PATENTED 11/02/1948

ASSIGNED TO DOW CHEMICAL CO. PATENT# 2,453,088

UNIQUE AREAS FIRST DISTRIBUTIVE MIXER TO UTILIZE  
ELONGATED LEADS FOR MULTIPLE PITCH.

MAINLY USED FOR PROCESSING STYRENE, MANY ARE STILL IN USE.

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## 1950 – 1955

BASIC PATENT

NEW ADVANCES

- 1.) 20:1 L/D
- 2.) SQUARE PITCH DESIGN
- 3.) VENTING
- 4.) TWO STAGE DESIGN
- 5.) BLISTERS FIRST DISPERSIVE MIXER
- 6.) LPDE BLOWN FILM RATE 3 1/2 - 20:1 L/D - 150 PPH

NEW MATERIALS PROCESSED

- 1.) ACRYLIC
- 2.) SARAN



### SQUARE PITCH SINGLE STAGE DESIGN

PRIMARY DEVELOPER P. SQUIRES

UNIQUE AREAS FIRST SQUARE PITCH DESIGN (LEAD=DIAMETER)  
PREVIOUS AREA AT DISCHARGE END.

USED FOR PROCESSING CELLULOSE AND CELLULOSE ACETATE  
BUTYRATE

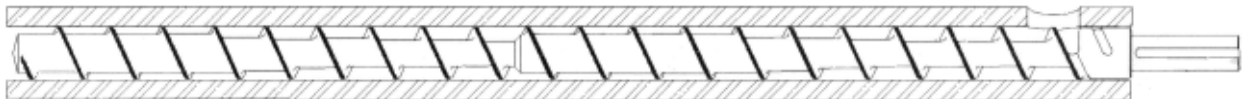
### VENTED EXTRUSION

Inventer F.E. DULAGE FILED 02/26/1945 PATENTED 11/02/1948

ASSIGNED TO DOW CHEMICAL CO. PATENT# 2,453,088

UNIQUE AREAS FIRST DISTRIBUTIVE MIXER TO UTILIZE  
ELONGATED LEADS FOR MULTIPLE PITCH.

MAINLY USED FOR PROCESSING STYRENE, MANY ARE STILL IN USE.



### SQUARE PITCH TWO STAGE DESIGN

Inventer F.E. DULAGE FILED 02/26/1945 PATENTED 11/02/1948

ASSIGNED TO DOW CHEMICAL CO. PATENT# 2,453,088

UNIQUE AREAS FIRST DISTRIBUTIVE MIXER TO UTILIZE  
ELONGATED LEADS FOR MULTIPLE PITCH.

MAINLY USED FOR PROCESSING STYRENE, MANY ARE STILL IN USE.

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**1960 – 1965**

## BASIC PATENT

### NEW ADVANCES

- 1.) L/D RATIOS 28:1, 32:1, 36:1
- 2.) MAILLEFER LONG BARRIER
- 3.) QLT
- 4.) DOUBLE VENTING
- 5.) LPDE BLOWN FILM RATE 350 PPH



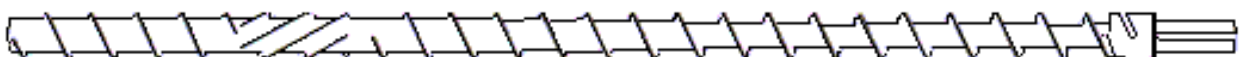
### MAILLEFER LONG BARRIER

INVENTOR: C.E. MAILLEFER , S. A. FILED 12/20/1960 PATENTED  
12/19/1967

ASSIGNED TO: MAILLEFER , S. A. PATENT # 3,358327

SWISS APPLICATION 82,535/59 APPLIED SWITZERLAND: 12/03/1959

UNIQUE AREAS FIRST SEPRATION DEVICE. AN INCREASED CLEARANCE FLIGHT IS INITIATED ON THE DOWNSTREAM SIDE OF THE PRIMATY FLIGHT WITH THE LEAD LONGER THAN THE PRIMARY FLIGHT LEAD AFTER A NUMBER OF TURNS THE "BARRIER FLIGHT" WILL INTERSECT THE UPSTREAM SIDE OF THE PRIMARY FLIGHT THE BARRIER THAT IS CONSTRUCTED RESTRAINS THE SOLIDS ON THE DOWNSTREAM SIDE OF THE "BARRIER FLIGHT " IN THE PRIMARY CHANNEL AND AS MELTING PROGRESSES, THE MELT IS CARRIED DOWNSTREAM IN THE AUXILIARY CHANNEL BY THE PRIMARY FLIGHT. ARE PITCH DESIGN (LEAD=DIAMETER) PREVIOUS AREA AT DISCHARGE END.



QLT (QUALITY LOW TEMP.) DESIGN

Inventer R.B. GREGORY FILED 01/29/1964 PATENTED 01/31/1967

ASSIGNED TO N.R.M. CORP. PATENT# 3,300,810

UNIQUE AREAS FIRST DISTRIBUTIVE MIXER TO UTILIZE A REVERSE  
HELIX TO IMPEDE FLOW AND DYNAMICALLY MIX MATERIALS.

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GEYER LONG BARRIER

Inventer P. GEYER FILED 04/02/1961 PATENTED 04/02/1966

ASSIGNED TO UNIROYAL. INC. PATENT# 3,375,549

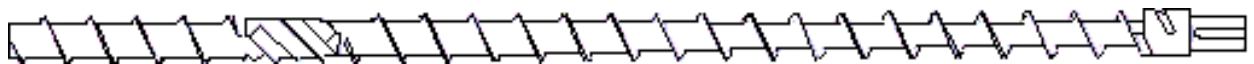
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## 1965 – 1970

BASIC PATENT

NEW ADVANCES

1.) GREGORY MIXER



GREGORY MIXER

INVENTOR: R.B. GREGORY. FILED 04/12/1966 PATENTED 11/19/1968

ASSIGNED TO: FRANK W. EGAN &\* CO. PATENT # 3,411,179

UNIQUE AREAS FIRST DESPERSIVE MIXER TO UTILIZE A BARRIER  
IN A MIXING SECTION TO APPLY HIGHER SHEAR STRESS TO THE  
HIGER VISCOSITY COMPONENTS AND A LOWER SHEAR STRESS TO  
THE LOWER VISCOSITY COMPONENTS. THIS IS ACCOMPLISHED BY  
AN INLET GROOVE THAT IS PRESURIZED AND FORCES THE

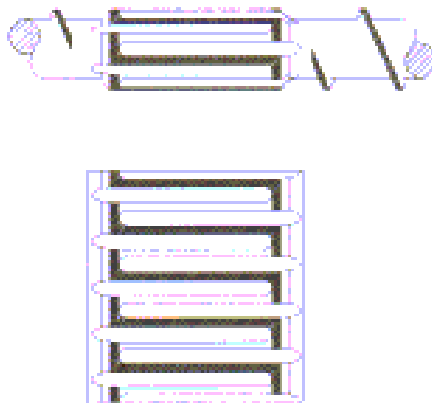
MATERIAL THROUGH A NARROW ORFICE INTO AN EXIT GROOVE.

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LEROY (UCC) MIXER

INVENTOR: G. LEROY. FILED 03/24/1967 PATENTED 12/30/1969

ASSIGNED TO: UNION CARBIDE CORP.. PATENT # 3,486,192



NOTES: THIS WAS THE UNION CARBIDE VERSION OF THE GREGORY MIXER. THE ONLY FUNCTIONAL DIFFERENCE IS THE FLUTES ARE STRAIGHT RATHER THAN HELICAL. THIS DESIGN IS SOMETIMES KNOWN AS THE "MADDOCK MIXER", AS B. MADDOCK DEVELOPED THIS DESIGN AT UNION CARBIDE.

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**1970 – 1975**

BASIC PATENT

NEW ADVANCES

- 1.) EFFICIENT SCREW
- 2.) "W" MIXER



## EFFICIENT SCREW DESIGN

INVENTOR: R. F. DRAY. FILED 05/05/1970 PATENTED 03/21/1972

ASSIGNED TO: FEED SCREWS, INC. & OWENS-BROCKWAY, INC.  
PATENT # 3,650,652

UNIQUE AREAS LEAD CHANGED AT END OF FEED SECTION TO A LONGER LEAD WITH AUXILIARY CHANNEL BEING FORMED BY INCREASED LEAD. SOLID BED STAYED INTACT AS NORMAL WIDTH OF CHANNEL STAYED THE SAME. AUXILIARY CHANNEL IS USED ONLY TO MAINTAIN CONTINUITY IN THE MELT FILM, NOT AS A MELT SEPARATION DEVICE.



## "W" MIXER DESIGN

INVENTOR: R. F. DRAY. FILED 09/15/1972 PATENTED 01/29/1974

ASSIGNED TO: FEED SCREWS, INC. PATENT # 3,788,612

UNIQUE AREAS FIRST DISPERSIVE/DISTRIBUTIVE MIXER TO UTILIZE BI-DIRECTIONAL FLOW TO AID IN DISTRIBUTIVE MIXING AND SELF-CLEANING, FIRST MIXER TO UTILIZE CHANNEL, NARROWING BY TAPERING THE CHANNEL DEPTH WITH A BALL END MILL.

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DSB2

INVENTOR: N. C. WHEELER FILED 08/27/1980 PATENTED 07/27/1982

ASSIGNED TO: NOT ASSIGNED. PATENT # 4,341,474



NOTE: THIS IMPROVEMENT PATENT ATTEMPTS TO JOIN THE MAILLEFER AND DRAY TECHNOLOGIES THE FORMATION OF THE AUXILIARY CHANNEL IS THE SAME AS DRAY, THE INCREASED LEAD OF THE BARRIER FLIGHT IS SIMILAR TO MAILLEFER. THE ONLY DIFFERENCE FROM MAILLEFER IS THE SECONDARY AUXILIARY LEAD FOR CLOSING OFF THE PRIMARY CHANNEL. IT IS INTERESTING TO NOTE THAT THIS PATENT WAS NEVER ASSIGNED TO DAVIS STD AS WHEELER WAS AN EMPLOYEE OF DAVIS STD

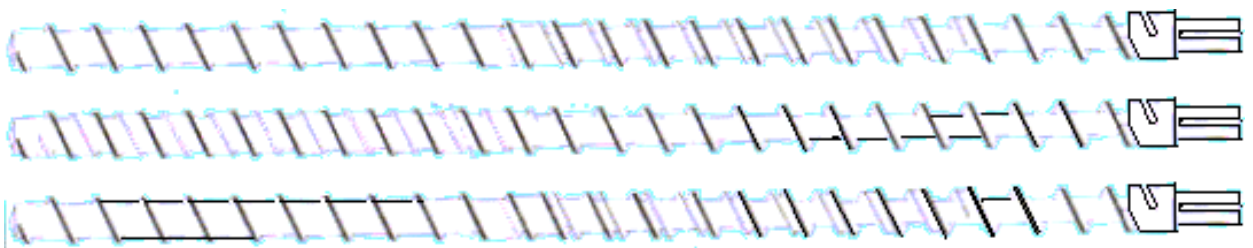
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## 1970 – 1975

BASIC PATENT

NEW ADVANCES

1.) SCHIPPERS



SCHIPPERS DESIGN

INVENTOR: H. SCHIPPERS FILED 04/07/1971 PATENTED 10/31/1972

ASSIGNED TO: BARMAC BARMAC MACHINE NFA BRICK. PATENT #  
3,751,512

UNIQUE AREAS THIS PATENT SHOULD HAVE BEEN THREE SEPERATE PATENTS AS THREE ARE THREE UNIQUE FEATURES.

1.) MELT SEPERATION DESIGN. IN THIS VERSION THE PROMATY CHANNEL SHALLOWS AS THE AUXILIARY CHANNEL, DEEPENS, THE BARRIER CLEARANCE IS APPROXIMATELY TWICE THE SCREW TO BARREL CLEARANCE-

2.)`DISPERSIVE/DISTRIBUTIVE MIXER DESIGN IN THIS VERSION THE FLIGHT DEPTH IN THE PRIMARY CHANNEL IS CONTINUOUSLY VARYING FROM MINIMUN TO MAXIMUN AS THE AUXILIARY CHANNEL IS VARYING FROM MAXIMUN TO MINIMUN VALUES. THIS ENCOURAGES THE MATERIAL TO CROSS THE BARRIER IN BOTH UPSTREAM AND DOWNSTREAM DIRECTIONS REPEATEDLY.

3.) DISTRIBUTIVE MIXER DESIGN. TRANSPOSTION OF PRIMARY FLIGHT TO AUXILIARY FLIGHT TO FACILITATE MATERIAL MOVEMENT FROM PRIMARY TO AUXILARY FLIGHT. THE CLEARANCE ( FOR EXAMPLE) OF THE PRIMARY FLIGHT WHILE DECREASING FLIGHT ARE TRANSFERED TO THE AUXILIARY FLIGHT. THE FORWARDING OR PUSHING CAPABILITIES OF THE PRIMARY FLIGHT ARE TRANSFERRED TO THE AUXILARY FLIGHT THE MATERIAL IN THE PRIMARY CHANNEL CO-MINGLES WITH THE MATERIAL IN THE AUXILARY FLIGHT.

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**1980 – 1985**

BASIC PATENT

NEW ADVANCES

## 1.) TRIANGLE MIXER



### TRIANGLE MIXER DESIGN

INVENTOR: R. F. DRAY FILED 06/28/1982 PATENTED 04/24/1984

ASSIGNED TO: NOT ASSIGNED. PATENT # 4,444,507

UNIQUE AREAS THE FIRST DISTRIBUTIVE MIXER THAT DIVERTED FLOW FROM THE TRAILING SIDE OF THE FLIGHTS TO A GROOVE, MAINTAINING CROSS-SECTIONAL AREA OF PRECEDING CHANNEL THROUGHOUT THE DEVICE.

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## 1985 - 1990

### BASIC PATENT

#### NEW ADVANCES

- 1.) CONCEPT DESIGN
- 2.) REVERSE FLOW MIXER
- 3.) ADJUSTABLE DAM



### CONCEPT DESIGN

Inventer R. F. DRAY FILED 02/05/1988 PATENTED 01/30/1990

ASSIGNED TO NOT ASSIGNED PATENT# 4,896,969

UNIQUE AREAS FIRST TO ESTABLISH THE MELT FILN IN THE AUXILIARY CHANNEL INDEPENDENT OF THE PRIMARY CHANNEL.



### REVERSE FLOW MIXER

Inventer R. F. DRAY FILED 09/16/1987 PATENTED 06/27/1989

ASSIGNED TO NOT ASSIGNED PATENT# 4,824,414

UNIQUE AREAS FIRST DESIGN TO UTILIZE REVERSE FLOW TO IMPROVE HEAT TRANSFER.



### ADJUSTABLE DAM DESIGN

Inventer R. F. DRAY FILED 02/17/1987 PATENTED 02/09/1988

ASSIGNED TO NOT ASSIGNED PATENT# 4,723,847

UNIQUE AREAS FIRST DESIGN TO INTERNALLY ADJUST PRESSURE THROUGH A MOVABLE RESTRICTOR IN THE SCREW CHANNEL.

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## 1995 - 2000

### BASIC PATENT

#### NEW ADVANCES

- 1.) INTERRUPTING LEADS FOR MIXING
- 2.) REVERSE FLOW MIXER
- 3.) ADJUSTABLE DAM



### CONCEPT DESIGN

Inventer R. F. DRAY FILED 02/05/1988 PATENTED 01/30/1990

ASSIGNED TO NOT ASSIGNED PATENT# 4,896,969

UNIQUE AREAS FIRST TO ESTABLISH THE MELT FILN IN THE  
AUXILIARY CHANNEL INDEPENDENT OF THE PRIMARY CHANNEL

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